Observational Study

Medicine

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A WeChat-based caregiver education program improves satisfaction of stroke patients and caregivers, also alleviates poststroke cognitive impairment and depression

A randomized, controlled study

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Abstract

Caregiver education program has been applied to stroke patients, while its effect on mental health in stroke patients is still obscure. This study aimed to assess the impact of the WeChat-based caregiver education (WBCE) program on cognition, anxiety, and depression in stroke patients.

Totally, 170 patients with ischemic stroke were included. They were randomized at a 1:1 ratio to the WBCE group (N = 86) and control care (CC) group (N = 84), and their caregivers received WBCE or CC for 12 months, respectively.

Mini-mental state examination (MMSE) score was increased in the WBCE group compared with that in the CC group at the 9th month (M9) (27.2 ± 1.9 vs 26.6 ± 1.6, $P = 0.017$) and M12 (27.1 ± 1.8 vs 26.5 ± 1.5, $P = 0.015$), while cognitive impairment rate was decreased in WBCE group compared with that in CC group at 12th month (M12) (30.2% vs 45.2%, $P=0.043$). In the meantime, the Hospital Anxiety and Depression Scale (HADS) for Anxiety score (6.5 ± 3.1 vs 7.5 ± 2.8, $P = 0.020$), HADS for depression score (6.7 ± 3.1 vs 7.7 ± 3.3, $P = 0.040$) and depression rate (33.7% vs 48.8%, $P = 0.046$) in WBCE group were reduced compared with those in CC group at M12. Besides, an elevation in the satisfaction score of patients at M12 (8.0 ± 1.2 vs 7.4 ± 1.2, $P = 0.002$) and that of caregivers at 6th months (M6) (6.6 ± 1.1 vs 6.2 ± 1.3, $P = 0.038$) and M12 (7.2 ± 1.1 vs 6.8 ± 1.4, $P=0.042$) were found in WBCE group compared with CC group.

WBCE program not only improves the satisfaction of stroke patients and caregivers but also attenuates cognitive impairment and depression in stroke patients.

Abbreviations: CC = control care, MMSE = mini-mental state examination, HADS = Hospital Anxiety and Depression Scale, HADS-A = HADS for anxiety, HADS-D = HADS for depression, ITT = intention-to-treat, SD = standard deviation, WBCE = WeChat-based caregiver education.

Keywords: anxiety and depression, cognitive impairment, ischemic stroke, satisfaction, WeChat-based caregiver education

1. Introduction

Stroke, a cerebral vascular disease, is the second leading cause of death globally.[1,2] Stroke is divided into ischemic stroke and hemorrhagic stroke, of which ischemic stroke accounts for about 77.8% of all stroke cases in China.[2] Additionally, stroke induces a high morbidity rate of approximately 22.3% in China and has a likelihood to cause significant disability[2] that correlates with cognitive dysfunction, functional impairment, and poor physical and mental health.[3]

Cognitive impairment, anxiety, and depression are associated with poor prognosis in poststroke patients.[4–6] Cognitive impairment is caused by blood circulation disorder and hypoxic-ischemic injury in the brain, which leads to neurological dysfunction. Subsequently, it causes trouble in speaking, understanding, and behavior in stroke patients.[7] Meanwhile, anxiety and depression are common psychological disorders in poststroke patients, and they are 2 significant predictors of poor functional outcomes in poststroke patients.[8,9] Thus, how to help stroke patients to rehabilitate cognitive impairment and alleviate anxiety and depression need to be solved.

Numerous stroke patients in our program may hardly understand and speak during the education. For this reason, a new way has been proposed to suggest that their caregivers receive knowledge about the disease and related rehabilitation methods. Currently, caregiver education programs have already been applied

The authors have no funding and conflicts of interest to disclose.

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

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How to cite this article: Kang K, Li S. A WeChat-based caregiver education program improves satisfaction of stroke patients and caregivers, also alleviates poststroke cognitive impairment and depression: a randomized, controlled study. Medicine 2022;101:27(e29603).

Received: 8 October 2021 / Received in final form: 22 April 2022 / Accepted: 2 May 2022

http://dx.doi.org/10.1097/MD.0000000000029603

to stroke caregivers, including 8 weekly telephone calls programs,[10] individual education programs,[11] and a face-to-face psychoeducation program.[12] They can improve the caregiver's satisfaction.[10] However, these programs have some limitations: either the caregivers fail to contact specialists timely, or they must leave the stroke patients to go to the hospital for training. Moreover, the role of caregiver education programs on cognitive impairment, anxiety, and depression in stroke patients is not evaluated.

In this study, we designed a WeChat-based caregiver education (WBCE) program which contained sharing health education and rehabilitation guidance in the video, communicating with the trained nurse in real-time as well as intensive follow-up by WeChat Application (Tencent Corporation, Guangzhou, Guangdong Province, China) (a most frequently-used social software in China). We conducted this randomized, controlled study to explore whether WBCE could rehabilitate cognitive impairment and reduce anxiety and depression in ischemic stroke patients.

