

Diseases spectrum of older patients: An age stratified analysis in a new model of Telemedicine

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Research article

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Abstract

Background: Medical service for the older patients is a worldwide challenge for the public health system. Telemedicine is the new development of traditional clinical medicine and can provide an innovative method of medical services for the older adults and effectively solve the problem. A new model of telemedicine jointly performed by general practitioners and specialists in a university teaching hospital has been established. Different from the existing telemedicine models that had been widely adopted, it provides a solution for the key issues in telemedicine where a doctor is unable to conduct a direct physical examination and the associated diagnostic error. The joint telemedicine center is supported by multi-disciplinary medical experts of a university teaching hospital and supervised by the government health administrative department which ensures the quality of medical practice.

Method: The aim of the study is to perform age stratified analysis of disease spectrum of older patients receiving telemedicine and determine the main diseases in different age groups of older patients. 472 older patients (aged ≥ 60) were enrolled and divided into the young older group (aged 60 to 74), the old older group (aged 75 to 89) and the very old group (aged ≥ 90) according to the new age stratification of older people defined by World Health Organization. Proportion of the top 10 diseases of older patients of different age groups was analyzed.

Results: Coronary heart disease and type 2 diabetes mellitus were identified as the top two diseases in the older patients and the young older patients as well as the old older patients receiving telemedicine.

Conclusions: The new model of telemedicine can provide convenient and efficient medical services for older patients and overcome the disadvantage of currently used models of telemedicine. Different disease spectrum characteristics were identified in different age groups of older patients receiving telemedicine. Coronary heart disease and type 2 diabetes mellitus were found as the main diseases of the older patients receiving telemedicine. The results of this study will provide basis for the health administrative departments to formulate health policies for older patients.

Introduction

Medical service for the older patients is a worldwide challenge for the public health system. Telemedicine can provide medical service for older patients. Evaluation of the efficiency, cost, and patients' and caregivers' acceptance of telemedicine in older population had been conducted.^[1] The importance of telemedicine in the diagnosis and treatment of ailments in older patients has attracted ever increasing attention.^[2] Research on the feasibility, acceptability, and effectiveness in providing telemedicine to the older patients has been widely carried out.^[3, 4] A new model of telemedicine has been established in Shanghai. The key innovation of this new model is the telemedicine was conducted jointly by general practitioners (GP) in community health centers and specialists in a university teaching hospital via the Internet. Unlike the typical telemedicine that has been practiced in other countries, the new model provides a solution for the key issues in telemedicine where a doctor is unable to conduct a direct

physical examination and the associated potential diagnostic error. The joint telemedicine center is supervised by the government health administrative department which ensures the quality of medical practice. The new joint telemedicine center can also carry out tele-continuing medical education. However, disease spectrum in the older patients of different age groups receiving telemedicine is not well characterized. This study aims to perform age stratified analysis of disease spectrum and determine the main diseases that need to be focused in different age groups of older patients in the super city of 24 million people. The population of the elderly has reached 5.0328 million in Shanghai. The disease spectrum of the elderly patients in such a big city with a large number of older people is definitely different from that of the developed countries. Therefore, it is necessary to analyze the disease spectrum of older patients in Shanghai.

Methods

A consecutive sample of 552 patients (aged 18 to 98) visiting the joint telemedicine center in a university teaching hospital was investigated. Among them, 472 older patients (aged ≥ 60) were enrolled (mean age 75.14 ± 8.72 years old). According to the most recent age stratification for older people as defined by World Health Organization (WHO), they were divided into the young older group (aged 60 to 74), the old older group (aged 75 to 89) and the very old group (aged ≥ 90). All diseases of patients were classified according to International Classification of Diseases-10 and each patient was classified according to the first diagnosis of the older patient applying for telemedicine. The proportion and gender differences of the major diseases and the top 10 diseases in older patients of different age groups when receiving care via telemedicine for the first time were analyzed. Gender, age, disease diagnosis, disease composition and ranking of all patients were recorded and analyzed. The protocol for this research project has been approved by the Ethics Committee of Shanghai Municipal Eighth People's Hospital and the approval number is 2019-006. It conforms to the provisions of the Declaration of Helsinki in 1975 (as revised in Edinburgh 1983). Informed, written informed consent was obtained from every participant.

