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Original Article

Application of "Internet+" cognitive-behavioral intervention in caregivers of children with congenital heart disease undergoing elective surgery during the COVID-19 pandemic

Liping Jin[1,2*], Peipei Chen[1,2*], Xuehui Fang[3], Congmin Li[2], Guiming Yang[2], Annuo Liu[1]

[1]School of Nursing, Anhui Medical University, Hefei 230061, Anhui, China; [2]Cardiovascular Department, Anhui Provincial Children's Hospital, Hefei 230051, Anhui, China; [3]Anhui Provincial Chest Hospital (Provincial Joint Defense Institute), Hefei 230000, Anhui, China. [*]Equal contributors and co-first authors.

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Abstract: Objective: To explore the effects of cognitive and behavioral interventions for caregivers of children undergoing interventional surgery for congenital heart disease (CHD) during COVID-19. Methods: A prospective study was conducted on 140 children with CHD who were hospitalized in the Department of Cardiology in a children's hospital from March 2020 to March 2022. The children were randomly divided into an intervention group and a control group, with 70 cases in each group. In the control group, caregivers gave routine care, and in the intervention group, "Internet+" cognitive and behavioral interventions were given. The psychological status of caregivers before and after intervention, day care ability on the operation day, readiness for hospital discharge of the caregivers, sleep quality, and postoperative complications of the children, the medication compliance, review compliance and satisfaction were compared between the two groups. Results: During the COVID-19 pandemic, the anxiety and depression scores of caregivers in the intervention group were significantly lower than those in the control group ($P<0.05$), and the caregiving ability and readiness for hospital discharge of the caregivers in the intervention group were better than those in the control group ($P<0.05$). The sleep quality of children in the intervention group was significantly better than that in the control group during the first week after operation ($P<0.05$). Postoperative complications were significantly fewer in the intervention group than in the control group ($\chi^2=24.433$, $P<0.001$). The medication compliance, review compliance, and satisfaction were higher in the intervention group than in the control group ($P<0.05$). Conclusion: During the pandemic period of COVID-19, "Internet+" cognitive and behavioral intervention has a good effect and should be promoted in clinical practice.

Keywords: Cognitive behavioral intervention, congenital heart disease, interventional surgery, COVID-19

Introduction

Congenital heart disease (CHD) is caused by anomalous anatomical structure of the heart due to abnormal development of heart vessels during embryonic development, and it is one of the common of death in children [1-3]. Interventional therapy is a method of percutaneous puncture of the peripheral vasculature by pushing a catheter to the corresponding site of the cardiac lesion with the assistance of fluoroscopic X-ray and echocardiography. With the development of interventional techniques and occludes, trans-catheter occlusion therapy has a high success rate and has become the main treatment for CHD [4]. Caregivers of children with CHD usually face a great deal of mental stress [5], and the caregiving ability of caregivers has a direct impact on the recovery and quality of life of the children [6, 7]. Cognitive-behavioral interventions are aimed at improving the cognition and behavior of individuals by reconstructing their cognition and correcting their maladaptive behaviors so that they can manage the disease scientifically. Most studies focused on the cognitive-formative interven-

Table 1. Demographic characteristics of child patients

Variable	Intervention (n=70)	Control (n=70)	*P* value
Gender			0.86
M	25 (35.7%)	24 (34.3%)	
F	45 (64.3%)	46 (65.7%)	
Age (yrs.)	4.32±2.72	4.15±2.45	0.71
One child			0.76
Y	34 (48.6%)	32 (45.7%)	
N	36 (51.4%)	38 (54.3%)	
Residence			0.83
Country	42 (60.0%)	43 (61.4%)	
City	28 (40.0%)	27 (38.6%)	
CHD Types			0.52
VSD	20 (28.6%)	19 (27.1%)	
ASD	31 (44.3%)	32 (45.7%)	
PDA	16 (22.9%)	14 (20.0%)	
PS	3 (4.3%)	5 (7.1%)	