2. Methods

2.1. Subjects

One hundred seventy patients with ischemic stroke and their caregivers were consecutively recruited in this randomized controlled study from September 2018 to December 2019. The ischemic stroke patients met the inclusion criteria as follows: (i) diagnosed with ischemic stroke; (ii) aged over 18 years old; (iii) able to complete questionnaire evaluation applied in the study; (iv) had a settled caregiver who was able to take care of the patients daily for a long time. The following patients were excluded if they: (i) had evidence of hemorrhagic stroke; (ii) persisted in vegetative states caused by stroke; (iii) had a mini-mental state examination (MMSE) score of <10; (iv) had severe mental illness requiring long-term medication treatment; (v) were complicated with malignancies or poorly controlled comorbidities. The caregiver should satisfy the following requirements: (i) had a positive attitude towards participating in this study; (ii) age between 18 and 65 years old; (iii) were skillful at using the WeChat application (app) and its related functions on a smartphone. However, caregivers were excluded if they had poor physical conditions, mental diseases, negative mental states, and cognitive or communication problems. In addition, pregnant or lactating women were not included in the current study. The Institutional Review Board approved this study, and all participants signed informed consent.

2.2. Random assignment

Eligible patients (and/or their caregivers) were given an opaque envelope corresponding to their enrollment number, and they were randomly divided into the WBCE group (N = 86) or the CC group (N = 84) at a 1:1 ratio according to their grouping information sealed in the envelope. The grouping information was created using the blocked randomization method with a block size of 4. The random assignment of patients was performed by a nurse who was blind to the patient clinical information.

2.3. Intervention in the WBCE group

In the WBCE group, the WBCE program has been implemented for 12 months by the WeChat app (Tencent Corporation, Guangzhou, Guangdong Province, China), the most widely used social application in China. On the day of discharge, the caregivers of patients were given detailed instructions about the WBCE program, then a WeChat Group in the WeChat app was set up, and all caregivers joined it. The WeChat Group was used to carry out the following interventions: (i) health education and rehabilitation guidance: the trained nurses had recorded short videos of health education and rehabilitation instruction consents (covering stroke knowledge, secondary stroke prevention, medicine management, exercise rehabilitation, matters needed attention, nutritional health, mental health, and family support), then they sent the short videos to the WeChat Group, and this work was conducted weekly for a total of 12 months; (ii) real-time communication: if there were any rehabilitation questions, the caregiver was expected to contact the trained nurses in the WeChat Group or in one-to-one chatting model (if necessary), then the trained nurses would actively help them; (iii) intensive follow-up: the trained nurses took the initiative to communicate with each caregiver every other week in a one-to-one chatting model of WeChat, and to monitor the latest recovery status of patients, providing guidance and urging patients to undergo reexamination regularly. Apart from the WeChat Group, a WeChat Official Account was also built to post current medical articles weekly to caregivers about the latest medical findings in new drugs and advancements in stroke treatment, patient rehabilitation, and mental health care.

2.4. Intervention in CC group

In the CC group, when patients were discharged from the hospital, the caregivers were given discharge guidance and health education, including stroke knowledge, secondary stroke prevention, medicine management, exercise rehabilitation, matters needing attention, nutritional health, mental health, and family support. Then they were advised to return to the hospital every 3 months for study assessment and reexamination after discharge.

2.5. Assessment

The MMSE scale and HADS were applied to evaluate the patients' cognitive impairment, anxiety, and depression. The assessment of MMSE and HADS was made at baseline (M0), then at the 3rd month (M3), 6th month (M6), 9th month, and 12th month (M12) after starting the study. The MMSE score ≤26 was considered cognitive impairment.[13] The HADS for anxiety (HADS-A) score >7 was regarded as anxiety, and the HADS for depression (HADS-D) score >7 was considered as depression.[14] Furthermore, patient satisfaction scores (from 0 to 10) and caregiver satisfaction scores (from 0 to 10) were assessed at M6 and M12, and a higher satisfaction score indicated higher satisfaction with the study care program.

2.6. Statistical analysis

The required sample size for determining a 10% difference between 2 groups in depression rate at M12 was 136 subjects, with a power of 95% and a significant level of <0.05. An estimated rate of loss to follow-up was set as 20%; as a result, the final samples size added up to 170 in total. According to the intention-to-treat (ITT) principle, all patients were included in the final analysis. As for patients who lost follow-up during the study, the last measured data from them or their caregivers were used as the following assessment. SPSS 24.0 (IBM Corp., Armonk, New York) and GraphPad Prism 5.01 (GraphPad Software Inc., San Diego, CA) were applied for data analysis and graphing. Data were described by the mean and standard deviation (SD) or count with percentage. Comparison between 2 groups was analyzed by the independent sample t-test or Chi-square test, where the P value <0.05 indicated a significant difference.

3. Result

3.1. Study flow

A total of 183 ischemic stroke patients treated in our hospital were invited to this study, while 13 patients were excluded, including 7 patients who did not meet the inclusion criteria or

met the exclusion criteria and 6 patients who disagreed to participate. Subsequently, the remaining 170 patients were recruited and then randomized at a 1:1 ratio to the WBCE group (N = 86), whose caregivers received WBCE for 12 months, and the CC group (N = 84), whose caregivers received CC for 12 months. In the WBCE group, there were 8 patients (9.3%) who dropped out during the 12-month intervention period, including 3 (3.5%) patients who were dead and 5 patients (5.8%) who lost follow-up. In the CC group, 7 patients (8.3%) dropped out during the 12-month intervention period, including 1 patient (1.2%) who was dead and 6 patients (7.1%) who lost follow-up. Finally, 86 patients in the WBCE group and 84 patients in the CC group were analyzed in the study (Fig. 1).

