


Smartphone Use by Caregivers for Patients With Heart Failure During Hospitalization: An Investigation

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Abstract

This study investigated the use of smartphones by family caregivers for hospitalized patients with chronic heart failure (CHF). In total, 120 patients and their unpaid family caregivers participated in this study. The caregivers were divided into two groups based on the perceived importance of smartphones in patient care. Both groups completed the General Demographic Information Survey, Problematic Mobile Phone Use Questionnaire, Barthel Index Scale, Modified Early Warning Score (MEWS), Johns Hopkins Fall Risk Assessment Tool (JH-FRAT), and Family Burden Scale of Diseases Survey. Moreover, left ventricular ejection fraction (LVEF) and stroke volume (SV) were measured in all participants. The age of hospitalized patients with CHF was correlated with the Barthel Index Scale, MEWS, and JH-FRAT, whereas LVEF and SV were correlated with MEWS. The important group had a much higher financial burden than the nonimportant group. Linear regression analysis revealed that financial burden and mental health had a remarkable impact on the content of mobile calls about treatment. Furthermore, the economic status of family caregivers determined the importance of smartphone calls in the care of patients with CHF during hospitalization.

Keywords

mobile application, mobile health, heart failure, caregiver, economic burden, smartphone

Introduction

Heart failure (HF) is a rapidly growing chronic cardiovascular disease that predominantly affects older adults.¹ Despite advances in treatment, over 1 million patients are hospitalized for HF in the United States each year, leading to significant morbidity, mortality, and healthcare costs.² The aging population has led to an increasing number of patients with HF, often requiring frequent and prolonged hospitalization.^{3,4} This places a heavy burden on patients and their caregivers, thereby impacting their physical, mental, social, and spiritual well-being.⁵

Smartphones, serving 5.1 billion users globally, have seen a 4.2% increase in mobile connections from 2018.⁶ Their real-time communication capabilities through various platforms, including voice, picture, and video, have facilitated applications in medical consultation, healthcare, discharge follow-up, and family ward management for out-of-hospital management of patients with chronic heart failure (CHF), leading to positive outcomes.^{7,8}

In current practice, physicians and nurses are often in direct face-to-face contact with patients with CHF and their

caregivers during hospitalization. However, no studies have addressed the role of smartphones used by family caregivers in caring for patients with CHF during hospitalization. Therefore, in this study, the role of smartphones in caring for patients with CHF was explored.

Materials and Methods

Selection of Subjects

In this study, 120 patients with CHF who were hospitalized in the cardiovascular ward of our hospital from January

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2023 to June 2023 and their family caregivers were recruited as subjects, and simple random sampling was conducted using the random number table method. The inclusion criteria were as follows: (1) patients ≥ 18 years of age; (2) those with left ventricular ejection fraction (LVEF) $\leq 45\%$, as assessed via echocardiography; (3) those with a history of CHF ≥ 3 months, as diagnosed by the attending physician and with New York Heart Association Functional Classification of III-IV; (4) those whose caregivers assume the primary care responsibility; (5) and those who understood the study requirements and were willing to provide written informed consent. The exclusion criteria were as follows: (1) patients with severe mental disorders; (2) those with acute HF; (3) those with severe hearing impairment; and (4) those who refused to take the survey. The family caregivers in this study were unpaid family members, and the inclusion criteria were as follows: (1) family caregivers who lived >10 km from the hospital; (2) those who had not been replaced during hospitalization; (3) those who had a blood or marriage relationship with the patients; (4) those ≥ 18 years of age; and (5) those who had good hearing ability and could communicate using smartphones. The exclusion criteria for the family caregivers were as follows: (1) those who had communication barriers and refused to complete the questionnaire; (2) those with more severe heart, brain, kidney, and other organ diseases; and (3) those with alcoholism and other mental and cognitive dysfunction.

Sixty-three family caregivers (31 males and 32 females; average age: 55.34 ± 14.89 years) who viewed smartphones as important for treating patients with CHF during hospitalization were classified as the important group. Fifty-seven family caregivers (26 males and 31 females; average age: 54.25 ± 12.36 years) who viewed smartphones as not important for treating patients with CHF during hospitalization were classified as the nonimportant group. Cardiac color Doppler ultrasonography results, including those for LVEF and stroke volume (SV), were collected for all enrolled CHF patients.