Note: Count and percentage expressed data except for age, defined by mean ± standard deviation. M: male, F: female, yrs.: years, Y: yes, N: no, CHD: congenital heart disease, VSD: ventricular septal defect, ASD: atrial septal defect, PDA: patent ductus arteriosus, PS: pulmonary valve stenosis.

tions act directly on patients themselves, while fewer studies address cognitive-behavioral interventions for caregivers. The advent of the Internet+ Link era provides patients with real-time, convenient and refined healthcare services [8]. During the pandemic period of COVID-19, there are more uncertainties, and the task of prevention and control is complex and variable [9], which bring adverse emotions to health personnel [10]. Internet technology provides conditions for rapid response in the health care delivery system because of its institutional and technical feasibility [11]. The aim of this study was to investigate the effects brought to the children with CHD after giving cognitive-behavioral interventions on their caregivers using internet in the context of the COVID-19, so as to provide a reference for its application in different clinical situations.

Data and methods

General data

This prospective study included 140 children who received the first intervention for CHD in a children's hospital from March 2020 to March 2022. The children were randomly divided into an intervention group (70 cases) and a control group (70 cases) according to a random number table. The mean age of the intervention group was 4.32 years and that of the control group was 4.15 years. Paired t test was employed to determine the differences in age between the intervention and control groups, and no significant difference was illustrated ($P>0.05$, **Table 1**). There was also no statistically significant difference in the age, sex, or education level between the caregivers of the two groups ($P>0.05$), so the target values of the two groups were comparable (**Table 2**).

Inclusion criteria (caregivers and children): 1) children with indications for CHD intervention; 2) children who did not receive interventional procedure for CHD before; 3) children who had successful procedures; 4) caregivers without cognitive or communication impairment; 5) subjects who voluntarily participated in the study and gave an informed consent; 6) caregivers who were proficient in communication using internet. Exclusion criteria: 1) children who were in need of complex CHD surgery; 2) children with diseases such as bleeding disorders or coagulation disorders; 3) children with intracardiac hyperplasia, active endocarditis or sepsis; 4) children with fever or cough one week before surgery; 5) children with unsuccessful interventional treatment.

Interventions

Children in the control group were given routine perioperative education upon admission, routine care during hospitalization, and routine discharge instructions upon discharge. Routine care for CHD included maintaining indoor air circulation, providing adequate drinking water and a diet rich in calories, protein and vitamins. The cognitive-behavioral interventions for the caregivers of children in the intervention group were uniformly conducted by two specially trained nurses at three time points: at admission, before surgery and before discharge. The measures taken by the intervention group include sharing disease-related knowledge through the Internet and preparing materials before surgery. Then, the pictures and videos during the operation will be shared with the caregivers on the Internet, and the caregivers

Table 2. Demographic characteristics of caregivers

Variable	Intervention (n=70)	Control (n=70)	*P* value
Relationship			0.56
Father	25 (35.7%)	24 (34.3%)	
Mother	43 (61.4%)	43 (61.4%)	
Others	2 (2.9%)	3 (4.3%)	
Age (yrs.)	29.56±6.33	30.90±5.51	0.183
Occupation			0.76
Farmer	8 (11.4)	9 (12.9)	
Blue-collar workers	24 (34.3)	22 (31.4)	
White-collar worker	17 (24.3)	19 (27.1)	
Others	21 (30.0)	20 (28.6)	
Education			0.65
≤ Junior high school	15 (21.4)	17 (24.3)	
Senior high school	25 (35.7)	21 (30.0)	
College and above	30 (42.9)	32 (45.7)	

Note: Counts and percentage expressed data except for age, defined by mean ± standard deviation. yrs.: years.

will be instructed on how to calm the children and postoperative rehabilitation training videos. See **Table 3** for details.

Observation indexes

Psychological status: The Anxiety Self-Assessment Scale (SAS) and the Depression Self-Assessment Scale (SDS) were given to the caregivers of both groups on the day before surgery. Higher scores indicate more pronounced anxiety and depression [12].

Caregiver daytime caregiving ability: The caregiving ability of the child's caregivers was evaluated using the daytime caregiving ability scale developed by Du Yulin [13]. The scale was given on the day of surgery.

