Design and Research of Intelligent Products for the Management of Chronic Diseases of the Elderly

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Abstract. This paper aims to explore the design of intelligent products based on the needs of elderly users. Based on the existing literature results, the possibility of design intervention in the management of chronic diseases of the elderly was proposed, and the general characteristics and behavioral characteristics of the elderly users were studied by questionnaire method, the acceptability and subjective attitude of the elderly in using intelligent products and services were found, and the survey results were analyzed by mathematical statistics. The results showed that older people who considered it necessary to record physical data were higher than those who did not. With the increase of education, the proficiency of using mobile phone also increases; According to the elderly's score of functional needs, the function with the highest score is automatic detection, followed by automatic analysis, remote consultation, diet therapy and community communication. Finally, based on the questionnaire survey results, this paper developed the design practice of intelligent medical products for hypertension, a common chronic disease of the elderly, and proposed the design strategy of intelligent products and services for chronic disease management of the elderly.

Keywords: Chronic disease management · Smart product design · Smart endowment

1 Introduction

As of December 2018, China had 140 million elderly people aged 65 or above, accounting for about 10.5% of the country's total population, according to official data. China has entered a serious aging society. At the same time, researchers from the Chinese center for disease control and prevention published survey data showing that 75.8% of Chinese people aged 60 and over suffer from one or more chronic diseases, and one suffers from multiple chronic diseases. Common chronic diseases mainly include cardiovascular and cerebrovascular diseases, cancer, diabetes, chronic respiratory system and other diseases. Among the Chinese residents aged 60 and above surveyed, 58.3% had hypertension, 19.4% had diabetes and 37.2% had dyslipidemia. To enrich the supply of smart health service products for the elderly, the development

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of health management wearable devices, portable health monitoring equipment, chronic disease monitoring equipment, home service robots and other smart home products and services will become a real demand. The reality is that at present, the research on intelligent products for the management of chronic diseases of the elderly in China is still in its infancy, and the existing intelligent products do not fully consider the functional needs, cognitive styles, behavioral patterns and experience needs of the elderly user group. With the aggravation of the aging of Chinese society, it is urgent to carry out the research on intelligent products for the management of chronic diseases of the elderly under the background of smart pension. And the elderly due to the decline of body functions and a reduction in the ability to follow up study, presents the particularity of different from the general population, led to the elderly in the use of smart home products produced in cognition, understanding, decision-making, implementation, feedback in the process of friction, resulting in inaccurate operation, switch function is not smooth, information is not natural, and a series of related to products and services system function, operation, design problem of the experience of the interactions, thus deepening the intelligent products and digital divide between older users.

At present, China is implementing a scientific and technological old-age care plan in line with its national conditions, which requires the use of information technology and the Internet to achieve efficient and high-quality old-age care management, so as to basically form a old-age care industry system covering the whole life cycle by 2020. Hope to introduce the pension services of the Internet, use the Internet for information exchange, information processing, data storage, information maintenance, big advantages of data mining, make the old man in the life care, health management, health care get personalized service, so that it can help pension institutions, community greatly enhance management efficiency, and makes the endowment satisfaction greatly improved. In 2019, the state issued the “healthy China action (2019-2030)”, in Chinese action to promote health committee held in Beijing on July 29, 2019: are mentioned in the press conference of elderly health promotion action advocated the elderly themselves well slow disease management, delay condition, reduce the complications, at the same time, encourage and support enterprises by taking advantage of information technology, such as “Internet+” developing wearable healthy elderly support technology and equipment, etc. This greatly supports the development and promotion of new intelligent products.