By using the IBM SPSS Statistics Version 20.0 (IBM Inc., Chicago, USA), statistical analysis of the study data was performed. Continuous variables were analyzed by Student's t-test and expressed as the mean \pm standard deviation ($\bar{x} \pm s$) or median and interquartile range. Categorical variables were analyzed by chi-square test or Fisher's exact test. p value < 0.05 was considered statistically significant.

Results

The older patients (aged ≥ 60) accounted for 85.51% (472/552) of all applicants for joint telemedicine. The young older patients and the old older patients accounted for accounted for the highest proportion (48.7% and 44.7% respectively) of the older patients. There are gender differences in the young older patient group. See Table 1. Coronary heart disease ($n=68$, 14.4%) and Type 2 diabetes mellitus ($n=68$, 14.4%) were found to have the highest rate in older patients receiving telemedicine and the constituent ratio of these two diseases were the highest, followed by Chronic kidney disease (CKD), and cerebral infarction and hypertension. The constituent ratio of these five diseases was 14.4%, 14.4%, 10.2%, 8.5%,

and 7.0%, respectively. Coronary heart disease and Type 2 diabetes mellitus were the top two diseases in the older patients applying for joint telemedicine. See Table 2.

After age stratified analysis, Type 2 diabetes mellitus and coronary heart disease were found to be the top two diseases in the young older patients applying for joint telemedicine. See Table 3. Coronary heart disease and Type 2 diabetes mellitus were found to be the top two diseases of the old older patients applying for telemedicine. The constituent ratio of these two diseases was listed in Table 4. Disease spectrum and constituent ratio of major diseases of the very old patients applying for joint telemedicine were shown in Table 5.

Discussion

Prevention of diseases in the elderly is more important than treatment. Telemedicine may become the main way for the older patients to seek medical advice in the future. It is of great value to clarify the characteristics of disease spectrum of older patients in order to determine the focus of prevention of the key diseases. There are significant differences in the physiological functions of the older patients of different ages. Therefore, we performed age stratified analysis of disease spectrum characteristics of three age groups of older patients according to the new age stratification of older people defined by WHO.

It has been reported that telemedicine is feasible and acceptable in providing medical services to older patients and clinicians should apply telemedicine in daily practice to overcome the barriers of distance and access to medical services.[4] Telemedicine could close the gap for older patients who are unable to go to hospital in time. Shah MN, et al. found emergency care enhanced by telemedicine is an acceptable way to provide emergency care to the elderly in senior living communities.[5] In our study, older patients accounted for the majority of applications for telemedicine which showed that older patients have a great demand for telemedicine. Telemedicine has been used to monitor older patients with high-risk chronic heart failure for an early evaluation of signs and symptoms of acute decompensation.[1] The use of telemedicine as telehealth interventions has been used to improve medication adherence in older patients with heart failure.[6] Since the mode of telemedicine in other countries rely upon a direct communication between a doctor and a patient via the Internet but the doctor would be unable to give the patient a direct physical examination, it may lead to diagnostic errors. In our study, the new model of telemedicine jointly performed by general practitioners and specialists has been applied to provide medical services for older patients. This practice has been proved as an efficient telemedicine model for older patients and can be extended to the rest of the world.

The application of telemedicine in home health monitoring can help self-management of the older patients with chronic disease. Recent studies have found that low adherence to recommendations is one of the causes of unsatisfactory results of chronic heart failure treatment in older patients.[7] In our study, it was found that the new model of joint telemedicine can make the older patients strictly carry out the doctor's orders. This is because the medical orders were issued by specialists and then supervised by general practitioners. Therefore the compliance of the older patients was significantly improved.

