



The effectiveness of health education based on the 5Ts for teach-back on oral nutritional supplements compliance of post-discharge patients after surgery for gastric cancer: a randomized controlled trial

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Abstract

Objective This study aims to explore the 5Ts teach-back(5Ts) to improve oral nutritional supplements (ONS) compliance of discharged patients after gastric cancer surgery.

Setting and methods Patients were recruited from the Bethune First Hospital of Jilin University. The patients were randomly assigned to 5Ts ($n=54$) and routine health education ($n=54$). Weekly ONS compliance was collected by “weekly ONS diary.” ONS knowledge, health literacy, and health education satisfaction were collected at baseline and 5 weeks after discharge. Chi-square test, Mann–Whitney U test, and T test were used for data analysis.

Results At the end of the intervention, there were 41 and 40 patients in intervention and control group. 5Ts significantly improve ONS compliance, ONS knowledge level ($P=0.000$), health literacy level ($P=0.011$), and health education satisfaction ($P=0.009$) of patients. At the end of follow-up, there were 30 and 27 patients in two groups, and no significant difference in ONS compliance ($P=0.728$).

Conclusion The 5Ts can significantly improve patients’ ONS compliance and the effect of health education.

Trial registration number This prospective trial was registered in the Chinese Clinical Trial Registry at ChiCTR2000040986 (<http://www.chictr.org.cn>).

Patient or public contribution Jia Wang and Haiyan Hu contributed to the performance of the study, analysis and interpretation the data, and drafted the manuscript; Jianan Sun and Qing Zhang contributed to the supervision of the study and interpreted the data; Zhiming Chen contributed to the analysis and interpretation the data; Qiuchen Wang contributed to the performance of the study and revised the manuscript; Mingyue Zhu contributed to interpretation the data; Jiannan Yao contributed to revise the manuscript; Hua Yuan and Xiuying Zhang contributed to the conception of the study, performed the study, interpreted the data, and significantly revised the manuscript. All authors screened the final version of the manuscript.

Keywords Gastric cancer · Teach-back method · Oral nutritional supplements · Compliance

Introduction

Gastric cancer was the fifth most common cause of cancer worldwide and was currently the third most common cause of cancer death [1]. At present, although medical treatment has made great progress, surgery excision was still the main effective treatment for gastric cancer [2]. However, gastrectomy and intraoperative digestive tract reconstruction will cause metabolic changes and absorption disorders in patients, resulting in reduced nutritional intake and seriously affecting the nutritional status of patients [3]. In addition, the average length of hospital stay in China was limited and patients did not have enough time to fully recover, leading to

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a high incidence of malnutrition and worsening nutritional status after discharge [4]. Numerous studies had shown that approximately 40 to 80% of gastrectomy patients suffered from malnutrition [5, 6], which may further lead to numerous negative consequences for patients after discharge [7], including reduced chemotherapy tolerance, impaired quality of life, increased morbidity, and reduced survival [8, 9]. Therefore, appropriate nutritional support is of great significance to improve the nutritional status of post-discharge patients after surgery for gastric cancer.

The European Society of Clinical Nutrition and Metabolism (ESPEN) guidelines recommend oral nutritional supplements (ONS) as first-line nutritional therapy for malnutrition after tumor surgery [10]. Numerous clinical studies and systematic analyses have shown that ONS can improve nutritional status and clinical outcomes for hospitalized patients or medical patients in community and nursing home Settings, and further save overall health care costs [11–13]. According to the consensus, discharged patients after gastric cancer surgery should continue to receive nutritional therapy based on ONS for three months or more as needed, depending on their eating and nutritional status [3]. Patient compliance to ONS was the key to the smooth implementation of ONS [14]. However, the ONS compliance was at a poor level due to age, lack of ONS education, lack of relevant knowledge, taste and other reasons [15]. For example, the study of Wan et al. showed that the average compliance of patients with gastric cancer was only 30.59% at 12 weeks (w), and the compliance decreased obviously at 5w [16]. It was worth noting that some researchers had pointed out that lack of ONS education was a significant barrier to ONS compliance [17, 18].

Effective health education could improve the patient's understanding of the disease, so that the patient could consciously cooperate with the treatment [19]. However, in the current clinical practice, the health education mode of medical staff to patients was mostly oral education or distribution of brochures [20], which was a kind of infusing education, was unilateral knowledge input to patients, ignoring the understanding degree of patients to input knowledge [21]; some patients and their families complained that medical staff convey information in ways they could not understand, resulting in poor communication between the two sides [22]. In addition, health literacy (HL) reflected an individual's ability to acquire, understand and process basic health information and services, and to make appropriate health decisions to maintain and promote their own health [23]. Currently, the majority of cancer patients had low levels of HL, such patients had low problem solving ability, treatment motivation and compliance [24]. Therefore, clarifying patients' understanding level of disease knowledge, effectively promoting doctor-patient communication and enhancing patients' HL are conducive to enhancing patients'

awareness of self-management, which may be the key issues to be solved in health education programs for patients with gastric cancer.

The teach-back method was a teaching strategy of two-way transmission of information. Health Care Personnel (HCP) conducted health education to the patients in plain language, and then let the patients describe in their own language to determine their level of understanding or what they had forgotten. If there was wrong or not understood information, HCP will emphasize again and cycle until the patients understands and grasps it correctly [25]. A preliminary review of the literatures showed that the teach-back method had been used as an educational strategy for low-income women [26], people with low HL [27], and people with chronic diseases [28], which could improve patient understanding [29], informed consent [30], and improve dietary compliance [31]. However, the operating steps of the teach-back method have not been completely unified in various studies at present [32]. Based on previous studies on the teach-back method, Kathryn and other researchers developed the 5Ts for Teach Back (5Ts), which was a standardized and operable scheme [33]. Therefore, in this study, the health education program developed based on the 5Ts was expected to improve the ONS compliance of post-discharge patients with gastric cancer after gastrectomy.

Methods

Study design

This study was a single-center, prospective randomized controlled trial. From January 2021 to October 2021, we evaluated the effect of the health education based on 5Ts of post-discharge after gastric cancer surgery. The study was conducted at the Bethune First Hospital of Jilin University. All patients received intervention for 5w (T1) and were followed up to 12w (T2) after discharge. Primary outcomes were ONS compliance, HL, and ONS knowledge level. Secondary outcomes included health education compliance and satisfaction.