3.2. Baseline characteristics

The baseline characteristics of ischemic stroke patients are shown in Table 1. The CC group had a mean age of 65.3 ± 8.5 years old with 26 (31.0%) females and 58 (69.0%) males; meanwhile, the WBCE group showed a mean age of 65.1 ± 8.0 years old with 32 (37.2%) females and 54 (62.8%) males. Further comparison analysis presented no difference in demographic and clinical characteristics between the WBCE and the CC groups (all P>0.05).

3.3. Cognitive impairment in WBCE group and CC group

MMSE score was higher in the WBCE group compared with that in the CC group at M9 (27.2 ± 1.9 vs 26.6 ± 1.6, P=0.017) and M12 (27.1 ± 1.8 vs 26.5 ± 1.5, P = 0.015), while there was no difference in MMSE score at M0, M3 and M6 between the 2 groups (all P>0.05) (Fig. 2A). As to cognitive impairment rate, there was a decline in the WBCE group compared with the CC group at M12 (30.2% vs 45.2%, P = 0.043), while no difference had been found between the 2 groups at M0, M3, M6, and M9 (all P > 0.05) (Fig. 2B).

3.4. Anxiety and depression in WBCE group and CC group

HADS-A score decreased in the WBCE group compared with that in the CC group at M12 (6.5 ± 3.1 vs 7.5 ± 2.8, P = 0.020); besides, there was no difference in HADS-A score at M0, M3, M6, and M9, and anxiety rate at all visit points between the 2 groups (all P > 0.05) (Fig. 3A, B). Meanwhile, the HADS-D score (6.7 ± 3.1 vs 7.7 ± 3.3, P = 0.040) and depression rate (33.7% vs 48.8%, P = 0.046) were lower in the WBCE group than those in the CC group at M12. In addition, there was no difference in HADS-D score and depression rate between the 2 groups at M0, M3, M6, and M9 (all P>0.05) (Fig. 3C, D).

3.5. Patient and caregiver satisfaction in WBCE group and CC group

An increase in patient satisfaction score was observed in the WBCE group compared with the CC group at M12 (8.0 ± 1.2 vs 7.4 ± 1.2, P=0.002), while no difference was found between the 2 groups at M6 (P = 0.157) (Fig. 4A). What's more, caregiver