Sleep quality: The Pittsburgh Sleep Quality Inventory (PSQI) was used to evaluate the sleep quality of the children before and 1 day, 1 week and 1 month after surgery [14]. Children ≥6 years old were rated by themselves, and those younger than 6 years old were rated by their caregivers on behalf. The 1-week and 1-month postoperative scores were given by the same caregiver and obtained by nurses at follow-up visits.

Complications: Urinary retention, infection, bleeding and ecchymosis after surgery were evaluated.

Adherence to postoperative medication and review: At 1 week and 1 month after surgery, the control group was asked by telephone and the intervention group was asked by telephone or WeChat or QQ about the children's adherence to postoperative medication and review.

Satisfaction analysis: The Likert 5-point scale was used for evaluation, with 5 being very satisfied, 4 being relatively satisfied, 3 being relatively unsatisfied, 2 being unsatisfied, and 1 being very unsatisfied. The satisfaction of the child's caregivers was evaluated at discharge and 1 month after the surgery, respectively [15].

Caregivers' readiness for discharge: Readiness for hospital discharge scale (RHDS) initially developed by Weiss *et al.* in 2006 was ameliorated for use in our study [16]. Three dimensions including self-condition, adaptability, and expected care support were evaluated based on 25 items. The score of each item ranges from 0 to 10. The total score is the sum of all dimensions, and is positively correlated with the readiness for discharge.

Statistical methods

EPIDATA 3.2 software was used for data entry, and SPSS 25.0 software was used for statistical analysis of the data. The measured data were expressed as mean ± standard deviation. The comparison of the means between groups was performed by independent sample t-test, and the comparison within the same group before and after the intervention was performed by the paired t-test. The level of significance was set at $\alpha=0.05$.

Results

Comparison of psychological status and day care capacity of caregivers

Before the intervention, the depression and anxiety scores of the caregivers in the intervention and control groups were similar ($P>0.05$). After the intervention, the depression and anxiety scores of the intervention group were lower than those of the control group, and the day care capacity of the intervention group was

Table 3. Cognitive-behavioral intervention program

Time	Main Content	Form	Duration (min)	Specific measures
At admission	Hospital Assessment + Cognitive Behavior Interventions	Internet+ Communicating from a safe distance	20	After admission, informed consent was obtained. Through communication with internet, the caregiver's psychological status was assessed. Disease-related knowledges were shared using pictures, audio and video links, including explanations on medical insurance registration, pre-surgery material preparation (diapers, milk powder, clean blankets and clothes, toys and items that can soothe the child), bedtime urination exercises, etc. The reasons to limit chaperones during the of COVID-19 and require negative pcr test were also explained in the assessment and interventions.
1 day before surgery	Pre-operative Assessment + Cognitive Behavior Interventions	Internet+ Communicating from a safe distance	20	We assessed their psychological status and cognitive and behavioral conditions regarding cooperation with perioperative treatment and care, and gave psychological support by verbal communication. Pictures and videos regarding postoperative puncture site pressure, pulse perception, tips during the surgical procedure, postoperative puncture site bleeding and observation of the condition were shared. The caregivers were instructed about how to intervene with children who were ornery or experiencing adverse emotions after awakening from surgery by using the child's favorite objects or toys, or by playing their favorite music and cartoons, so as to calm the child or eliminate postoperative discomfort.
1 day before discharge	Discharge assessment + Cognitive behaviors interventions	Internet+ Communicating from a safe distance	15	Their psychological condition and pre-discharge preparation was assessed, and their understandings of post-discharge aspects such as diet, rest, exercise and review were evaluated. The puncture points and post-operative medications were checked. At the same time, videos of relevant precautions and rehabilitation exercises during rehabilitation were shared, and personalized rehabilitation plans were made together with the caregivers. Explanations and guidance were given to ensure that they could be implemented correctly.

higher than that of the control group ($P<0.05$, **Table 4**).

Comparison of sleep quality of children

On the day before surgery, there was no significant difference in sleep quality between the two groups ($P>0.05$). After the intervention, the sleep quality of the intervention group was significantly better than that of the control group on the day after surgery and at 1 week after discharge ($P<0.05$). However, at 1 month after surgery, there was no significant difference between the two groups ($P>0.05$, **Table 5**).