Telemedicine can greatly shorten the space distance that older patients need to cross and reduce the time it takes to see a doctor. It was found that older patients are more satisfied with their health care than younger patients and in the oldest cohorts, are at high risk for passive relationships and communication complications related to low literacy and poor health status.[8] Clinicians should be familiar with the disease spectrum characteristics of older patients of different age group. Acquaintance of the differences of the disease spectrum of older patients of different ages may provide clinicians an opportunity to take timely measures to improve outcomes.

Telemedicine has been successfully applied in some medical professions and can be used as a useful way to provide much-needed intensive behavioral therapy in remote and resource-poor environment.[9] The way of applying telemedicine to serve patients' mental health can widen the channels of seeking medical treatment for elderly patients.[10] In recent years, the incidence of various psychiatric illnesses has increased significantly in the elderly. The psychotherapy provided by telemedicine for senile depression patients was found to be superior to that provided in the physician's office and it can be used to overcome the nursing obstacles related to the distance of older patients.[11] The use of telemedicine in monitoring and managing mental health of older patients will be a new attempt in the application of telemedicine in the management of chronic diseases in the older people.

In this study, it was found that the constituent ratio of coronary heart disease and Type 2 diabetes mellitus accounted for the highest proportion (14.4% and 14.4%, respectively) of the older patients (aged ≥ 60) applying for telemedicine. This is largely because, with the development of aging of human society, the incidence of coronary heart disease, Type 2 diabetes mellitus and other geriatric diseases gradually increased with the increase of the age of the older people. At the same time, this is also related to the dietary habits with the higher content of sugar, fat and cholesterol in Shanghai. In recent years, the incidence of obesity in middle-aged people has increased significantly. As one of the main risk factor for Type 2 diabetes, obesity plays an important role in the increase of the incidence of Type 2 diabetes.

Taddei CF, et al. Found that hypertension was the most common reason for a medical appointment in older patients with cardiovascular disease.[12] Similarly, in our study, hypertension was found to be one of the top five diseases in the old older patients and the very older patients. The constituent ratio of hypertension of the old older patients applying for telemedicine was 9.5%.

Telemedicine has been widely used in the health care of older patients in the city community and remote areas. Suburbs of American cities have difficulties to provide health care to older adults and the use of telemedicine can help solve the problems of delivering health care services to rural older patients.[13] It has been reported that telemedicine can be an appropriate way to provide medical services to older patients more efficiently in order to prevent vascular diseases and other complications.[14] Compared with health care in urban areas, health care in rural areas often faces problems such as shortage of medical specialists, facilities with inferior equipment and insufficient resources. In France, a telemedicine experiment was carried out to favor access to care for disabled older people.[15] In our study, a new model of telemedicine was applied to provide medical services and health care for older patients. The

advantage of this new model stems from the fact that, the older patient was initially examined and diagnosed by a GP in the community health center. If the patient's condition is complex, GP will contact specialist in large general hospital via the Internet and carry out joint tele-diagnosis and tele-treatment with the specialist. Subsequently, the patient may be transferred to large general hospital for further treatment. Apparently, the new telemedicine mode is advantageous compare to the commonly used model of telemedicine in the developed countries, where the consultation and diagnosis are conducted directly between one patient and one doctor alone through the Internet without being able to perform a physical examination of the patient, which may lead to difficulties in making a correct diagnosis, or even result in misdiagnosis.

Telemedicine can reduce medical expenditure and meet the growing demand for health care of the elderly. In the new model of telemedicine of this study, the cooperation of general practitioners and specialists made it possible that older patients can enjoy expert diagnosis and treatment in the communities where they live. After the joint tele-diagnosis and tele-treatment, older patients can refer to the large-scale general hospital for further treatment according to the recommendations of specialists. And specialists in general hospitals and general practitioners share information on patients' diagnosis and treatment through Internet, including patient's medical history, health records, laboratory test results. They have broken the time and space constraints, realized the professional guidance and technical support of the specialists to general practitioners online. The practice of the innovation has proved it is an effective telemedicine model for older patients and can be extended to other countries and regions.