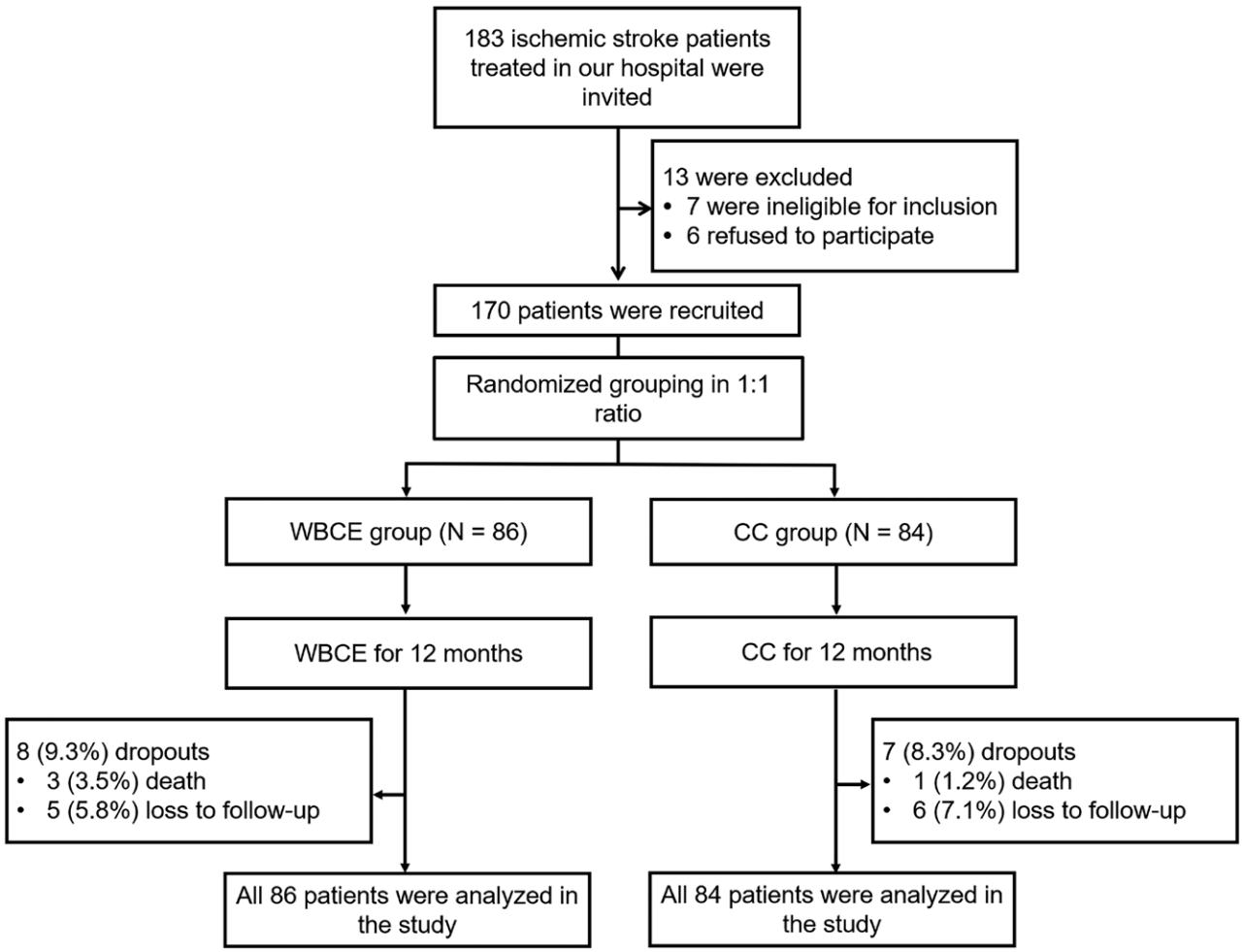


Figure 1. The flow of the current study. CC = control care, WBCE = WeChat-based caregiver education.

Table 1

Clinical characteristics.

Items	CC group (N = 84)	WBCE group (N = 86)	*P* value
Demographics of patients			
Age (years), mean ± SD	65.3 ± 8.5	65.1 ± 8.0	0.822
Gender, No. (%)			0.390
Female	26 (31.0)	32 (37.2)	
Male	58 (69.0)	54 (62.8)	
Smoke status, No. (%)			0.772
Never	39 (46.4)	43 (50.0)	
Former	43 (51.2)	42 (48.8)	
Current	2 (2.4)	1 (1.2)	
Education status, No. (%)			0.760
Primary school or below	20 (23.8)	19 (22.1)	
Junior high school	22 (26.2)	29 (33.7)	
High school	28 (33.3)	25 (29.1)	
University or above	14 (16.7)	13 (15.1)	
Marriage status, No. (%)			0.662
Married	34 (40.5)	32 (37.2)	
Single/divorced/widowed	50 (59.5)	54 (62.8)	
Location, No. (%)			0.893
Urban	14 (16.7)	15 (17.4)	
Rural	70 (83.3)	71 (82.6)	
Comorbidities			
Hypertension, No. (%)	69 (82.1)	74 (86.0)	0.486
Hyperlipidemia, No. (%)	39 (46.4)	43 (50.0)	0.641
Diabetes, No. (%)	22 (26.2)	26 (30.2)	0.558
CKD, No. (%)	13 (15.5)	10 (11.6)	0.463
CVD, No. (%)	26 (31.0)	35 (40.7)	0.185
Disease characteristics			
Lesion location, No. (%)			0.849
Left	37 (44.0)	38 (44.2)	
Right	32 (38.1)	30 (34.9)	
Bilateral/brainstem/unknown	15 (17.9)	18 (20.9)	
Recurrence experience, No. (%)	23 (27.4)	24 (27.9)	0.939
Demographics of caregivers			
Caregiver age (years), mean ± SD	49.3 ± 8.4	50.5 ± 8.4	0.367
Caregiver gender, No. (%)			0.428
Female	65 (77.4)	62 (72.1)	
Male	19 (22.6)	24 (27.9)	
Caregiver education status, No. (%)			0.419
Primary school or below	10 (11.9)	10 (11.6)	
Junior high school	40 (47.6)	50 (58.1)	
High school	20 (23.8)	18 (20.9)	
University or above	14 (16.7)	8 (9.3)	
Caregiver marriage status, No. (%)			0.496
Married	68 (81.0)	73 (84.9)	
Single/Divorced/widowed	16 (19.0)	13 (15.1)	

CC = control care, CKD = chronic kidney disease, CVD = cardiovascular disease, SD = standard deviation, WBCE = WeChat-based caregiver education.

satisfaction score was enhanced in the WBCE group compared with the CC group at M6 (6.6 ± 1.1 vs 6.2 ± 1.3, *P*=0.038) and M12 (7.2 ± 1.1 vs 6.8 ± 1.4, *P* = 0.042) (Fig. 4B).

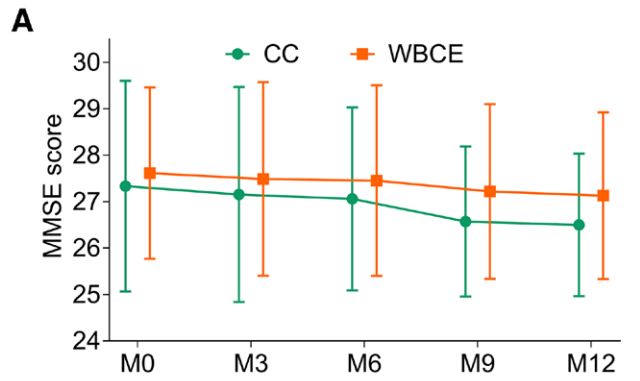
3.6. Cognitive impairment, anxiety, and depression in subgroups