Participants

During the study, all eligible patients were screened for inclusion in the study. Inclusion criteria: age ≥ 18 years; All patients were pathologically diagnosed as gastric cancer stage I, II, and III before surgery; subtotal gastrectomy or total gastrectomy; nutritional risk screening 2002 (NRS2002) score ≥ 3 ; patient-generated subjective global assessment (PG-SGA) grades of B or C; There were no pre-operative gastrectomy, radiotherapy or chemotherapy; the patient was capable of oral feeding; patients or their family

members had smartphones and could use WeChat; patients were written informed consent. Patients with concomitants of other cancers, allergies to components in ONS, mental illness, impaired consciousness, and inability to communicate normally were excluded from the study.

The sample size was 40 patients in each group at the end of the intervention, allowing 10% dropped loss and 10% mortality. The calculation formula was as follows: $n_1 = n_2 = (U_\alpha + U_\beta)^2 2P(1-P) / (P_1 - P_2)^2$, consider $\alpha = 0.05$, $U_\alpha = 1.96$; $\beta = 0.1$, $U_\beta = 1.28$, based on the study of Xu et al. [34].

Randomization, allocation concealment, and blinding

The block random grouping method was adopted, and the length of block was six. According to the order of admission, every six subjects are divided into one group, which is grouped by simple random grouping method. The specific steps are as follows:

1. Number the patients according to the sequence of admission time;
2. Using the rand function in Excel, give each patient a random number;
3. The random numbers were arranged from small to large. The patients ranked one-three were taken as the experimental group and the patients ranked four-six were taken as the control group. Patients were given opaque envelopes containing results presented in forms of one (intervention group) and two (control group). The nurses who issued the envelopes and statistical analysts were unaware of the grouping results.

Procedures

Health education content

The members of the research team include professors in the field of gastric cancer nutrition in the Nursing College and nutrition specialist nurses in gastrointestinal surgery. According to the content of conventional health education and clinical practice, on the basis of studies, books, guidelines and consensus [3, 14, 35], this study developed ONS health education content and made health education manuals, including five themes. They are as follows: nutrition and malnutrition; the definition and function of ONS; forms and types of ONS; ONS administration method and precautions; adverse reactions and treatment measures of ONS. After the health education program is formed, the members of the research team will discuss the content together and modify the inappropriate points. After the modification, the program will be further implemented in clinical practice. In

our study, patients' primary physicians prescribed ONS for their first postoperative exhaust, usually within 7 days after surgery. At this point, the researchers will begin a health education program for both groups of patients.

Intervention group

The intervention group received a health education program based on the 5Ts. Kathryn et al. developed the 5Ts in order to make the process of teach-back more specific and convenient for learning. 5Ts was a standardized, actionable definition of Teach Back with five specific, observable steps: Triage, Tools, Take Responsibility, Tell Me, and Try Again. The Triage, Tools, and Try Again steps were used to effectively delivery information, while the Take Responsibility and Tell Me steps were used to assess whether the patient had received the information [33].

Triage: In the triage step, the HCP determined the most important educational topics. Research showed that the more information a clinician provided, the less information a patient remembered correctly. Therefore, an HCP with several pieces of information to cover must categorize the information by selecting what was most important for the patient to remember or understand. This step was key and prevented the HCP from providing too much information. For example, in the topic "Nutrition and malnutrition," the researchers identified information that was most important to patients, such as the concept of malnutrition and its impact on patients. In the process of information delivery, it was necessary to pay attention to replace medical terms involved in educational information with daily terms, so that patients can better understand.

Tools: A tool was broadly defined as anything that helped the HCP provide a clear explanation. Flyers, simple pen and paper drawings, models, diagrams or videos, using HCP's own body (such as a fist to represent a beating heart), or even a related story were all possible tools. In this study, the tools used to deliver educational information included a 17-min video, ONS instruction sheets and HCP's own body, etc.

Take Responsibility: The "Take Responsibility" step was crucial to no-shaming in the definition of Teach-back. This step occurred after the HCP passed the topic information. The ideal "taking responsibility" involved two things. The first was an acknowledgement of the amount or complexity of the information given. If a misunderstanding did occur, this could normalize the misunderstanding, thereby reducing the patient's sense of shame. The second implication was that HCP rather than the patient was being tested, a factor that also reduced the burden on the patient. In this study, when patients had misunderstandings, the researcher would say, "It's a lot of information and it's

hard to remember all of it at once, so I want to make sure I have a good explanation.”

Tell Me: In the “Tell Me” phase, HCP invited patients to state what they understood in their own words. Suppose an HCP spend 20 min explaining “adverse reactions and treatment measures of ONS” and then said, “Tell me what you've learned about ONS.” In this case, the patient might be overwhelmed by the amount of information she needed to answer and might not know where to start. Tell me more specifically, for example, “What are the adverse effects of ONS?” “What happens when you have diarrhea after taking ONS?” This approach allowed the patient and the HCP to focus on a specific piece of information.

Try Again: If the patient did not understand, the HCP must explain it again and modify the explanation to make it clearer. Depending on the size of the error, another round of teach-back might be required. HCP can take responsibility for mistakes by going back to the “take responsibility” step, for example, “I'm sorry, I must have not explained it well enough.” Taking responsibility again reduced the shame patients feel about mistakes.

In order to ensure the quality of health education, each round of education focused on only one health education item. Repeated the 5Ts for the next round of health education. Within 1w to 5w after discharge, patients' recall of educational themes will be evaluated by telephone or WeChat(a popular social media app in China) [36] by asking questions. Patients with incorrect answers will be re-educated on the wrong themes through 5Ts.

Control group

The control group received traditional health education in the gastrointestinal surgery department. According to ONS health education manual, oral health education was delivered to patients and their families by researcher. Within 5w after discharge, the patients' recall of educational themes was also evaluated weekly by telephone or WeChat. If the patients had any questions and actively sought answers, the researchers would answer them.

Data collection

Demographic and clinical information questionnaire

Demographic and clinical information was collected at baseline (T0) using questionnaires and collected by specialized researcher who was unaware of the grouping. Demographic information included age, sex, education level, comorbidities, and other data. Preoperative height, weight, body mass index (BMI), NRS2002 [37], and PG-SGA [38] were assessed by clinical dietitians. And

the hospital's medical record system was used to collect surgical information, pathological stages, and whether patients received chemotherapy.