Comparison of postoperative complications

The intervention group had significantly fewer postoperative complications than the control group ($\chi^2=24.433$, $P<0.001$). To be specific, the incidences of postoperative urinary retention, puncture site bleeding and puncture site petechiae were lower in the intervention group than in the control group ($P<0.05$). The difference in the incidence of infection between the two groups was not significant ($P>0.05$). See **Table 6**.

Comparison of compliance behavior and caregiver satisfaction

At 1 month after surgery, the caregivers evaluated the medication compliance and review compliance in the past month, and the results showed that the medication compliance and review compliance in the intervention group were higher than those in the control group ($P<0.05$). At 1 month postoperatively, a satisfaction survey was conducted on the caregivers of children in both groups, and the satisfaction of the intervention group was higher than that of the control group ($P<0.05$). See **Table 7**.

Comparison of readiness for discharge in caregivers

According to the RHDS scores, a significantly higher total score was obtained in caregivers with interventions than the controls ($P<0.05$). Among subordinate three dimensions, the interventions were observed to improve the self-

Table 4. Comparison of depression, anxiety status, and day care capacity of child caregivers in the two groups (x±s)

Group	Number of cases	Pre-intervention		Post-intervention		Day care capacity
		SAS score	SDS score	SAS score	SDS score	
Intervention group	70	32.01±1.13	27.90±2.19	26.48±1.50	23.20±1.51	97.13±1.07
Control group	70	32.31±0.91	27.26±2.47	31.32±2.74	26.33±2.67	92.01±1.31
t		1.790	1.627	12.981	8.529	25.503
P		0.076	0.106	<0.001	<0.001	<0.001

Note: SAS: Anxiety Self-Assessment Scale; SDS: Depression Self-Assessment Scale.

Table 5. Comparison of sleep quality scores between the two groups (x±s)

Group	Number of cases	1 day prior to surgery	1 day after surgery	1 week after discharge	1 month after surgery
Intervention group	70	9.11±2.01	8.56±1.27	8.88±1.60	9.31±1.90
Control group	70	8.93±2.36	8.04±1.12	8.28±1.62	9.03±1.92
t		0.489	2.586	2.195	0.855
P		0.626	0.011	0.030	0.394

Table 6. Comparison of postoperative complications between the two groups

Group	Number of cases	Postoperative urinary retention	Puncture point bleeding	Piercing bruisesm (Length to diameter >5 cm)	Infection (fever)	Total number of complications
Intervention group	70	3	2	10	1	16
Control group	70	11	8	23	3	45
χ^2		5.079	3.877	6.701	0.257	24.433
P		0.024	0.049	0.009	0.612	<0.001

Table 7. Comparison of medication compliance and review compliance between the two groups in the first month after surgery

Group	Number of cases	Drug compliance (good)	Review compliance (OK)	Satisfaction score
Intervention group	70	61	63	4.20±0.65
Control group	70	48	54	3.28±0.67
χ^2/t		7.002	4.214	8.236
P		0.008	0.040	<0.001

Table 8. Comparison of caregivers' readiness for discharge

	Total score (100)	Self-condition	Adaptability	Expected support support
Intervention	84.50±8.659	19.73±3.012	34.91±2.962	29.86±3.218
Control	81.00±8.848	18.17±3.190	32.96±2.931	29.87±3.571
t	2.365	2.970	3.929	0.025
P value	0.020	0.004	0.001	0.980

condition and adaptability of caregivers ($P<0.05$), whereas no difference was shown in the perception of expected care support between groups ($P>0.05$). Related data and statistical results are illustrated in **Table 8**.