2 Background

2.1 Chronic Diseases of the Elderly in China

With the development of society, the degree of population aging is getting deeper and deeper, and the elderly group as a special social group is gradually enlarged. With the increasing degree of population aging, the disease burden of the elderly population caused by age-related chronic non-communicable diseases (chronic diseases) will continue to increase [1]. Disability adjusted life year (DALY) is the total number of years of healthy life lost from onset to death, including YLL due to premature death and YLD due to illness. DALY is a comprehensive measure of quantity of life and quality of life in terms of time [2]. DALYs comprehensively analyzed the incidence, disability and death of the disease [3]. In China, the prevalence of chronic diseases in the elderly is as high as 71.8% [4], and 51.3% of DALYs is caused by health problems in the elderly aged $\geq$ 60 years. Chronic diseases cause 178.91 million DALYs in the elderly, accounting for 92.7% of the total disease burden of the elderly [5]. In the elderly group, the common chronic diseases are hypertension, cervical spondylosis, diabetes, arthritis and so on.

2.2 Design the Possibility of Intervening in the Management of Chronic Diseases of the Elderly

With the increasing incidence of chronic diseases, chronic diseases have become one of the major concerns of the medical industry [6]. Traditional medical treatment has been unable to meet the needs of our aging chronic disease treatment and rehabilitation control [7]. The development and popularization of intelligent products bring the dawn to solve these problems. The European Union, the United States, Canada, Japan and other developed countries have implemented the use of pervasive computing (UPC) and background intelligence (AmI) technology to assist the elderly in their daily lives at home since the 1990s. Functions include automatically detecting the elderly's independent completion of daily activities related to housework, and providing prompt or assistance when necessary. Medical care testing and environmental monitoring were conducted for the elderly, and automatic rescue and alarm were conducted in emergency situations (Gustafsson 2010). EMTapia (2004) believes that sensors can be applied everywhere in residential buildings, and simple and tiny sensing facilities can be designed to bring convenience to the life of the elderly. Zouba (2009) proposed that changes in daily activities (ADL) of elderly users should be intelligently monitored and analyzed to detect and treat health problems before they get worse. Wang Lin (2015), a Chinese scholar, conducted an investigation on the current situation of the use of information technology products by the elderly, as well as the functions and design requirements of the products. Xing Zhudi (2015) pointed out that smart home for the elderly needs to pay attention to special needs from health equipment, intelligent voice technology, intelligent detection and other aspects, and fit the functions with the needs. Liu Shulao (2015) the elderly intelligent household property can be divided into interaction and support attribute, interaction properties including operability, visual perceptual, representative, situation, spatial interaction and social interaction six classes, support properties include mathematical degree, barrier-free supportive, safety, convenience, the sensory function of self control and promote. However, current smart products attach great importance to "intelligence" and "high technology", and face more young people, while ignoring the "suitable aging" of smart products and services in specific applications [8].

In addition, China released the "healthy China action (2019-2030)" this year, and mentioned in the press conference of the healthy China action promotion committee held in Beijing on July 29, 2019: the health promotion action for the elderly advocates the elderly to manage chronic diseases, delay the disease and reduce complications, and encourages and supports enterprises to develop wearable health support technologies and devices for the elderly by using “Internet+” and other information technologies. Therefore, the use of intelligent products to intervene in the management of chronic diseases of the elderly has a great possibility. In the whole exploration process, several directions have been gradually formed: social service management, hardware management, software management, software and hardware combination, and network end system management.

2.2.1 Space for Design Intervention in Hardware Management Classes

Medical product hardware is generally used to detect relevant disease data or directly treat patients. Most medical product hardware will have direct contact with human body. Therefore, in the use of the process of contact with the human body to fully consider ergonomics and product usability design. After extensive research on medical products, this paper concludes that the main pain points in the hardware of medical products are: first, with the decline of physical quality and learning ability of the elderly, bulky and complex hardware products are no longer suitable for the elderly group. At present, most medical products on the market are too specialized in appearance and function, which cannot well meet the cognitive and aesthetic needs of the elderly. In addition, the product features complex operation, many buttons, the partition is not scientific and reasonable, bringing some obstacles to the elderly users; Second, due to the large size of some medical products hardware, in the storage process will take up more space, it is not convenient to carry; Third, there are different medical products hardware for the same chronic disease, while there are few products specially designed for the elderly, so there is not enough space to choose.