Primary endpoints

ONS compliance “Weekly ONS diary” were collected to calculate ONS compliance [16]. The “weekly ONS diary” produced by Wan et al., contains the date, the name of ONS, the amount of taking ONS, and adverse reactions. Calculation method of compliance: weekly compliance rate (%) = dosage taken/prescribed dosage * 100% weekly. In this study, the weekly compliance rate of patients within 12w after discharge was collected, and the compliance rate at 5w and 12w as well as the average compliance rate within 5w and 12w were statistically analyzed.

In this study, patients were divided into compliance groups with dual indicators of Dose and days every week after discharge, and then the trend of ONS compliance of discharged patients after gastric cancer surgery was analyzed: Full Dose and Full Time (DT); Full Dose and Insufficient time (Dt); Insufficient dose and Full Time (dT); Insufficient dose and Insufficient time (dt). The average patient compliance rate was calculated by adding the compliance rate per patient divided by the total number of patients.

ONS knowledge level ONS knowledge level was designed by researchers according to health education content [3, 14, 35], including five themes, a total of 20 questions, 5 points for each question. The total score ranged from 0 to 100, and the higher the score, the higher the ONS knowledge level.

HL HL was measured by the Chinese version of Health Literacy Management Scale (HeLMS) translated [39], which contained 24 items in 4 dimensions. It included the ability to acquire information (9 items), the ability to communicate and interact (9 items), the willingness to improve health (4 items) and the willingness to provide financial support (2 items). Likert 5 score was adopted, 1 meant “very difficult or very unwilling” and 5 meant “no difficulty or very willing.” The total score ranged from 24 to 120. The higher the score is, the higher the health literacy level is. The coefficient of total Amount Table Cronbach's α is 0.901, Cronbach's in each dimension α are 0.885–0.925, the reliability and validity are good. HL and ONS knowledge level will be collected at T1.

Secondary endpoints

Health education compliance Because of the total number of health education participation was 6, the calculation method of health education compliance was: participation times / 6 * 100%.

Health education satisfaction Based on the Chinese version of “Ware's” Patient Satisfaction Questionnaire (PSQ-18) translated by Cui et al. [40], this study was modified to form the health education satisfaction questionnaire. PSQ-18 was divided into 7 dimensions, including overall satisfaction, technical service quality, nurses' interpersonal communication ability, nurse-patient communication level, service economy, service timeliness, and service accessibility. Each dimension included forward and reverse questioning methods. The corresponding questions were normalized before statistical analysis, and the higher the score, the better the satisfaction. PSQ-18's maximum satisfaction score for each question was 5 points, with a full score of 90 points. The coefficient of total Cronbach's α is 0.852, split half reliability is 0.813, and KMO is 0.867, indicating good reliability and validity. Health education compliance and satisfaction will be collected at T1.

In order to exclude the influence of diet, we calculated and collected the calories in patients' daily diet based on the Chinese local diet assessment Form (1–5 points) [41].

Ethics

The study was conducted at the Bethune First Hospital of Jilin University. The study was approved by our Institutional Review Board (No.2020082802) and carried out in accordance with the Declaration of Helsinki (as revised in 2013) and its subsequent amendments to ethical standards. In addition, all participants provided written informed consent forms.

Statistical analysis

All statistical analyses were performed using SPSS25.0 software (SPSS Inc., Chicago, IL). Normal distribution data were expressed by median \pm standard deviation ($M \pm SD$). Non-normally distributed data are summarized and compared by median (P_{25}, P_{75}), and classified variables are expressed in numbers and percentages. Wilcoxon rank sum test was used to evaluate changes in weight and BMI at T0, T1 and T2 in two groups. Chi-square test, Mann–Whitney U test, and T -test were used to assess differences in baseline characteristics and other outcome measures between the two groups. When P value < 0.05 , the difference was considered statistically significant.

Results

Patients characteristics

Of the 160 patients, 108 met the inclusion criteria and were randomized, with 54 assigned to the intervention

group and 54 to the control group. Baseline demographic and clinical characteristics of patients, as shown in Table 1, showed no significant difference between the two groups ($P > 0.05$). During the intervention, 13 patients in the intervention group and 14 patients in the control group were lost due to death, complications, loss of contact and other reasons, but no patients changed from the control group to the intervention group. In addition, during the follow-up from 5 to 12w after discharge, 11 patients and 13 patients in the two groups were lost due to death and non-compliance, respectively. Finally, data of 81 patients were included for analysis at T1 and 57 patients were included for analysis at T2 (Fig. 1).

Primary endpoints

Comparison of ONS compliance between the two groups within 12w after discharge

As can be seen from Fig. 2, ONS compliance of all patients from discharge to T2 showed a decreasing trend over time. At T1, the compliance rate of patients in the intervention group (55.69%) was significantly higher than that of the control group (32.86%) ($P = 0.009$), while at T2, the compliance rate of patients in the intervention group was higher than that of the control group (25.95% vs 21.40%). But there was no significant difference ($P = 0.728$). In addition, the average compliance rate at T1 in the intervention group (65.70%) was significantly higher than that in the control group (43.73%) ($P = 0.005$). The average compliance rate at T2 between the two groups showed the same results (48.14% vs 32.77%, $P = 0.020$). In addition, patients in the intervention group showed a sharp decline in compliance 4–5w after discharge, but the decline rate slowed down 5–6w after discharge.

The number of dT was highest in both groups within 12w after discharge. In Fig. 3, the number of DT in the intervention group decreased gradually throughout the 12-week follow-up period, from more than 20 to less than 10, but remained stable at less than 10 after 9w; the number of dT gradually increased and stabilized at 10w. The number of Dt patients was the lowest, and decreased gradually in the first 5w after discharge, and disappeared at 10w. The number of dt was increasing during 12w after discharge. Figure 4 reflects the change of ONS compliance in the control group within 12w after discharge. With the change of time, the number of DT gradually decreased, stabilized at less than 10 from the second week, and remained unchanged from the 8–12w. DT occupies the largest proportion, but the number is gradually decreasing with the change of time. Dt had the lowest number and disappeared in 9w.