Ischemic stroke patients were divided into 2 subgroups based on stroke recurrence experience. In patients with stroke recurrence experience, their cognitive impairment, anxiety, depression, and satisfaction at M12 were of no difference between the WBCE group and the CC group (all $P > 0.05$) (Fig. 5A, H). Among those patients without stroke recurrence experience, an increase was found in the M12 MMSE score (27.2 ± 1.8 vs 26.6 ± 1.4, $P = 0.027$) and M12 patients' satisfaction score (8.0 ± 1.2 vs 7.5 ± 1.2, $P = 0.016$), while a decrease was described in M12 HADS-A score (6.2 ± 2.9 vs 7.3 ± 2.8, $P = 0.027$) in the WBCE group compared with the CC group. In addition, no difference was exhibited in the M12 cognitive impairment rate, M12 anxiety rate, M12 HADS-D score, M12 depression rate, and M12 caregiver satisfaction score between the 2 groups (all $P > 0.05$) (Fig. 5I–P).

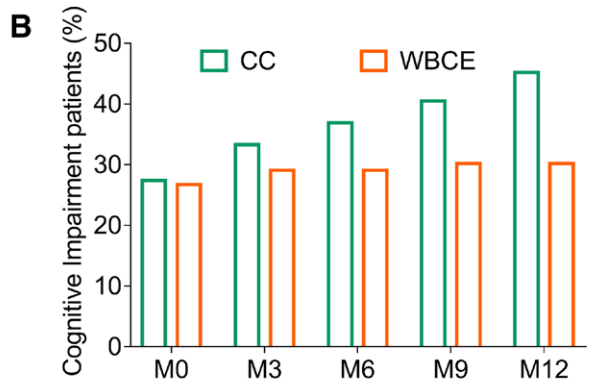
4. Discussion

In this study, we observed that (1) the WBCE program could alleviate the cognitive impairment in patients with ischemic stroke; (2) the WBCE program mitigated anxiety to some extent and relieved depression obviously in ischemic stroke patients; (3) the WBCE program improved the satisfaction of both ischemic stroke patients and caregivers.

The overwhelming majority of stroke patients are usually accompanied by the language barrier, physical movement disorder, and other dysfunctions,[15] which make the stroke patients and their family members fall into the troubles of nursing and caring for a long time.[16] Hence, caregivers play a vital role in stroke patients, which experienced a significant majority burden in nutrition management,[17] psychologic health,[18] physical training, and rehabilitation.[19] Evidence suggests that apart from regular rehabilitation treatment for stroke patients, additional

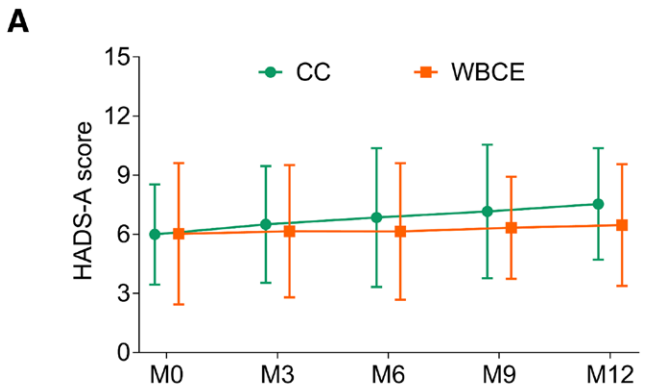


	M0	M3	M6	M9	M12
CC	27.3±2.3	27.2±2.3	27.1±2.0	26.6±1.6	26.5±1.5
WBCE	27.6±1.8	27.5±2.1	27.5±2.1	27.2±1.9	27.1±1.8
P value	0.373	0.325	0.204	0.017	0.015

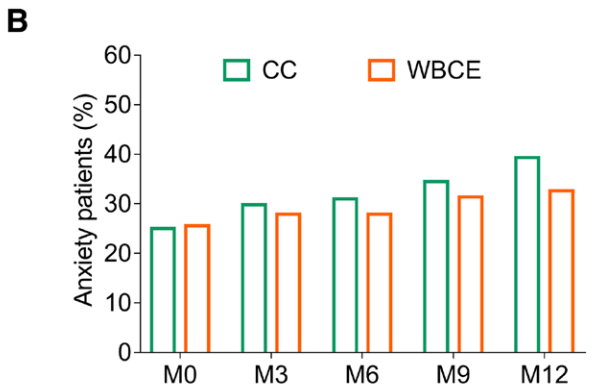


	M0	M3	M6	M9	M12
CC	23 (27.4)	28 (33.3)	31 (36.9)	34 (40.5)	38 (45.2)
WBCE	23 (26.7)	25 (29.1)	25 (29.1)	26 (30.2)	26 (30.2)
P value	0.926	0.549	0.227	0.162	0.043