Telemedicine has become a new way to improve the diagnosis and treatment level of general practitioners in primary medical institutions and to meet the growing demand for health care for the elderly. It can provide more reliable, professional, efficient and convenient medical services for the older patients in the suburbs. Richard S, et al. found telemedicine was an effective way to improve accessibility and benefits of reducing the risk of intravenous tissue plasminogen activator treatment of older patients with severe ischemic strokes in rural areas.[16] In our study, it was found that cerebral infarction was the third of the top five major diseases in the young older patients and the fifth of the top five major diseases of the old older patients applying for telemedicine. It was also found that the constituent ratio of cerebral infarction ranked the third with a proportion of 8.5% in all older patients applying for the joint telemedicine. The joint telemedicine model can plays an important role in the treatment of older patients with cerebral infarction and can enable older patients to receive timely and effective treatment after cerebral infarction.

In this study, it was found the young older patients and the old older patients accounted for the highest proportion of the older people applying for telemedicine. This is associated with the rapid decline of the health status of the older people after they reach 60 years old and enter into a period of high incidence of diseases in their lives. Many diseases, such as diabetes and hypertension, occur in these age groups (aged 60 to 74 and aged 75 to 89).

In the US, it was found that the incidence rate of CKD increased dramatically in the older population in 1992–2005.[17] In our study, it was shown that the constituent ratio of CKD ranked the second proportion, accounting for 10.2% of the older patients (aged ≥ 60) applying for telemedicine. Through age stratification of the older patients, the constituent ratio of CKD ranked the third proportion (13.3%) of the old older patients and the fifth proportion (7.4%) of the young older patients applying for telemedicine. This is largely due to the rapid development of economy and the obvious improvement of living standards, which resulted in a significant increase in the morbidity of diabetes, hypertension and hyperuricemia in the older people during the past 30 years in Shanghai. These in turn led to the corresponding increase in the morbidity of diabetic nephropathy, hypertensive nephropathy, and uric acid nephropathy. These diseases will eventually develop to the stage of chronic renal insufficiency which contributes to an increase of the incidence of CKD.

Telemedicine can improve the experience of older patients. In the joint telemedicine of this study, the cooperation of general practitioners and specialists made it possible that older patients can enjoy expert diagnosis and treatment in the communities where they live and there's no need to go to the large-scale general hospital. After the joint tele-diagnosis and tele-treatment, older patients can be referred to the large-scale general hospital for further treatment according to the recommendations of specialists. In the new model of joint telemedicine, specialists in general hospitals and general practitioners share information on patients' diagnosis and treatment through the Internet, including patient's medical history, health records, laboratory test results, Computed Tomography (CT) and magnetic resonance imaging (MRI) images. It allowed professional guidance and technical support of the specialists to general practitioners online beyond the time and space constraints.

The potential contribution of telemedicine to the reduction of mortality or morbidity, and in reducing the occurrence of hospitalization is currently being evaluated and their impact to health economics is also being validated.[18] In our study, due to the application of joint telemedicine, the timely diagnosis and treatment of the older patients by the experts of large-scale general hospital were achieved and the probability of hospitalization of the older patients was reduced. The mortality rate of the older patients was also decreased.

Additional progress has been made in the application of telemedicine in other fields of medical services. For example, a primary care group diabetes care program using telemedicine achieved better diabetes control as measured by the 2-hr hemastix.[19] In France, the economic and social benefits of telemedicine solutions had been studied and telemedicine projects concerning the elderly is highly value.[20]

In this study, we found that cardiovascular diseases and metabolic diseases have become the main diseases for older patients to apply for telemedicine. This is because with the gradual improvement of the material and cultural living standards of the elderly, the rapid development of medical and health care, and the popularization of personal health habits, infectious diseases are not the main diseases of the elderly. Instead, cardiovascular diseases and metabolic diseases have become the main diseases of the elderly.