Table 1 Demographic and clinical characteristics at the baseline in the intervention and control groups

Variable	Intervention Group (n=54)	Control Group (n=54)	t/U/X ²	P value
Gender, n (%)			0.185	0.667
Male	40(74.1)	38(70.4)		
Female	14(25.9)	16(29.6)		
Age(years), $\bar{x} \pm SD$	60.00 \pm 10.93	61.02 \pm 10.23	-0.500	0.618
Weight(kg), $\bar{x} \pm SD$	62.39 \pm 8.65	63.66 \pm 10.00	-0.703	0.484
BMI (Kg/m ²), $\bar{x} \pm SD$	22.47 \pm 2.78	22.83 \pm 3.37	-0.599	0.551
Residence, n (%)			0.178	0.673
Urban	37(68.5)	39(72.2)		
Rural	17(31.5)	15(27.8)		
Way of living, n (%)			2.575	0.276
Live with spouse	36(66.7)	39(72.2)		
Live with children	8(14.8)	3(5.6)		
Live with spouse and children	10(18.5)	12(22.2)		
Professional types, n (%)			5.672	0.461
Employees of public institutions	5(9.3)	5(9.3)		
Employee of enterprise unit	4(7.4)	6(11.1)		
Workers	4(7.4)	2(3.7)		
Farmers	18(33.3)	20(37.0)		
Freelance	4(7.4)	0(0.0)		
Retired	16(29.6)	16(29.6)		
No	3(5.6)	5(9.3)		
Type of Medical insurance, n (%)			2.582	0.461
Employee medical insurance	21(38.9)	27(50.0)		
Medical insurance for urban residents	10(18.5)	8(14.8)		
New rural cooperative medical insurance	23(42.6)	18(33.3)		
At his/her own expense	0(0.0)	1(1.9)		
Education level, n (%)			0.973	0.808
Primary school or below	16(29.6)	14(25.9)		
Junior high school	24(44.4)	23(42.6)		
High school	10(18.5)	10(18.5)		
College or university	4(7.4)	7(13.0)		
Marital status, n (%)			1.763	0.184
Spouse deceased or divorced	7(13.0)	3(5.6)		
Married	47(87.0)	51(94.4)		
Household per capita monthly income, ¥, n (%)			2.518	0.472
< 1000	6(11.1)	4(7.4)		
1001–3000	28(51.9)	28(51.9)		
3001–5000	18(33.3)	16(29.6)		
> 5000	2(3.7)	6(11.1)		
Smoking, n (%)			2.455	0.117
Yes	18(33.3)	26(48.1)		
No	36(66.7)	28(51.9)		
Drinking, n (%)			0.635	0.425
Yes	18(33.3)	22(40.7)		
No	36(66.7)	32(59.3)		
Comorbidity n (%)			3.297	0.509
0	36(66.7)	36(66.7)		
1	14(25.9)	12(22.2)		
2	4(7.4)	3(5.6)		

Table 1 (continued)

Variable	Intervention Group (<i>n</i> =54)	Control Group (<i>n</i> =54)	t/U/X ²	<i>P</i> value
3	0(0.0)	2(3.7)		
4	0(0.0)	1(1.9)		
Primary caregivers, <i>n</i> (%)			0.705	0.703
Spouse	33(61.1)	34(63.0)		
Children	17(31.5)	14(25.9)		
Himself/herself	4(7.4)	6(11.1)		
Age of the primary caregivers(years), $\bar{x} \pm$ SD	50.11 \pm 10.77	52.98 \pm 10.75	-1.386	0.169
Education level of the primary caregivers, <i>n</i> (%)			0.815	0.846
Primary school or below	15(27.8)	14(25.9)		
Junior high school	15(27.8)	19(35.2)		
High school	16(29.6)	13(24.1)		
College or university	8(14.8)	8(14.8)		
Professional types of the primary caregivers, <i>n</i> (%)			4.766	0.689
Employees of public institutions	4(7.4)	7(13.0)		
Employee of enterprise unit	6(11.1)	7(13.0)		
Teachers	1(1.9)	0(0.0)		
Workers	6(11.1)	4(7.4)		
Farmers	16(29.6)	16(29.6)		
Freelance	11(20.4)	6(11.1)		
Retired	6(11.1)	10(18.5)		
No	4(7.4)	4(7.4)		
NRS2002, <i>M</i> (<i>P</i> ₂₅ , <i>P</i> ₇₅)	4[3,5]	3[3,5]	1398.0	0.690
PG-SGA, <i>M</i> (<i>P</i> ₂₅ , <i>P</i> ₇₅)	8[6,10]	10[6,12]	1182.0	0.088
Approach, <i>n</i> (%)			0.911	0.340
Open	7(13.0)	4(7.4)		
Laparoscopic	47(87.0)	50(92.6)		
Surgical procedure, <i>n</i> (%)			0.052	0.820
Total gastrectomy	13(24.1)	12(22.2)		
Subtotal gastrectomy	41(75.9)	42(77.8)		
Operation time (min), <i>M</i> (<i>P</i> ₂₅ , <i>P</i> ₇₅)	180[147,206]	190[155,218]	1394.0	0.694
Intraoperative blood loss (ml), <i>M</i> (<i>P</i> ₂₅ , <i>P</i> ₇₅)	35[20,100]	30[20,82.5]	1349.5	0.503
Tumor types, <i>n</i> (%)			4.422	0.110
Adenocarcinoma	49(90.7)	52(96.3)		
Squamous cell carcinomas	4(7.4)	0(0.0)		
Signet ring cell carcinoma	1(1.9)	2(3.7)		
Pathological stage, <i>n</i> (%)			0.737	0.692
I	19(35.2)	20(37.0)		
II	21(38.9)	17(31.5)		
III	14(25.9)	17(31.5)		
Adjuvant chemotherapy, <i>n</i> (%)			0.156	0.693
Yes	34(63.0)	32(59.3)		
No	20(37.0)	22(40.7)		
The texture types of ONS, <i>n</i> (%)			0.540	0.462
Powder	51(94.4)	49(90.7)		
Liquid	3(5.6)	5(9.3)		

ONS oral nutritional supplement; PG-SGA patientgenerated subjective global assessments; *M* median