Discussion

"Internet+" cognitive-behavioral interventions alleviate caregivers' anxiety and depression and improve their caregiving ability

Because of COVID-19, caregivers are more psychologically stressed and prone to anxiety and depression when they are affected by factors such as limited social functioning, especially lack of understanding of the disease and fear of cardiac surgery. Some studies have shown [17] that cognitive behavioral interventions can effectively alleviate depres-

sion and anxiety in cardiac patients after surgery. On the one hand, the caregivers of children with CHD are usually the closest people to the children, and they are more psychologically concerned about the children and fear of heart surgery. This anxiety is often more complicated than the emotions of the children. Cognitive interventions on cognitive situation such as psychological guidance and disease education can improve caregivers' understanding of the disease and can enhance their confidence in treatment. On the other hand, caregivers of children with CHD are mostly young people who are more exposed to the Internet and aware of the hazards of the COVID-19, so they are more likely to develop adverse emotions [18], which can have an impact on social functioning and other aspects [19]. Through "Internet+" cognitive-behavioral interventions, we can effectively improve limited communication, so as to help caregivers establish a heathy mindset, guide correct behaviors, and shift their attention to the affected child to alleviate their negative emotions. In addition, the caregiver's ability to care for the child was enhanced through individualized instruction by a dedicated nurse who used a variety of teaching methods to inform, explain and instruct the caregiver about the disease and surgery. In this study, caregivers in the intervention group were significantly less anxious and depressed than those in the control group and had higher daytime caregiving capacity than those in the control group (**Table 4**).

"Internet+" cognitive-behavioral intervention improves sleep quality in children

It has been demonstrated [20] that cognitive-behavioral interventions can affect the sleep quality of patients. In this study, the sleep quality score of children in the intervention group was higher than that in the control group. Most children with CHD are young and not cognitively fully-developed. So, entering an unfamiliar environment and seeing unfamiliar faces can lead to fear and other negative feelings. In addition, the pain at the puncture site after awakening from anesthesia, postoperative complications, and the need for bed braking can cause severe discomfort to the children, reducing their quality of life and speed of recovery. Cognitive and behavioral interventions for caregivers at key points in time through the Internet can bring a sense of security to the child by keeping the caregiver in a good mood. In this case, the children can easily accept care operations given by the caregivers, such as puncture site pressure and electrode site change, which can reduce crying and other undesirable emotions and behaviors, so that the sleep pattern is not affected and disturbed. In addition, through the Internet interventions, caregivers can always check when there is anything unclear, so that they know what to prepare and to do before the operation, such as using the child's favorite objects and toys, or playing the child's favorite music or songs to distract the child's attention, which can effectively relieve the child's discomfort and improve the child's sleep quality. In this study, there was no significant difference in the sleep quality scores between the two groups of children 1 month after surgery (P=0.394), but the sleep quality scores of children in the intervention group were higher than those in the control group 1 day and 1 week after surgery, (P=0.011, 0.030, **Table 5**).

"Internet+" cognitive-behavioral interventions improve compliance behavior of children and their caregivers and reduce surgical complications

Common complications after interventional procedures include postoperative urinary retention, bleeding at the puncture site, subcutaneous hematoma or petechiae, or infection [21]. There are three common reasons for urinary retention after surgery: most children are not accustomed to bedside urination and cannot initiate urination; failure to give urination exercises before surgery or short duration of exercises; and children's inability to accept the instructions given by medical staff for urination. In this study, the correct urinary exercise video link was sent to the caregivers through the Internet upon admission, and the caregivers were able to correctly recognize, understand, and implement the urinary exercise. Also, the caregivers gave the children bed urinary exercise before to give them sufficient adaptation process, which made the process easier for the children, thus significantly reducing the incidence of postoperative urinary retention.

Children with CHD are mostly under 6 years old and have incomplete cognition, so they are

more likely to distance themselves from the medical workers, who are unfamiliar to them. So, the degree of cooperation with the treatment and care of the disease depends mainly on their caregivers. Through cognitive-behavioral interventions for caregivers, the caregivers were fully aware of the disease and knew what to do and when to do it. This study showed that the occurrence of bleeding and petechiae at the puncture site was significantly lower in the intervention group than in the control group, possibly because of the use of the Internet to give perioperative cooperation guidance and other related content. By using the children's favorite objects or toys to distract and calm the children, the occurrence of crying and non-cooperation was reduced. At the same time, the caregivers know how to properly observe and handle conditions such as puncture point pressure and bleeding, effectively reducing the incidence of puncture point bleeding, subcutaneous hematoma or petechiae.