Therefore, there is still a lot of room for development in medical product hardware design, including product interaction mode, humanized emotional design and other contents. But also products have begun to explore in this field at present. The product form can better reflect the product function. The cuff is used for collecting physiological data and controlling the subject for data processing and transmission. The product can better meet the operation mode and function of the elderly group.

2.2.2 Space for Design Intervention in the Software Management Class

A growing number of mobile applications software products applied to the management of chronic diseases. However, there are still some design breakthroughs at present. First, although the whole medical treatment process system is relatively complete, the tracking of postoperative recovery, especially the tracking of chronic diseases, mainly relies on the traditional follow-up, which still has great deficiencies in software functions, which will be the entry point for future design intervention. Second, the current product interface information structure design is not reasonable, the product usability is insufficient, coupled with the elderly for the intelligent product operation is not skilled lead to the decline in information acceptance, will also become a breakthrough in software design; Three is that of a software product visual design can not fully meet the aesthetic and cognitive of older users, such as font, font size, color and symbol design, the optimization of visual elements to improve the operation of older users experience.

2.2.3 Design Intervention Space in the Combination of Hardware and Software

The combination of hardware and software is a popular way at present, that is, medical products hardware and supporting software complement each other to jointly prevent and manage chronic diseases. In the combination of hardware and software, there are several points worth paying attention to: First, emotional design of medical products for the elderly, the hardware is a cold instrument, how to bring the elderly a warm feeling through the combination of hardware and software. Second, the way hardware and software interact will be a breakthrough in design. That is, what functions are implemented by hardware and what functions are implemented by software, the interaction between the two also needs to be designed. In addition, because the elderly are slow to accept new things, shortening the strangeness between the product and the elderly through design will make the product win in the competition. How to integrate the product into the life of the elderly naturally is also the breakthrough point of design.

3 Methods and Processes

3.1 Questionnaire Design

Based on the preliminary basic research, this paper will carry out the design and research of intelligent products for the management of chronic diseases of the elderly. In order to study the demand degree of chronic diseases management of the elderly, the experience of using intelligent products and the management form of chronic diseases of the elderly, this experiment adopts the questionnaire method to carry out the design and research. In the process of setting up the questionnaire, reference was made to relevant literature on chronic diseases of the elderly. A total of 20 questions were set in the questionnaire, including chronic diseases monitoring of the elderly, attitudes to recorded data, personal daily living habits and other aspects.

3.2 Questionnaire Distribution and Collection

Six major cities in China, including nanjing, Shanghai, Xi'an, Shenzhen, Jinan and Shenyang, were selected according to the comprehensive factors of urban economic development level, geographical location and city type. A total of 105 questionnaires were distributed online, of which 35 were filled by the elderly themselves and 70 were filled by their children according to the actual situation.

19 invalid questionnaires were removed, leaving 86 valid questionnaires, with an effective rate of 81.9%.

The gender ratio and age distribution of users are reasonable, which can provide a reasonable basis for the questionnaire results. After the questionnaire was collected, SPSS software was used for data statistics and analysis.

4 Research Results

4.1 Analysis of the Needs for Chronic Disease Management of the Elderly

According to the analysis of the independent sample T test, as shown in Table 1, there are significant differences in the degree to which the elderly who record data consider it necessary to record data. The significance (double-tail) is 0.001 and 0.000 respectively, both less than 0.05.In daily life, the data records statistics is recognized by the majority elderly and there is indeed a need for data records. However, 64.26% of the elderly only performed data recording due to various reasons, such as inconvenient recording and unknown how to analyze after recording.