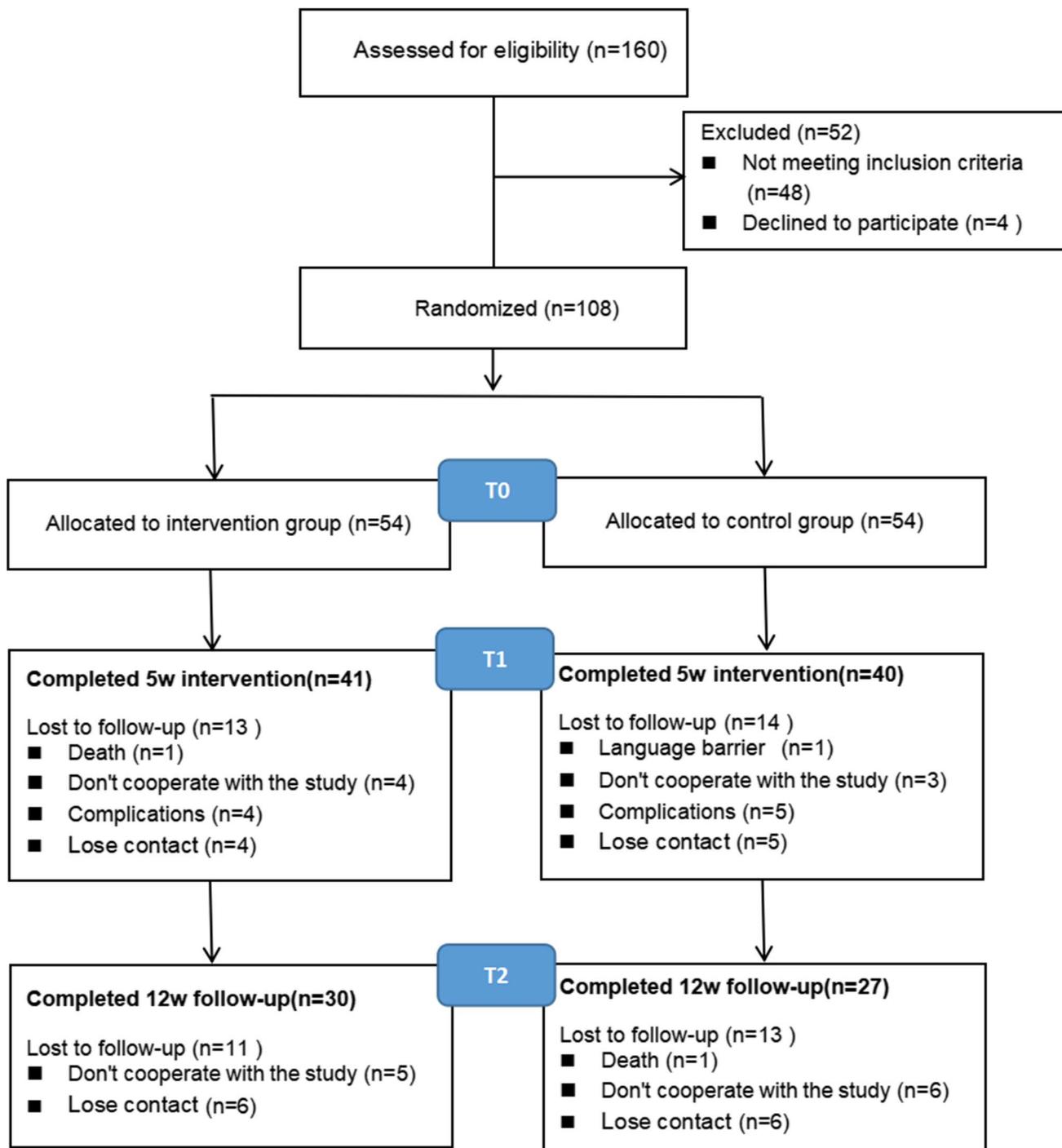


Fig. 1 Flow chart of the study

Comparison of ONS knowledge level between the two groups before and after intervention

At T0, there was no significant difference in the scores and total scores of all dimensions between the two groups ($P > 0.05$). Nutrition and malnutrition, ONS Administration

Method and Precautions, Adverse reactions and treatment measures of ONS, and Total scores reported by the intervention group were significantly higher than those of control group at T1 ($P = 0.036; 0.006; 0.012; 0.000$). There were no significant differences between the two groups in other outcomes of ONS knowledge level ($P > 0.05$) (Table 2).

Fig. 2 Comparison of ONS compliance between the two groups within 12w after discharge. Abbreviation: IG: Intervention group; CG: Control group

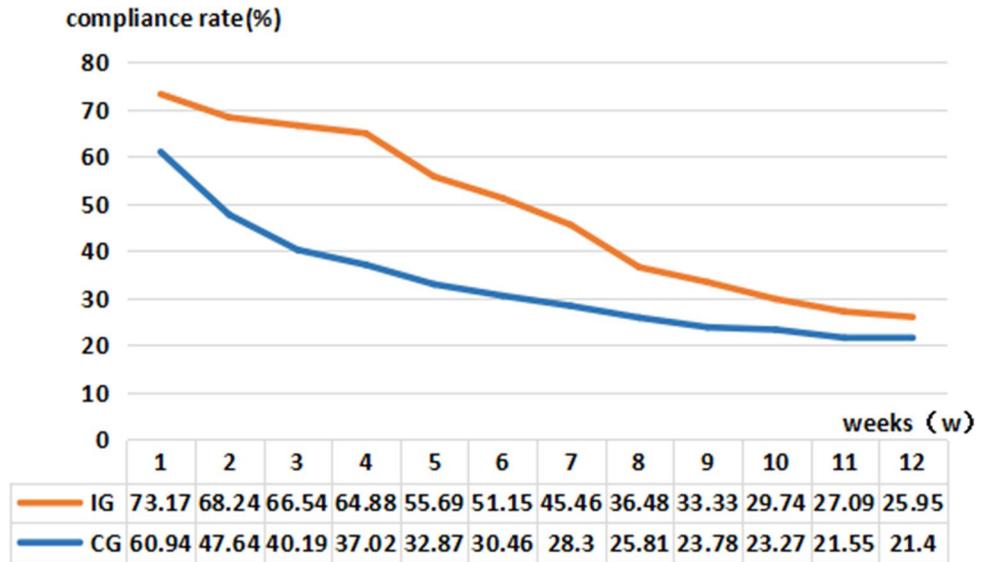


Fig. 3 Changes in ONS compliance of the intervention group within 12w after discharge