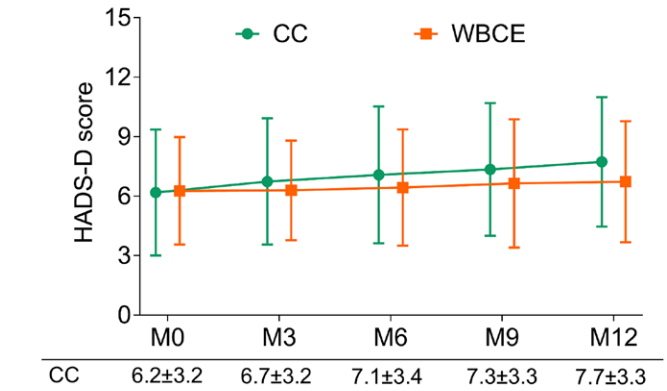
Figure 2. Comparison of cognitive impairment between the WBCE group and the CC group. Comparison of MMSE score (A) and cognitive impairment rate (B) between the WBCE group and the CC group. CC = control care, WBCE = WeChat-based caregiver education, MMSE score = Mini-Mental State Examination, M0 = baseline, M3 = 3rd month, M6 = 6th month, M9 = 9th month,; M12 = 12th month.



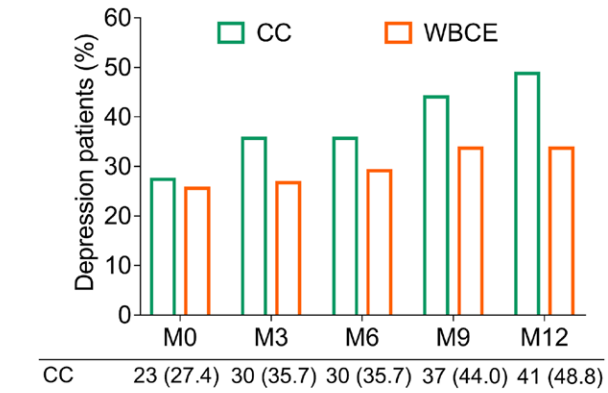
	M0	M3	M6	M9	M12
CC	6.0±2.5	6.5±3.0	6.8±3.5	7.2±3.4	7.5±2.8
WBCE	6.0±3.6	6.2±3.4	6.1±3.5	6.3±2.6	6.5±3.1
P value	0.941	0.474	0.189	0.074	0.020



	M0	M3	M6	M9	M12
CC	21 (25.0)	25 (29.8)	26 (31.0)	29 (34.5)	33 (39.3)
WBCE	22 (25.6)	24 (27.9)	24 (27.9)	27 (31.4)	28 (32.6)
P value	0.931	0.789	0.663	0.664	0.361

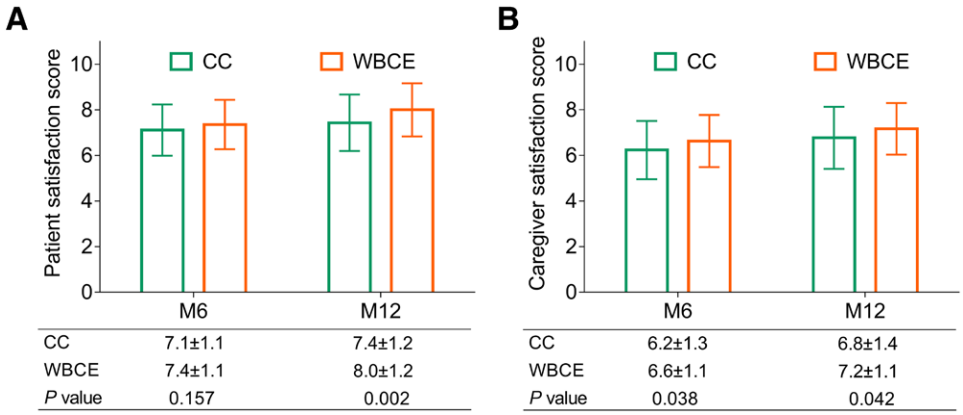


	M0	M3	M6	M9	M12
CC	6.2±3.2	6.7±3.2	7.1±3.4	7.3±3.3	7.7±3.3
WBCE	6.3±2.7	6.3±2.5	6.4±2.9	6.6±3.2	6.7±3.1
P value	0.845	0.311	0.193	0.164	0.040



	M0	M3	M6	M9	M12
CC	23 (27.4)	30 (35.7)	30 (35.7)	37 (44.0)	41 (48.8)
WBCE	22 (25.6)	23 (26.7)	25 (29.1)	29 (33.7)	29 (33.7)
P value	0.790	0.207	0.355	0.167	0.046

Figure 3. Comparison of anxiety and depression between the WBCE group and the CC group. Comparison of HADS-A score (A), anxiety rate (B), HADS-D score (C), and depression rate (D) between the WBCE group and the CC group. CC = control care, HADS-A = Hospital Anxiety and Depression Scale for Anxiety, HADS-D = Hospital Anxiety and Depression Scale for Depression, M0 = baseline, M3 = 3rd month, M6 = 6th month, M9 = 9th month, M12 = 12th month, WBCE = WeChat-based caregiver education.



	M6	M12
CC	7.1±1.1	7.4±1.2
WBCE	7.4±1.1	8.0±1.2
P value	0.157	0.002

	M6	M12
CC	6.2±1.3	6.8±1.4
WBCE	6.6±1.1	7.2±1.1
P value	0.038	0.042

Figure 4. Comparison of satisfaction in patients and caregivers between the WBCE group and the CC group. Comparison of patients' (A) and caregivers' (B) satisfaction scores between WBCE group and CC group. CC = control care, WBCE = WeChat-based caregiver education, M6 = 6th month, M12 = 12th month.