Selection of Scales

In this study, 120 patients with CHF and their family caregivers were enrolled. After the patients were admitted to the hospital and their HF symptoms were improved through treatment, the caregivers provided information. Hospitalized patients who met the inclusion criteria were approached by the researcher and were explained about the nature and objectives of the study. When patients are included in a study, ethical principles, including informed consent, privacy and confidentiality, cultural and religious respect, effective communication and understanding, and respect and caring, should be considered to ensure thorough understanding and self-filled responses and avoid missing or unclear items.

The General Demographic Information Survey aims to gather essential details about patients with CHF and their caregivers, including age, sex, marital status, education

level, residence, family background, family function, medical insurance, disease status, LVEF, and SV.

The investigator-designed Caregiver's Mobile Phone Usage Survey was administered as a self-administered semi-structured questionnaire to the selected participants. This questionnaire primarily encompassed the following aspects: frequency of daily phone calls, modes of communication, usage during hospitalization, content of conversations, treatment requests, individuals informed, importance of mobile phones, and role of mobile phones in treatment. The content validity of this survey was evaluated by experts in the field, including 3 cardiovascular experts and 3 nursing experts. The item-level content validity index was 0.833, and the scale-level content validity index was 0.875, indicating good content validity. Furthermore, the survey demonstrated satisfactory validity and reliability, with a Cronbach's α coefficient of 0.87.

The Barthel Index Scale, developed by Mahoney et al in 1965, assesses patients' self-care abilities in daily life using 10 items, such as defecation control, grooming, and mobility. Each item is scored based on the level of assistance required, resulting in a total score ranging from 0 to 100. A score of 100 indicates complete self-care, 61-99 indicates mild dependence, 41-60 indicates moderate dependence, and ≤ 40 indicates severe dependence.⁹ The Chinese version of this scale has a Cronbach's α coefficient of 0.916.

The Modified Early Warning Score (MEWS) is a tool used by bed nurses to assess a patient's condition and predict the risk of serious complications within 1 h of hospital admission. It comprises 5 physiological indicators, each assigned a score based on specific numerical ranges. The total score, ranging from 0 to 15, indicates the severity of the patient's illness and their prognosis.

The Johns Hopkins Fall Risk Assessment Tool (JH-FRAT), developed by Poe et al in 2007,¹⁰ is widely used to assess patients' fall risk. It consists of two parts; the first part categorizes patients as low or high risk based on specific criteria, whereas the second part includes seven items, resulting in a total score ranging from 0 to 35, with higher scores indicating a greater risk of falls. The scale can effectively assess the fall risk of inpatients in China, with results categorized into low, medium, and high risk.

The Family Burden Scale of Diseases (FBS) is designed to assess the impact of diseases on family members. The Chinese version of this scale includes 6 dimensions and 24 items, evaluating areas such as financial burden, daily activities, and family relations. Each item is scored from 0 to 2, with a total score ranging from 0 to 48. A higher score indicates a greater family disease burden. The scale, compiled by Pai et al,¹¹ has demonstrated good reliability and validity, with a Cronbach's α coefficient of 0.87-0.99.

Statistical Analysis

Data normality was assessed using the Kolmogorov-Smirnov test. Continuous variables are presented as means

± standard deviations, and categorical variables are presented as adjusted proportions. Differences between categorical variables were compared using the chi-square test or Fisher's exact test when necessary. Pearson correlation analysis was used to test correlations between continuous or discrete variables. Linear regression analysis was used to examine the relationship between treatment-related smartphone calls and the 6 dimensions of the FBSD. Statistical significance was set at $P < .05$ for all tests. Statistical analyses were performed using SPSS (version 22.0; IBM Corporation, Armonk, NY, USA) and GraphPad Prism (version 9.0; GraphPad Software, Inc., La Jolla, CA).

Data Availability

The datasets generated and/or analyzed during the current study are not publicly available as these are proprietary data.

Results

Comparison of General Demographic Information and Medical Characteristics Between Family Caregivers and Patients With CHF

During hospitalization of patients with CHF, a statistical difference in family income was observed ($\chi^2 = 9.610$, $P < .05$)

Table 1. Comparison of General Data Between Family Caregivers and Patients With CHF.