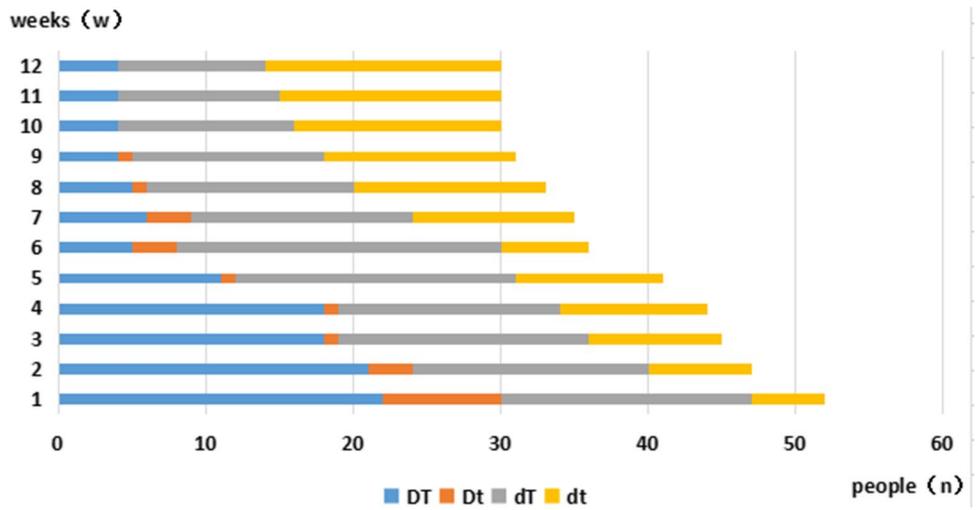


Fig. 4 Changes in ONS compliance of the control group within 12w after discharge

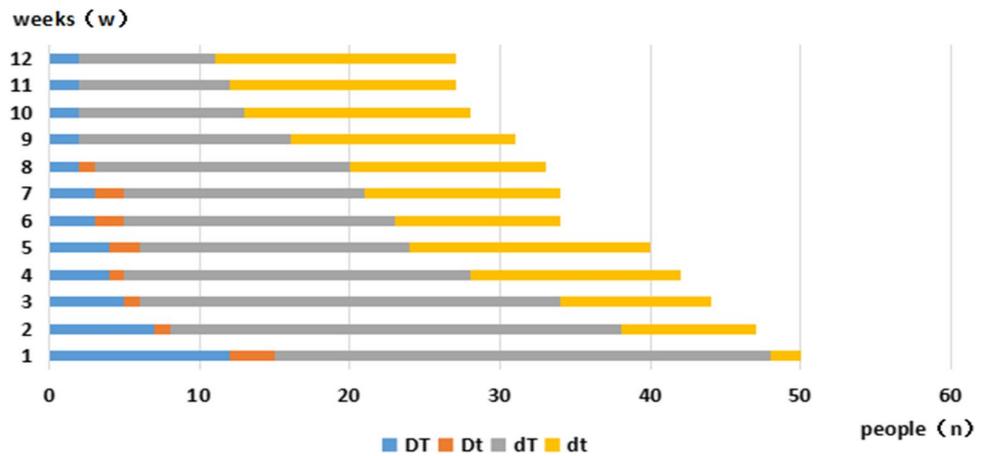


Table 2 Comparison of ONS knowledge level between the two groups before and after intervention

Variable	Time	Intervention Group	Control Group	U/t	P value
Nutrition and malnutrition, M (P ₂₅ , P ₇₅)	T0	10 (5,10)	10 (5,15)	1420.5	0.811
	T1	15 (15,15)	15 (10,15)	639.5	0.036*
The definition and function of ONS, M (P ₂₅ , P ₇₅)	T0	1.5 (1,5)	2 (1,6)	1385.0	0.649
	T1	8 (7.5,10)	8 (5.25,9)	641.0	0.086
Forms and types of ONS, M (P ₂₅ , P ₇₅)	T0	0 (0,0)	0 (0,0)	1458.0	1.000
	T1	5 (0,10)	5 (0,5)	718.0	0.298
ONS administration method and precautions, M (P ₂₅ , P ₇₅)	T0	15 (5,20)	10 (0,15)	1175.0	0.077
	T1	35 (30,40)	30 (25,35)	536.5	0.006*
Adverse reactions and treatment measures of ONS, M ± SD	T0	3 (0,5.25)	3 (0,6)	1423.0	0.826
	T1	14.76 ± 5.30	11.80 ± 5.05	2.570	0.012*
Total, M ± SD	T0	28.48 ± 15.40	25.56 ± 15.65	0.979	0.330
	T1	74.12 ± 12.61	63.13 ± 14.38	3.661	0.000*

M ± SD m ± standard deviation; ONS oral nutritional supplement; M median

*P < 0.05

Table 3 Comparison of HL level between the two groups before and after intervention

Variable	Time	Intervention Group	Control Group	U/t	P value
The ability to acquire information, M ± SD	T0	34.52 ± 7.15	34.59 ± 7.43	-0.053	0.958
	T1	40.98 ± 5.32	38.00 ± 7.40	2.081	0.041*
The ability to communicate and interact, M ± SD	T0	27.50 ± 5.73	28.11 ± 4.55	-0.613	0.541
	T1	34.83 ± 5.51	31.78 ± 6.02	2.383	0.020*
The willingness to improve health, M ± SD	T0	12.35 ± 3.38	12.94 ± 3.51	-0.893	0.374
	T1	16.24 ± 2.38	14.50 ± 3.74	2.511	0.014*
The willingness to provide financial support, M (P ₂₅ , P ₇₅)	T0	6 (5,7)	6 (5,7)	1242.0	0.175
	T1	7 (6,8)	7 (6,8)	735.5	0.411
Total, M ± SD	T0	80.48 ± 14.36	81.35 ± 13.67	-0.323	0.748
	T1	99.27 ± 11.05	91.13 ± 16.74	2.590	0.011*

M ± SD m ± standard deviation; HL health literacy; M median

*P < 0.05

Comparison of HL level between the two groups before and after intervention

From Table 3, at T0, there was no significant difference between the two groups in the scores of all dimensions and total scores ($P > 0.05$). At T1, compared to the control group, patients in the intervention group had significant improvement in three dimensions: the ability to acquire information, the ability to communicate and interact, and the willingness to improve health and total scores ($P = 0.041$; 0.020 ; 0.014 ; 0.011). And the total HL score in both groups was at a high level. However, there was no significant difference between the two groups in “The willingness to provide financial support” ($P = 0.411$).

Secondary endpoints

Comparison of health education compliance between two groups

75.92% of patients randomly assigned to the intervention group received 6 times of health education, while 74.07% of patients in the control group received 6 times of health education, and there was no significant difference between the two groups ($P = 0.780$).