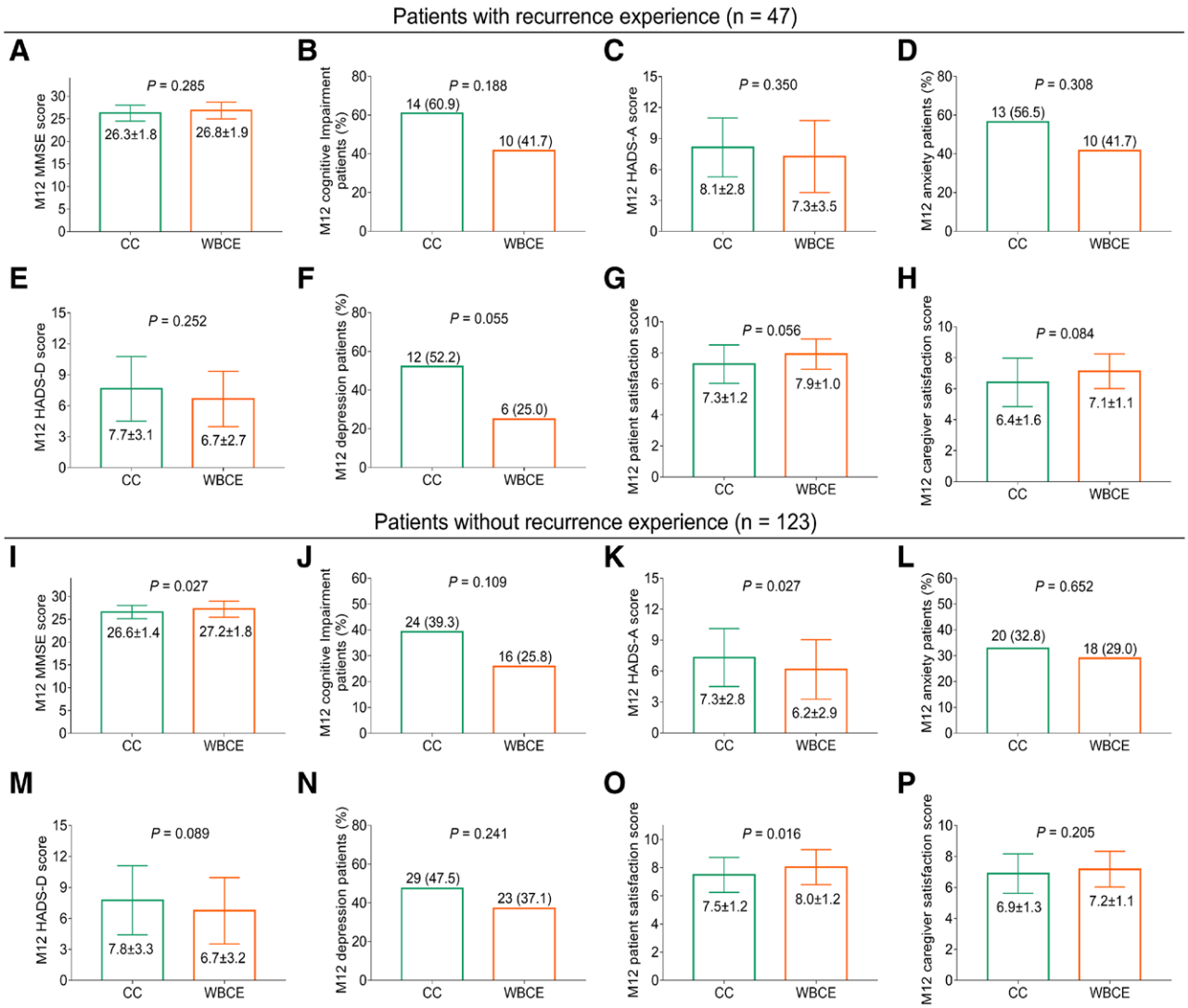


Figure 5. Comparison of cognitive impairment, anxiety, and depression in patients with/without stroke recurrence experience. Comparison of MMSE score (A), cognitive impairment rate (B), HADS-A score (C), anxiety rate (D), HADS-D score (E), depression rate (F), patients' satisfaction (G), caregivers' satisfaction (H) at M12 between the WBCE group and the CC group in patients with stroke recurrence experience. Comparison of MMSE score (I), cognitive impairment rate (J), HADS-A score (K), anxiety rate (L), HADS-D score (M), depression rate (N), patients' satisfaction (O), caregivers' satisfaction (P) at M12 between the WBCE group and the CC group in patients without stroke recurrence experience. CC = control care, HADS-A = Hospital Anxiety and Depression Scale for Anxiety, HADS-D = Hospital Anxiety and Depression Scale for Depression, MMSE score = Mini-Mental State Examination, M12: 12th month, WBCE = WeChat-based caregiver education.

rehabilitation therapies are subsequently applied by caregivers to improve the balance function in severe stroke patients.[20] Another research displays that individualized education programs for caregivers can reduce anxiety and depression in ischemic stroke patients.[11] Thus, it is evident that caregivers play a vital role in stroke patients' rehabilitation and mental health.