Table 1. Independent sample T test for recording data and necessity of recording data

	Levin's variance equality test		Mean equality t test		Mean equality t test				
	F	Significance	t	Degree of freedom	Significance (two-tailed)	Mean difference	Standard error difference	Difference 95% confidence interval lower limit	Difference 95% confidence interval upper limit
Assume that such variance	7.210	.010	3.448	56	.001	.860	.249	.360	1.360
The equal variance is not assumed			8.686	49.000	.000	.860	.099	.661	1.059

As can be seen from the analysis in Table 2, the significance value of the education level of the elderly and the degree of necessity of recording data is 0.723, greater than 0.05, so there is no significant difference. We cannot reject the former hypothesis: the elderly with all education levels feel it necessary to record data. The homogeneity test of variance showed that the significance was 0.102 greater than 0.05, so multiple comparative analysis was unnecessary.

Table 2. ANOVA

	Sum of squares	Degrees of freedom	The mean square	F	Significant
Between groups	.299	2	.150	.326	.723
Within the group	25.218	55	.459		

To test the old design demand in the area of chronic disease in statistical measurement data, necessity will be divided into three levels: almost no need, general and special necessary need, shown in Table 3, Among them, 23.3% think it is almost unnecessary to count chronic diseases, and 50% think it is generally necessary, and 26.7% think it is necessary to special old man. Therefore, it is proved that the elderly pay more attention to the necessity of chronic disease measurement data recording and have design requirements.

Table 3. Statistical necessity scale for the elderly

	Frequency	Percentage	Effective percentage	Cumulative percentage
Hardly necessary	20	23.3%	23.3%	23.3%
Generally necessary	43	50%	50%	73.3%
Especially necessary	23	26.7%	26.7%	100.0
Total	86	100.0%	100.0%	

Through observation and in-depth interviews, the functional requirements for chronic disease management of the elderly are divided into automatic detection, automatic analysis, remote consultation, community communication and diet therapy. Based on the elderly's score of functional requirements, descriptive statistics were made for the score, as shown in Table 4. The highest scoring function is automatic detection (M = 4.56, SD = 0.60), followed by remote consultation (M = 4.31, SD = 0.68), diet therapy (M = 3.93, SD = 0.89), automatic analysis (M = 3.68, SD = 0.91), and community communication (M = 3.56, SD = 0.99).

Table 4. Statistical necessity scale for the elderly

Functional requirements	N	Mean	Standard deviation	Standard error	95% confidence interval of the mean	
					The lower limit	The upper limit
Automatic monitoring	86	4.5625	0.6092	0.1523	4.2272	4.8978
Automatic analysis	86	3.6875	0.9164	0.2291	3.1832	4.1918
Remote inquiry and consultation	86	4.3125	0.6818	0.1704	3.9373	4.6877
Community exchange	86	3.5625	0.9980	0.2495	3.0132	4.1118
Diet diet	86	3.9375	0.8992	0.2248	3.4426	4.4324

4.2 Correlation Between the Use Experience of Smart Products and the Education/Experience of the Elderly

The research group conducted the correlation analysis of education background and experience in using intelligent products, and the correlation analysis of education background and whether medical intelligent products were used.

As can be seen from Table 5, 75.0% of the elderly with a bachelor's degree or above are proficient in using smart products, 51.1% of the elderly with a college degree are proficient in using smart products, and 28.5% of the elderly with a high school education or less are proficient in using smart products.

Table 5. Cross tabulation of education and experience in using smart products

Degree	No use at all	Inproficiency	General skilled	More skilled	Very skilled	Total
High school education or below	28.6%	42.9%	14.3%	14.2%	0%	100.0%
Junior college	10.5%	38.4%	41.1%	10.0%	0%	100.0%
Undergraduate or above	3.1%	21.9%	49.2.0%	25.0%	0.8%	100.0%

This indicates that the degree level is positively correlated with the proficiency of using smart products, and the higher the degree, the higher the proficiency of using smart products.

According to the chi-square test, as shown in Table 6, Pearson chi-square, likelihood ratio and linear correlation between the education background of the respondents and their experience in using intelligent products were 0.003, 0.002 and 0.001, respectively, all of which were less than 0.05.