Comparison of health education satisfaction between two groups

From Table 4, regarding the score of health education satisfaction, Nurses' interpersonal communication ability

Table 4 Comparison of health education satisfaction between two groups

Variable	Intervention Group	Control Group	U/t	P value
Overall satisfaction, M (P ₂₅ , P ₇₅)	9 (8,10)	9 (8,9)	654.5	0.099
Technical service quality, M (P ₂₅ , P ₇₅)	18 (17,19)	18 (16.25,18)	642.5	0.083
Nurses' interpersonal communication ability, M (P ₂₅ , P ₇₅)	9 (9,10)	9 (8,9)	581.5	0.018*
Nurse-patient communication level, M (P ₂₅ , P ₇₅)	9 (9,10)	9 (8,9)	606.6	0.031*
Service economy, M (P ₂₅ , P ₇₅)	8 (7,10)	8 (7,8.5)	671.5	0.152
Service timeliness, M (P ₂₅ , P ₇₅)	9 (8,10)	8 (7,9)	585.5	0.023*
Service accessibility, M (P ₂₅ , P ₇₅)	18 (16.5,19.5)	16.5 (15,18)	538.5	0.007*
Total, M±SD	79.88±7.02	75.70±7.01	2.678	0.009*

M±SD m± standard deviation; ONS oral nutritional supplement; M median

*P < 0.05

(P=0.018), nurse-patient communication level (P=0.031), service timeliness (P=0.023), service accessibility (P=0.007), and total scores (P=0.009), there existed significant differences among the two groups at T1.

Number of lost to follow-up

Within 12w after discharge, the number of patients lost to follow-up gradually increased with time, and the number of patients lost to follow-up in the control group was slightly higher than that in the intervention group. During the period from 5 to 6w, the number of lost visits increased considerably (Fig. 5). The number of people who dropped follow-up at 10–12w did not increase in the intervention group, but increased slowly to 11–12w in the control group.

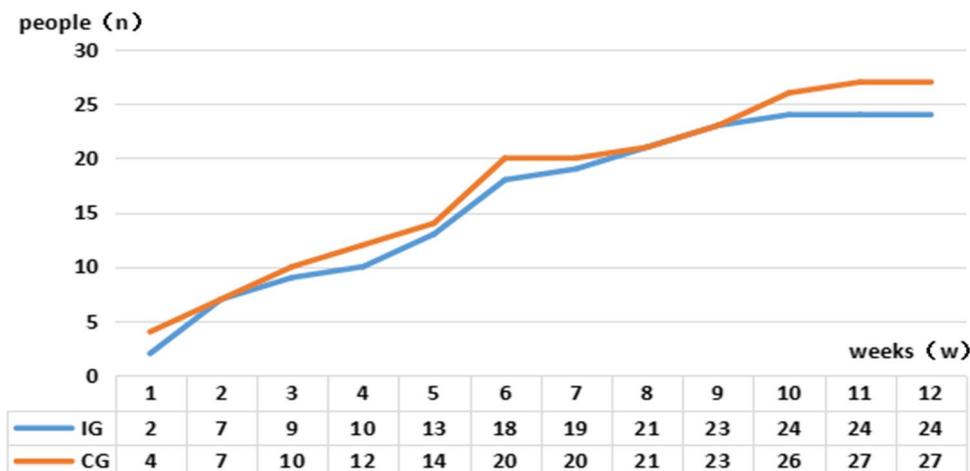
Discussion

Although ONS therapy was the preferred way to prevent and treat malnutrition in patients with gastric cancer, improve the nutritional status of patients and reduce the cost of

nutrition-related treatment, ONS compliance had become a major obstacle to the effective role of ONS. This study showed that health education based on 5Ts could improve the ONS compliance of discharged patients with nutritional risk after gastric cancer surgery, increased the understanding of ONS knowledge, and improved the HL level of patients. In addition, health education based on 5Ts also promoted the satisfaction of patients with health education and the communication between nurses and patients. These results had important significance for HCP optimized health education program to improve post-discharge ONS compliance and improve the treatment outcome of patients with nutritional risk after gastric cancer surgery.

The intake of ONS was often lower than the recommended dose, which made the intake of nutrients unable to meet the target amount of individual needs and affected the effect of nutritional treatment [15, 42]. Chu et al. explored the effect of teach-back method on ONS health education of discharged patients after gastrointestinal tumor surgery, and the results showed that the ONS compliance of patients in the intervention group was significantly higher. However, it only collected the ONS compliance of patients 7–10 days after discharge, which

Fig. 5 Number of lost to follow-up within 12w after discharge. Abbreviation: IG: Intervention group; CG: Control group



was relatively short [43]. This study revealed the effect of 5Ts on ONS compliance of discharged patients with gastric cancer, and further explored its long-term effects. The results showed that health education based on 5Ts could effectively improve the average compliance rate within 5w and 12w after discharge, and the compliance rate at 5w was significantly higher than that of the control group (55.69% vs 32.86%), but no significant difference was found at 12w (25.95% vs 21.40%). A previous study showed that patients with gastric cancer had an average ONS compliance of 30.59% within 12w after surgery and 12.9% compliance at 12w [16]. Obviously, in our study results, both the average compliance within 12w and the compliance at 12w of patients in the control group were higher than those in the Wan et al.'s study [16]. The prevention and management of adverse effects of ONS should be included in health education [3, 44], in this study, health education programs in both groups focused more on symptom management, which may have contributed to improved ONS compliance. This conformed that Marusic et al. study's opinion that adding prevention and early detection of adverse drug reactions in health education can improve patients' drug compliance [45]. Therefore, this study confirmed that the prevention and management of adverse effects of ONS was an indispensable part of health education for cancer patients after discharge. In addition, patients in the intervention group showed a sharp decline in compliance 4–5w after discharge, but the decline rate slowed down 5–6w after discharge. Four to six weeks after surgery was the peak of chemotherapy for cancer patients [46, 47]. During chemotherapy, patients gave up taking ONS due to the taste of ONS and adverse reactions, but will choose to resume taking ONS after chemotherapy due to the effect of peer support [16]. This seemed to explain this phenomenon. In future studies, we need to pay attention to the role of peer support in improving patients' ONS compliance.