Now, 5th generation mobile networks technology (5G) has been officially commercialized in Shanghai. We will develop wireless mobile telemedicine platform based on 5G Technology. With the further development of internet technology, telemedicine will be widely used in more extensive medical fields. We plan to carry out tele-surgery + 5G, tele-ultrasound examination + 5G, and tele-ECG monitoring technology in the near future. This study clarified the characteristics of the disease spectrum in the older patients applying telemedicine and will help the prevention of different key diseases in different age groups of older patients.

Conclusion

The new model of telemedicine can provide convenient and efficient medical services for older patients and overcome the disadvantage of currently used models of telemedicine. Different disease spectrum characteristics were identified in different age groups of older patients receiving telemedicine. Coronary heart disease and type 2 diabetes mellitus were found as the main diseases of the older patients receiving telemedicine. The results of this study will provide basis for the health administrative departments to formulate health policies for older patients.

Abbreviations

GP, general practitioner; WHO, World Health Organization; CKD, Chronic kidney disease; CT, Computed Tomography; MRI, Magnetic resonance imaging; 5G, 5th generation mobile networks technology

Declarations

Ethics approval and consent to participate

The protocol for this research project has been approved by the Ethics Committee of Shanghai Municipal Eighth People's Hospital and the approval number is 2019-006.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

YG analyzed and interpreted the data of the older patients receiving telemedicine and was a major contributor in writing the manuscript. JZ was responsible for the study concept and design. All authors read and approved the final manuscript.

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Tables

Table 1. Age Distribution Ratio of Older Patients (aged≥60) Applying for Joint Telemedicine

Age group	Number of patients (%)	Average age	Gender		χ^2	p
			Male	Female		
Young older	230(48.7)	67.69±3.97	83(36.1)	147(63.9)	7.312	0.026
Old older	211(44.7)	80.73±4.13	103(48.8)	108(51.2)		
Very older	31(6.6)	92.26±2.61	13(41.9)	18(58.1)		

Table 2. Constituent Ratio of Major Diseases of Older Patients (aged≥60) Applying for Joint Telemedicine

	All older patients			Male			Female		
Sort	Classification of diseases	Number of cases of disease	Constituent ratio (%)	Classification of diseases	Number of cases of disease	Constituent ratio (%)	Classification of diseases	Number of cases of disease	Constituent ratio (%)
1	Coronary heart disease	68	14.4	Type 2 diabetes mellitus	36	18.1	Coronary heart disease	35	12.8
2	Type 2 diabetes mellitus	68	14.4	Coronary heart disease	33	16.6	Type 2 diabetes mellitus	32	11.7
3	Chronic kidney disease	48	10.2	Chronic kidney disease	23	11.6	Chronic kidney disease	25	9.2
4	Cerebral infarction	40	8.5	Cerebral infarction	16	8.0	Cerebral infarction	24	8.8
5	Hypertension	33	7.0	Hypertension	12	6.0	Hypertension	21	7.7
6	Chronic gastritis	24	5.1	Chronic gastritis	9	4.5	Chronic gastritis	15	5.5
7	Cataract	13	2.8	Allergic dermatitis	9	4.5	Cataract	8	2.9
8	Allergic dermatitis	13	2.8	Cataract	5	2.5	Skin infections	8	2.9
9	Skin infections	11	2.3	Gout	4	2.0	Hyperlipidemia	7	2.6
10	Urinary tract infection	10	2.1	Erysipelas	4	2.0	Urinary tract infection	7	2.6

Table 3. Constituent Ratio Major Diseases of the Young Older Patients (aged 60 to 74) Applying for Joint Telemedicine