"Internet+" cognitive-behavioral interventions indirectly affect doctor-patient relationship, incidence of hospital-acquired illness and caregiver satisfaction

The assessment on visit behavior during the COVID-19 pandemic is necessary for improving treatment and mental health care planning, and developing preventive measures for a potential subsequent pandemic [22]. During COVID-19 pandemic, hospitals introduced many administrative restrictions that caused much inconvenience for both patients and doctors, leading to negative feelings among caregivers and affecting satisfaction. However, through the use of Internet+, management requirements could be fully communicated so that caregivers could fully understand the prevention and control measures during the COVID-19 pandemic such as limiting the number of visitors, which could reduce the incidence of hospitalization caused by covid-19 infection and relief negative emotions due to lack of understanding of restrictions. During the hospitalization period, we used the Internet to implement non-contact interventions, showing pictures and videos with explanations, so that caregivers and children could get timely solutions to their questions. During the postoperative rehabilitation, they needed to take medication for a long time and were required for both exercise and review. Dulfer et al. [23] evaluated the effect of exercise training on the quality of life and psychosocial functioning of children with CHD. Through pictures, videos, verbal medication guidance and exercise guidance by the Internet, the patients and caregivers were educated to pay enough attention to postoperative rehabilitation, and correct their wrong perceptions and behaviors. Standardizing follow-up reviews can improve the quality of life of the children, promote early recovery and increase satisfaction. From the results in **Table 7**, there was a significant difference between the two groups of children's compliance with medication and review visits after discharge (P=0.008, 0.040).

"Internet+" cognitive-behavioral interventions increase readiness for hospital discharge in caregivers

Despite of the development of pediatric cardiac surgery technology in decades and the significantly reduced mortality of children with CHD, the special pathophysiological characteristics of children resulted in a longer postoperative adaptation period after surgery [24]. The burden of follow up care mainly falls on caregivers of children after they are discharged from the hospital. It was reported that parents were unprepared to manage the complex care of a child patient if readiness for hospital discharge were lacking, which might lead to re-hospitalization of children with worse complications [25]. That is, the higher the level of readiness for discharge, the stronger the ability of caregivers to cope with the challenges after discharge, and the lower risk of complications and death. In general, the follow-up care requirements and relevant information would be provided to improve the readiness of discharge of caregivers [26], but reduced contact and communication between caregivers and medical workers during the pandemic period of COVID-19 made this more difficult. Instead, "Internet+" cognitive-behavioral interventions emphasizes the importance of the caregiver-child bond, confidence in providing effective care and sufficient post-hospital care knowledge and skills. Our results showed a better readiness for discharge in intervention group than in the control group. Besides, self-conditioning and adaptability were significantly improved by the interventions (**Table 8**). This is consistent with previous find-

ings that effective interventions could be conductive for caregivers to be ready to discharge and guarantee the quality of life of children outside the hospital, and this role could be provided online in special circumstances [27].

Currently, COVID-19 is still in its pandemic stage, requiring social distance among people. Communication and guidance through the Internet+ can achieve effective results by intervening in the incorrect cognitions and behaviors of caregivers of children with CHD. The positive emotions and behaviors of caregivers are the basis for guiding children to effectively cooperate with treatment and care. By intervening the caregivers, they understood disease-related knowledge, which effectively relieved their psychological stress, improved their caregiving ability, and improved the child's discomfort and sleep quality. Communication and training through the Internet to minimize face-to-face contact has also become an important measure to reduce the Covid-19 infection [28]. Caregivers cooperate with medical workers to correctly implement the interventional behaviors can reduce the incidence of postoperative complications in children, such as urinary retention, bleeding, and petechiae, improve compliance with medication and review, facilitate the recovery process, improve the quality of life of children, and increase the satisfaction of children and their caregivers.

Disclosure of conflict of interest

None.

Address correspondence to: Annuo Liu, School of Nursing, Anhui Medical University, 15 Feicui Road, Economic Development Zone, Hefei 230061, Anhui, China. E-mail: w971002y@sohu.com

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