Satisfaction of stroke patients and caregivers is a critical issue closely related to emotional stress, quality of life, and patient rehabilitation.[21] Currently, it is considered that focusing on the needs, values, and preferences of stroke patients and caregivers is of great importance.[22] Hence, improving the satisfaction of patients and caregivers is a vital part of interventions, which has received significant attention. A previous study describes that caregiver's satisfaction score is the highest after caregivers receive educated intervention.[10] Meanwhile, another recent study discloses that Chronic Care Model-based interventions improve satisfaction in stroke patients.[23] Our results were consistent with this finding that the WBCE program increased caregivers' satisfaction and enhanced ischemic patients' satisfaction, possibly because (1) communicating with trained nurses in time could solve the problems quickly that often occurred in the poststroke period. (2) caregivers could access specialists for consulting at home, rather than having to travel to the hospital, which obviously reduced time costs for caregivers and thus improved satisfaction of patients and caregivers.

The prognosis of stroke patients is quite unfavorable: according to a previous study, the 12-month fatality rate is 8.6%, and the 12-month disability rate is 16.6%.[24] Meanwhile, cognitive impairment is caused by neurological ischemia or hypoxia in stroke, which illustrates high morbidity (61%) 10 years after stroke.[25] To prevent cognitive impairment, stroke patients usually receive routine screening in terms of cognitive function and health education before leaving the hospital. However, these modalities may have no marked effect on stroke patients.[26] Previous studies have adopted a physical activity intervention for stroke patients, which reveals that physical training prevents cognitive decline in stroke survivors.[27] At the same time, physical exercise combined with cognitive training could bring about beneficial effects on cognitive function in stroke patients.[28] Although these interventions regulate cognitive impairment, there are few studies concerning the cognitive ability of ischemic stroke patients after the intervention of caregivers. Our study found that the WBCE program for caregivers could prevent cognitive impairment of ischemic stroke patients. Through the WBCE program, we speculated that (1) caregivers might learn effective methods to assist patients in recovering to normal life; (2) caregivers were in close contact with professional nurses in time for any problems during the process of nursing, which solved the problems of ischemic stroke patients quickly, and thus strikingly attenuated the possibility of cognitive impairment of patients. Besides, the modification of cognitive impairment requires a long time. Therefore, the change of cognitive impairment was only observed at M12.

Anxiety and depression are common complications caused by stroke, which are related to poor prognosis outcomes and higher recurrent stroke risk.[5,6] Hence, multiple types of intervention for stroke patients have been displayed to relieve anxiety and depression. For instance, emotional or informational support given by functional therapists may have a positive correlation with alleviated depression symptoms[29]; the practice of aquatic exercise is effective for treating depression and anxiety in stroke patients[30]; the caregiver-mediated exercise program illustrates a positive impact on the mood for ischemic stroke patients and their caregivers.[31] Furthermore, it is worth noting that intensive education for caregivers reduces anxiety and depression in stroke patients.[11] Our study revealed that the WBCE program reduced anxiety to a certain extent and depression in ischemic stroke patients, which was in line with previous findings reported. The probably reasons might include: (1) caregivers received knowledge about mental health, which might be applied to mediate patients' emotions and release their psychological pressure, anxiety, and depression caused by stroke; (2) caregivers could report patients' psychological clinical responses to the experts timely and get some effective feedbacks, which might play a potential role in the prevention of anxiety and depression; (3) anxiety and depression are associated with cognitive impairment,[32] with the rehabilitation of cognitive impairment, the anxiety and depression had been decreased. Besides, although cognitive impairment and depression would be improved with time, stroke patients and caregivers might still achieve benefits through a quicker amelioration of cognitive and depression, which indicated that the WBCE program could improve post-stroke management.

In addition, our study presented that the WBCE program only reduced cognitive impairment and anxiety in ischemic stroke patients without stroke recurrence experience, while it did not influence stroke patients with stroke recurrence experience. The explanation was that the WBCE program provided more effective approaches for caregivers of patients without a history of stroke recurrence to assist ischemic stroke patients in rehabilitating and managing their psychological health. In contrast, caregivers of patients with recurrent stroke might already have experience dealing with stroke patients' problems.

There were some limitations in this study: (1) this study only enrolled the ischemic stroke patients; thus, the results might not be appropriate for hemorrhagic stroke patients; (2) this research only evaluated the cognitive impairment, anxiety, and depression in ischemic stroke patients, the mood of caregivers was not evaluated, which might affect the emotion of ischemic stroke patients; (3) the follow-up time was only 12 months, which was short. The effect of a long-term intervention for caregivers on cognitive impairment, anxiety, and depression in ischemic stroke patients was not clear.

In conclusion, the WBCE program exhibits a positive influence on the satisfaction of ischemic stroke patients and caregivers, as well as cognitive impairment, anxiety, and depression in ischemic stroke patients. However, these findings should be confirmed in studies with a larger sample size in the future.

Author contributions

Kaining Kang: data curation, formal analysis, resources, project administration, writing – original draft.
Shurui Li: conceptualization, formal analysis, writing – review and editing, investigation.

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