	Young older patients			Male			Female		
Sort	Classification of diseases	Number of cases of disease	Constituent ratio (%)	Classification of diseases	Number of cases of disease	Constituent ratio (%)	Classification of diseases	Number of cases of disease	Constituent ratio (%)
1	Type 2 diabetes mellitus	33	14.3	Type 2 diabetes mellitus	20	24.1	Coronary heart disease	20	13.6
2	Coronary heart disease	32	13.9	Coronary heart disease	12	14.5	Cerebral infarction	17	11.6
3	Cerebral infarction	26	11.3	Cerebral infarction	9	10.8	Chronic gastritis	14	9.5
4	Chronic gastritis	22	9.6	Chronic gastritis	8	9.6	Type 2 diabetes mellitus	13	8.8
5	Chronic kidney disease	17	7.4	Hypertension	5	6.0	Chronic kidney disease	12	8.2
6	Hypertension	11	4.8	Chronic kidney disease	5	6.0	Thyroid nodule	7	4.8
7	Thyroid nodule	8	3.5	Allergic dermatitis	4	4.8	Hypertension	6	4.1
8	Hyperlipidemia	7	3.0	Cataract	2	2.4	Hyperlipidemia	6	4.1
9	Cervical spondylopathy	7	3.0	Osteoarthritis	2	2.4	Cervical spondylopathy	5	3.4
10	Cataract	6	2.6	Cholecystitis	2	2.4	Cataract	4	2.7

Table 4. Constituent Ratio of Major Diseases of the Old Older Patients (aged 75 to 89) Applying for Joint Telemedicine

Sort	Old older patients			Meal			Female		
	Classification of diseases	Number of cases of disease	Constituent ratio (%)	Classification of diseases	Number of cases of disease	Constituent ratio (%)	Classification of diseases	Number of cases of disease	Constituent ratio (%)
1	Coronary heart disease	35	16.6	Coronary heart disease	21	20.4	Type 2 diabetes mellitus	19	17.6
2	Type 2 diabetes mellitus	35	16.6	Chronic kidney disease	17	16.5	Hypertension	15	13.9
3	Chronic kidney disease	28	13.3	Type 2 diabetes mellitus	16	15.5	Coronary heart disease	14	13
4	Hypertension	20	9.5	Cerebral infarction	7	6.8	Chronic kidney disease	11	10.2
5	Cerebral infarction	13	6.2	Hypertension	5	4.9	Cerebral infarction	6	5.6
6	Urinary tract infection	8	3.8	Erysipelas	4	3.9	Urinary tract infection	5	4.6
7	Cataract	5	2.4	Urinary tract infection	3	2.9	Cataract	4	3.7
8	Allergic dermatitis	5	2.4	hyperuricemia	3	2.9	Osteoarthritis	3	2.8
9	Liver cancer	4	1.9	Gout	3	2.9	Allergic dermatitis	2	1.9
10	Rectal tumor	4	1.9	Allergic dermatitis	3	2.9	Ophthalmic diseases	2	1.9

Table 5. Constituent Ratio of Major Diseases of the Very Old Patients (aged \geq 90) Applying for Joint Telemedicine

	Very older patients			Male			Female		
Sort	Classification of diseases	Number of cases of disease	Constituent ratio (%)	Classification of diseases	Number of cases of disease	Constituent ratio (%)	Classification of diseases	Number of cases of disease	Constituent ratio (%)
1	Skin infection	6	19.4	Hypertension	2	15.4	Skin infection	4	22.2
2	Chronic kidney disease	3	9.7	Cataract	2	15.4	Chronic kidney disease	2	11.1
3	Allergic dermatitis	3	9.7	Skin infection	2	15.4	Coronary heart disease	1	5.6
4	Hypertension	2	6.5	Allergic dermatitis	2	15.4	Cerebral infarction	1	5.6
5	Cataract	2	6.5	Chronic kidney disease	1	7.7	Hyperuricemia	1	5.6
6	Ophthalmic diseases	2	6.5	Lung cancer	1	7.7	Skin cancer	1	5.6
7	Upper respiratory tract infection	2	6.5	Ophthalmic diseases	1	7.7	Allergic dermatitis	1	5.6
8	Laryngeal edema	2	6.5	Upper respiratory tract infection	1	7.7	Bullous pemphigoid	1	5.6
9	Coronary heart disease	1	3.2	Laryngeal edema	1	7.7	Ophthalmic diseases	1	5.6
10	Cerebral infarction	1	3.2				Osteoarthritis	1	5.6