Index	Important group	Nonimportant group	χ^2/t value	P-value
Caregiver				
Sex (n, %)				
Male	31 (49.2%)	26 (45.6%)	0.39	.690
Female	32 (50.8%)	31 (54.4%)		
Age (years old)	61.6 ± 16.42	57.85 ± 15.39	0.820	.417
Education level				
Primary school and below	5	3	1.56	.8159
Junior school	12	16		
High school or technical secondary school	23	19		
University and college	14	12		
Bachelor's degree or above	9	7		
Occupational situation				
On duty	14	13	0.397	.9409
Resigned	17	15		
Retired	31	26		
Unemployed	2	3		
Medical payment method				
Self-financed	8	2	3.752	.2896
Medical insurance for urban residents	13	12		
New rural cooperative medical system	30	28		
Employee medical insurance	12	15		
Family income				
<1000	12	3	9.610	.0475*
1000-3000	18	13		
3000-5000	23	21		
5000-10 000	7	12		
>10 000	3	8		
Patients with CHF				
Sex (n, %)				
Male	33 (52.3%)	32 (56.1%)	0.1704	.6798
Female	30 (47.7%)	25 (43.9%)		
Age (years old)	62.04 ± 14.21	60.00 ± 16.97	0.168	.893
CHF underlying disease				
Heart valvular disease (n, %)	27 (42.9%)	22 (38.6%)	0.636	.7276
Cardiomyopathy (n, %)	15 (23.8%)	12 (21.1%)		
Coronary heart disease (n, %)	21 (33.3%)	23 (40.3%)		
LVEF%	56.09 ± 17.67	58.95 ± 16.18	-0.637	.527
SV	60.72 ± 22.35	69.35 ± 22.39	-1.407	.168
Barthel Index Scale	84.87 ± 20.59	84.34 ± 20.01	0.095	.925
MEWS scale	1.10 ± 0.11	1.04 ± 0.20	0.49	.628
JH-FRAT	17.21 ± 3.85	16.25 ± 4.77	0.53	.612

CHF, chronic heart failure; MEWS, Modified Early Warning Score; JH-FRAT, Johns Hopkins Fall Risk Assessment Tool; LVEF, left ventricular ejection fraction; SV, stroke volume.

* $P < .05$.

Table 2. Survey Results on the Application of Smartphones Used by Family Caregivers.

Index	Important group	Nonimportant group	χ^2/t value	P-value
Number of contacts with family members every day				
1 time	16	15	2.869	.4123
2 times	22	27		
3 times	18	10		
4 times or more	7	5		
Ways to contact family members every day				
WeChat	33	30	1.798	.7728
Tik Tok	12	10		
QQ	7	6		
Dial	8	5		
Text message	3	8		
Daily treatment-related mobile phone calls				
Call most of the time every day	29	17	10.21	.017*
Call half the time every day	23	15		
Call for a few hours every day	8	16		
Call for very little time every day	3	9		
Confidants for answering calls every day				
Managed physician	21	17	0.515	.972
Bed nurse	16	14		
Family members and relatives	11	9		
Leaders, colleagues, and friends	15	9		
Others	10	8		
Other uses of smartphones every day				
Communicate illness	29	13	9.909	.0420*
Arrange matters	17	16		
Entertainment such as movies and games	8	9		
News information	6	10		
Online shopping	3	9		

* $P < .05$

between the important and nonimportant groups of patients with CHF and their family caregivers. However, no statistical difference in general demographic information, CHF underlying diseases, LVEF, SV, Barthel Index Scale, MEWS, and JH-FRAT was found between the 2 groups, as shown in Table 1.

Comparison of the Application of Smartphones Used by Family Caregivers in Caring for Patients With CHF During Hospitalization

During hospitalization of patients with CHF, statistical differences in terms of daily communication of illness and treatment-related mobile calls were observed between the important and nonimportant groups of patients with CHF and their family caregivers ($\chi^2 = 9.909$, $P < .05$; $\chi^2 = 10.21$, $P < .05$); however, no statistical difference in the application of smartphones in other aspects was observed between the 2 groups, indicating that smartphone communication technology is applied to many aspects of HF management and treatment (Table 2).

Comparison of Family Burden

Statistical analysis revealed a significant difference in family financial burden between the important ($13.18 \pm$

4.233) and nonimportant (9.92 ± 1.19) groups of patients with CHF and their family caregivers during hospitalization ($t = 2.428$, $P = .002$, $P < .05$). This indicated disparities in family financial status, with the important group experiencing a higher family financial burden than the nonimportant group. No statistical difference was found in the other 5 dimensions between the 2 groups.

Relationship Between Caregivers and Patients With CHF and Other Study Variables

Correlation analysis during hospitalization of patients with CHF revealed significant associations. The age of hospitalized patients with CHF was correlated with the Barthel Index Scale, MEWS Scale, and JH-FRAT ($r = -0.318$, $P < .01$; $r = 0.249$, $P < .05$; $r = 0.475$, $P < .01$, respectively). In addition, the cardiac function indexes EF% and SV were correlated with MEWS ($r = 0.281$, $r = -0.258$, $P < .05$). Notably, the age of family caregivers showed a negative correlation with the Barthel Index Scale ($r = -0.304$, $P < .05$), indicating that age influenced family caregivers' provision of care, particularly for patients with HF who required hospitalization and aggravation.