More surprisingly, our results showed that there were four different states of ONS compliance in gastric cancer patients during their stay at home. Patients were divided into groups of compliance with dual indicators of dose and days every week after discharge. We found that dT consistently predominated in both groups at 12w after discharge. This was consistent with Wan et al.'s findings [16]. Patients in the dT group, account for a large proportion, were able to meet the demand for times, but not for doses. This might be due to the digestive tract symptoms, such as nausea and vomiting, after taking ONS, causing patients to reduce the dose of ONS. The studies had reported that 21–60% of patients will stop taking ONS after adverse reactions [44]. Therefore, we suggest that during the follow-up of patients, regardless of whether the patients correctly answered the questions raised by researchers on the topic of "prevention and management of adverse effects of ONS," we will conduct health education for patients according to the steps of 5Ts. How to identify and target such patients to strengthen the dose of ONS to improve compliance is worthy

of further exploration by researchers. Based on qualitative interview results from previous study, patients may be supported by their peers to take ONS every day.

The study had demonstrated that knowledge of ONS treatment and disease plays an important role in long-term ONS compliance in patients with cancer malnutrition [35]. The results of our study showed that health education based on 5Ts could significantly improve patients' ONS knowledge level. In this study, the content of ONS health education included five themes, among which "The Definition and Function of ONS" and "Forms and types of ONS" showed no significant difference between two groups, but improved compared with T0. This might be because when patients were discharged, doctors will prescribe ONS suitable for them according to their nutritional status and personal conditions. When they occurred adverse reactions after taking ONS at home, the researchers assessed the causes and treatment measures of the adverse reactions by asking questions. If the adverse reactions were not alleviated after correct treatment, the type or brand of ONS would be changed. At this point, the researchers will again educate the patients on the "Administration Method and Precautions" of the replacement ONS through 5Ts. So patients might be more relatively familiar with only the ONS they regularly took. However, there were still some patients who interrupted follow-up and gave up taking ONS. A mixed study showed that some patients might believe that tonics were more effective than ONS because of traditional Chinese beliefs [16]. And the other study had also shown that patients might be unaware of the function of ONS and thus affect compliance [48]. Therefore, future studies can further improve patients' understanding of the functions and types of ONS, change patients' traditional and inherent concepts, and strengthen patients' motivation to take ONS.

The studies had shown that patients with high HL level had the motivation and ability to acquire, understand and use information, and were more likely to take correct self-management measures to improve medication compliance [49]. In our study, both groups of patients had moderate levels of HL after admission. After 5w of intervention, the HL of patients in the intervention group was significantly higher than that in the control group. Although our study also found that the health education compliance rate of patients in the intervention group was slightly higher than that in the control group (75.92% vs 74.07%), as can be seen from the observation of long-term effect, the number of DT in the two groups gradually decreased with the passage of time, but the number of DT in the intervention group was higher than that in the control group. In addition, the number of patients lost to follow-up within 12w after discharge increased with time, but the number of patients lost to follow-up in the intervention group was less than the control group. It may be that 5Ts improves compliance by enhancing the patient's HL and thereby enhancing their self-management level. However,

the direct relationship between them needs to be further determined, and how to improve patients' long-term follow-up compliance in future studies needs to be further explored. It's worth noting that in the dimension of "The willingness to provide financial support," there was no significant difference between the two groups. In this study, health education was free of charge and did not increase the treatment cost of patients, causing additional economic burden to patients.

The results of this study showed that health education based on 5Ts could effectively strengthen the communication between HCP and patients, and significantly improve patients' satisfaction with health education. Although there was no significant difference in overall satisfaction, technical service quality and service economy between the two groups, they were all at a high level. Hu et al.'s study showed that under the continuous inquiry and guidance of HCP, on one hand, patients' health needs were met and their health knowledge level was improved; On the other hand, patients and their families could truly feel respected and loved, which was conducive to the establishment of a harmonious and equal relationship between HCP and patients, so that HCP could maximize the understanding and trust of patients and their families, and ultimately improve patient satisfaction [50]. In the study of Li et al., a self-developed satisfaction scale was used to evaluate tongue cancer patients, and the results showed that the satisfaction of patients in the intervention group was significantly higher than that in the control group after the intervention of the teach-back health education model [51]. Our results also confirmed this.

Finally, there were some limitations in this study. First, this was a single-center study, and there may have been some degree of bias. Second, due to the impact of COVID-19, we cannot require all patients to return to the hospital for blood nutrition measurements and re-evaluation of PG-SGA. Therefore, we only use body weight and BMI to measure the nutritional status of patients. This was not only a traditional parameter, but also a simpler and more convenient nutrition assessment tool [4]. It had been reported that these parameters had a good prognosis for patients undergoing gastrectomy [52, 53]. Third, the number of patients in this study was continuously lost during the intervention process, resulting in the loss of a large number of samples. But given the possibility of such a situation, we recruited as many patients as possible at the beginning of the study and reached the required sample size at the end of the intervention.

Conclusion

To our knowledge, this is the first report of health education based on 5TS improving ONS compliance in discharged patients after gastric cancer surgery. Our study showed that such health education can improve patients' short-term and long-term ONS

compliance, and their ONS knowledge level, HL level and health education satisfaction. Future health education should pay more attention to the functions and types of ONS, so as to further strengthen the motivation of patients to take ONS.

Author contribution Jia Wang and Haiyan Hu contributed to the performance of the study, analysis, and interpretation the data, and drafted the manuscript; Jianan Sun and Qing Zhang contributed to the supervision of the study and interpreted the data; Zhiming Chen contributed to the analysis and interpretation the data; Qiuchen Wang contributed to the performance of the study and revised the manuscript; Mingyue Zhu contributed to interpretation the data; Jiannan Yao contributed to revise the manuscript; Hua Yuan and Xiuying Zhang contributed to the conception of the study, performed the study, interpreted the data, and significantly revised the manuscript. All authors screened the final version of the manuscript.

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Data availability The authors confirm that all data underlying the findings are fully available without restriction. All relevant data are within the paper.

Code availability No code.

Declarations

Ethics approval The study was approved by our Institutional Review Board (No.2020082802) and carried out in accordance with the Declaration of Helsinki (as revised in 2013) and its subsequent amendments to ethical standards. This trial was registered in the Chinese Clinical Trial Registry at ChiCTR2000040986 (<http://www.chictr.org.cn>).

Consent to participate The authors declare that all participants provided written informed consent forms.

Consent for publication The authors declare that they all agreed to publication.

Conflict of interest The authors declare no competing interests.

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