Table 6. Chi-square test

	Value	Degree of freedom	Asymptotic significance (bilateral)
Pearson chisquare	19.592[a]	6	.003
Likelihood ratio (L)	21.478	6	.002
Linear correlation	11.304	1	.001
Number of valid cases	86		

As can be seen from Table 7, the proportion of the elderly with bachelor's degree or above who frequently use medical intelligent products is 14.3%, the proportion of the elderly with college degree who frequently use medical intelligent products is 21.0%, and the proportion of the elderly with high school education or less who frequently use medical intelligent products is 9.4%. The overall performance is that

Table 7. Cross-tabulates the frequency of education and use of smart products of medical type for the elderly

Degree	Never used	Rarely used	Occasionally used	Often used	Frequently used	Total
High school education or below	56.2%	25.0%	9.4%	6.3%	3.1%	100.0%
Junior college	21.1%	31.6%	26.3%	15.8%	5.2%	100.0%
Undergraduate or above	28.6%	28.3%	28.8%	14.3%	0%	100.0%

with the increase of education, the proportion of the elderly using medical intelligent products is increasing. With a high school education or below, the majority of people who seldom use medical smart products are not proficient in using smart products. A considerable proportion of the elderly can operate and use smart products under the guidance of others.

According to the chi-square test, as shown in Table 8, there is a linear correlation between the education background of interviewees and whether they use medical intelligent products, which is 0.02, less than 0.05.

Table 8. Chi-square test

	Value	Degree of freedom	Asymptotic significance (bilateral)
Pearson card square	10.708[a]	10	.381
Likelihood ratio (L)	12.637	10	.245
Linear correlation	5.385	1	.020

5 Design Practice

5.1 Design Concept

Based on the previous questionnaire survey results and combined with the cognitive ability and learning ability of the elderly, this paper designed a medical intelligent product for hypertension, a common chronic disease of the elderly, for the elderly over 60 years old who can use smartphones independently.

The product is divided into two parts: hardware and software. The hardware part mainly collects blood pressure data, wears it on the upper arm, and measures blood pressure at any time. The data is uploaded to the mobile phone through bluetooth, enabling the elderly to view timely data and relevant data analysis in the APP. Through the “power switch”, “start”, “end” simple keys to achieve the measurement of blood pressure, the basic need for assistance, easy to operate.

5.2 Functional Design

The software APP is mainly composed of 4 parts, as shown in Fig. 1. The first part is data statistics and analysis. Most elderly people do not record data due to the tedious recording of data. Second, emergency call for help. Patients can call their children or other guardians with one key after their condition suddenly intensifies and they take medicine to stabilize their condition. The third is the function of doctor's advice, showing the doctor's suggestions for the treatment of patients, etc., which can be checked at any time to prevent forgetting; The fourth is related to hypertension text, video recommended, with voice reading function.

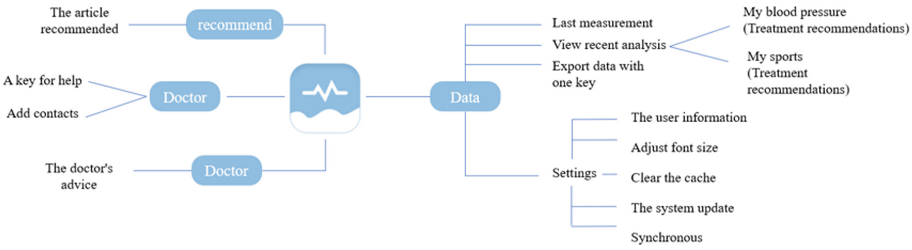

Fig. 1. Software function design

Let the intelligent medical products really integrate into life and play their due roles, instead of being a burden to use.

5.3 Software Interface Design

The overall interface is simple and adopts graphic design to reduce the cognitive burden of information receivers. The interface displays the latest measurement data, and red and blue represent different blood pressure values. When red values appear, abnormal blood pressure is indicated. At the same time, in the interface designed for the elderly, the font size is larger, such as the key call interface design. In addition, the color contrast in the interface is relatively strong, the graphical language is relatively rich, and the use of the product conforms to the operation habits of the elderly (Figs. 2 and 3).