Table 3. Linear Regression Analysis of Influencing Factors in Caregivers of Patients With CHF on the Content of Treatment-Related Smartphone Calls.

	B	Standard error	Beta error	t value	P-value
Constant	2.478	0.399		6.213	.000
Family financial burden	0.081	0.038	0.328	2.158	.035
Daily family activities	-0.024	0.054	-0.076	0.444	.659
Family entertainment activities	-0.030	0.056	-0.090	-0.542	.590
Family relations	0.005	0.051	0.015	0.090	.928
Family members' physical health	0.153	0.119	0.237	1.281	.205
Family members' mental health	-0.296	0.108	-2.471	-2.745	.008

Note: CHF, chronic heart failure.
 $R^2 = 0.438\%$, $F = 2.446$, $P < .05$.

Multiple Linear Regression Analysis of Influencing Factors in Caregivers on the Content of Treatment-Related Smartphone Calls

Linear regression analysis using the forward method revealed that family financial burden and the mental health of family members significantly influenced the content of treatment-related smartphone calls ($P < .05$, $P < .01$). These findings suggest that these factors play a crucial role in shaping the nature of smartphone communication related to treatment, as shown in Table 3.

Discussion

This study highlights the significant economic and humanistic burden imposed by HF on patients and their families, particularly those with low incomes.^{12,13} Family caregivers play a crucial role in managing daily tasks and providing support for patients with CHF, often facing physical, psychological, social, and economic challenges, especially in remote areas.^{14,15} The unpredictability of acute CHF attacks leads to hospitalizations. In situations where long-distance transport is difficult and medical procedures are complex, caregivers provide informal care and support using smartphones for various tasks. The present study also found that caregivers, often spouses of patients, experience negative emotional and economic impacts, including early retirement or reduced working hours, leading to increased responsibilities and overload.¹⁶⁻¹⁸ Caregivers often have to assume additional daily roles and responsibilities due to their caregiver's functional and psychosocial limitations.

Smartphones play a vital role in providing caregivers with instant communication for medical care, assistance, and emotional support, reducing patient hospital visits and waiting times, ultimately improving patient outcomes and reducing family burdens.¹⁹ The attendants of the patients feel more comfortable and confident in managing them in the hospital, particularly caregivers in remote areas. Caregivers with fewer financial constraints have more opportunities to support CHF treatment and rehabilitation using smartphones for nonhealth-related activities. Their perception of smartphones differs from that of caregivers facing economic challenges.

Conclusion

In summary, with smartphone technology the communication is quite rapid and easier, so the attendants of the patients feels more comfortable and confident in managing them in hospital, particularly in remote areas. our study revealed that smartphones play a significant role in aiding communication and providing emergency assistance, reminders, education, and support during the short-term hospitalization of patients with CHF in remote areas, thereby facilitating improved care by caregivers. However, the impact on caregivers is influenced by patient age, changes in cardiac function, and hospitalization. Smartphones serve as an auxiliary tool rather than a replacement for medical professionals. Economic differences among family caregivers determine the importance of smartphones as a mobile medical aid. Further research is needed to identify the specific beneficial features and functions of smartphones for the care of patients with CHF by their family caregivers.

Study Limitations

This study had some limitations. First, it only focused on caregivers of inpatients with CHF in the mobile medical environment, potentially limiting the understanding of smartphone use by caregivers of patients with other diseases. Second, the small sample size may have introduced bias. The sample size of 120 participants is relatively small, which may have limited the generalizability of the results and reduced the statistical power of the study. Finally, the inability to collect relevant data on elderly caregivers who do not use mobile communication tools due to personal preferences or other obstacles hinders the generalizability of the study's conclusions.

Authors' Note

XianNan Huang and Liuxue Lu contributed equally to this work and should be considered cofirst authors.

Data Availability

The datasets generated and/or analyzed during the current study are not publicly available as these are proprietary data.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.


Ethical Approval

This study was approved by the Ethics Committee of the Affiliated Hospital of Youjiang Medical University for Nationalities (YFY-LL-2022-112). All procedures performed were in accordance with the ethical standards of the Affiliated Hospital of Youjiang Medical. All participants volunteered for the study and provided written consent prior to the initiation of the study. They were also assured that their voluntariness, privacy, confidentiality, and anonymity would remain confidential.

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