Fig. 2. Software interface design 1

Fig. 3. Software interface design 2

6 Discussion and Conclusion

With the improvement of living standards and the widespread use of electronic technology products, more and more elderly people are learning to use smart products. According to the above data analysis, with the increase in education level of elderly people, their proficiency in using mobile phones is also increasing. However, among the respondents, the vast majority of the elderly have a high school education or lower, and they are more worried that they will not use smart technology products. With the growth of age, the physical function and learning ability of the elderly group decline, and they are unable to skillfully use smart products. Part of the reason is that the products themselves are not designed properly and cannot adapt to the operation habits of the elderly group. Therefore, the operation mode of smart products is more convenient and the interaction mode is more direct. The elderly group can use smart products autonomously with less time.

In terms of product functions, the management of chronic diseases can establish a bottom-up level of “seeing – insight – foresight” intelligent services, including: first, “seeing” the daily posture activities of the elderly and displaying the daily activity information and data of the elderly in a visual form. For example, for old people with heart disease, it can transform the sleeping position, body language such as movement through intelligent mattress monitoring the elderly, forming the number of times the elderly get up at night, body weight, sleep in the body such as heart rate, breathing frequency data, and displayed on the terminal equipment, in the form of visualization for doctors, children in a timely manner to understand the elderly health and sleep patterns, preventing incidents, forming a closed loop of sleep detection - sleep analysis - professional consultation.

Second, “insight” and analysis of the elderly body language data, adaptive response and intelligent processing; For the elderly users with arthritis and hypertension, falling can not only seriously damage the elderly’s ability to move, but also cause the elderly to have tension, anxiety, depression, irritability and other psychological disorders. In terms of fall and fall prevention technology, a variety of technical solutions are currently being studied, some of which are to install sensors on the floor, when the old man falls down, the instrument will alarm; There are infrared sensor or camera, according to the attitude of the elderly to determine whether there is a fall. Sensing devices equipped with the elderly will be active alarm, according to the walking posture to determine the state of the fall.

Third, according to the reasonable action effect of the elderly to “foresee” the behavior results, take the initiative to recommend the service information. The smart nursing technology products integrated with medical, psychology, ergonomics and other professional knowledge can not only monitor the physical condition of the elderly for early monitoring and early warning, but also predict the health risks of the elderly through the accumulation of big data, or provide medical reference. Equipped with an electronic blood pressure meter with data transmission function, the blood pressure data of the elderly can be automatically uploaded to the data platform as long as the elderly take blood pressure measurement without any other operation, and the children and caretakers of the elderly can timely check the blood pressure data and various warning information of the elderly. It can monitor its health status in real time by means of wearing and implanting. For example, “wearable ecg monitoring suit” can monitor the elderly’s heartbeat frequency and other health information in real time and continuously, and cooperate with the corresponding expert system and service system to achieve effective chronic disease management and risk management.

In terms of product interaction, body language shows a dynamic evolution trend according to age. For example, older people compared to the general user community of body language, facial expressions, head movements and gestures in sports, arm and hand movement, leg and foot movement etc. There is a big difference in these aspects. So the attitude of the behavior type and transformation rules, the relationship between behavior and space will be changed, therefore, intelligent product design for elderly users need to pay attention to: one is that targeted mapping between function and the function of the body of the elderly. Second, is that targeted mapping among the product interaction form, low attention, situational interaction semantics with the elderly cognitive patterns and interactive habits; Third, the product captures, transforms and explicitly expresses the implicit and empirical body language of the elderly, which will more effectively provide a basis and breakthrough point for innovative design. For example, provide certain visual operation clues and effective guidance to help users quickly understand the operation skills; The fourth is to reduce the difficulty of operation and design according to the behavioral ability of the elderly, so that the product brings real convenience to the user group.

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