BMC Surgery

RESEARCH

Open Access

The effects of nutritional support team intervention on postoperative immune function, nutritional statuses, inflammatory responses, clinical outcomes of elderly patients with gastric cancer

Jiansheng Chen[1†], Liling Zou[1†], Wenxing Sun[2], Junfeng Zhou[1*†] and Qingliang He[1*†]

Abstract

Background: To explore the effects of nutrition support team (NST) intervention on elderly patients with gastric cancer (GC).

Methods: The elderly GC patients (tumor stage I/II/III), admitted to our department from January 2015 to September 2021, were retrospectively analyzed and divided into NST group and traditional nutrition (TN) group according to nutritional management methods. The immune, inflammatory, nutrition-related indices, postoperative recovery and long-term prognosis of two groups were analyzed.

Results: A total of 258 elderly GC patients were included (NST group, n = 125; TN group, n = 133). After propensity score matching (PSM) in ratio of 1:1, 73 pairs of patients were matched. There were statistically significant differences in CD3 and CD4 level postoperative one month and IgG level postoperative one week between NST group and TN group ($P < 0.05$). There was no significant differences in serum CRP and IL-6 levels preoperative one day, postoperative one week and one month between two groups ($P > 0.05$). There were significant differences in body mass index (BMI) between the two groups postoperative one month ($P < 0.05$). The rate of infectious complications in TN group was significantly higher than that in NST group ($P < 0.05$). There was no statistically significant differences in 3-year relapse-free survival (RFS) or 3-year overall survival (OS) between NST group and TN group ($P > 0.05$).

Conclusions: Compared with TN management, NST intervention might be benefit to the immune function recovery and nutritional status, but there was no evidence that NST could improve the prognosis of elderly GC patients.

Keywords: Nutrition support team, Gastric cancer, Elderly patients, Immune function, Long-term prognosis

Background

Gastric cancer (GC) is the fifth most common cancer and the third most common cause of cancer death in the world, with more than 1 million new cases every year [1]. The incidence of GC has obvious regional differences, 40% of which are concentrated in China [2, 3]. Age is one of the highest risk factors for cancer, and the majority of solid tumors are regarded age-related diseases.

†Jiansheng Chen and Liling Zou equally contributed to this paper and thus shared the co-first authorship.

†Junfeng Zhou and Qingliang He equally contributed to this paper and thus shared the co-corresponding authorship.

*Correspondence: zjf2187@126.com; heqingliang89@sina.com

[1] Department of Gastrointestinal Surgery, The First Affiliated Hospital of Fujian Medical University, No.20 Chazhong Road, Fuzhou 350005, Fujian, People's Republic of China
Full list of author information is available at the end of the article

According to the investigation of scholars, the incidence of GC increases from the age of 50, and the main age of onset is between 60 and 70 years old, indicating that the elderly constitute the main body of GC patients [4, 5]. Cancer management in the elderly can be complex; comorbidity, multidrug and age-related physiological changes can affect the perioperative management and subsequent treatment choices of cancer [6, 7]. However, most current studies on gastric cancer treatment usually aimed at adults over 18 years old, and some do not include gastric cancer patients over 80 years old, let alone a specific population of elderly gastric cancer patients [8].

Different from younger GC patients, elderly GC patients are often accompanied by consumption and chronic diseases, such as diabetes, hypertension and chronic obstructive pulmonary disease [9]. In addition, the high metabolism of tumor makes malnutrition become very common in elderly GC patients. Severe malnutrition will further affect the body's immunity and important organ functions, and also increase the incidence of complications after GC surgery [10]. The nutritional status is even closely related to the long-term prognosis of GC patients [11, 12]. Therefore, high attention should be paid to the nutritional status of elderly GC patients before and after surgery. Currently, there is limited information on nutrition support team (NST) intervention for elderly GC patients. Thus, this study aimed to explore the effect of NST intervention mode on postoperative immune function and long-term prognosis of elderly GC patients.

Materials and methods

Patients

The elderly GC patients (tumor stage I/II/III) who underwent laparoscopic radical gastrectomy in Department of Gastrointestinal Surgery of the First Affiliated Hospital of Fujian Medical University from January 2017 to September 2021 were retrospectively analyzed. According to the ways of nutritional management, the patients were divided into NST group and traditional nutrition group (TN group). Inclusion criteria of patients were: (1) Age $\geq$ 60 years old (The legal age for senior citizens in China is 60 years or older.); (2) Before operation, gastroscopy confirmed that the pathology was GC, and CT showed no distant organ metastasis, so laparoscopic radical gastrectomy was performed; (3) No neoadjuvant therapy was received before operation; (4) No severe organ dysfunction and other intolerable diseases. Exclusion criteria were: (1) Patients with a history of gastric surgery; (2) American Society of Anesthesiologists (ASA) IV–V patients; (3) Combined with mental disorders and other diseases that could not be treated; (4) Patients with incomplete information. This study was approved by the Branch for Medical Research and Clinical Technology Application, Ethics Committee of the First Affiliated Hospital of Fujian Medical University (MTCA, ECFAH of FMU [2015] No.084). The patients and their families signed the informed consent forms after learning about the experimental processes.

Nutritional management

Nutritional support team (NST) mode

Composition and management mode The NST consists of 1 clinician, 1 nurse, 1 clinical pharmacist and 1 nutritionist. The nutritional support mode was that the nutritionist, clinical pharmacist and nurse followed the ward round of the surgical treatment group every day. After checking the patients, the nutritionist and clinical pharmacist given specific nutrition support plans for each patient, and the nurses carried out necessary nutrition support education for the patients and implement the nutrition support plans.

Assessment of nutritional status Clinicians and nutritionists conducted nutritional risk screening for patients within 24 h after admission. Nutritional status of subjects was assessed using the scored Nutrition Risk Screening (NRS) 2002 [13] and Patient-Generated Subjective Global Assessment (PG-SGA) tool [14]. NRS 2002 was an objective nutritional risk screening tool that includes four assessment aspects (anthropometric measurements, recent weight change, dietary intake and disease severity), scores range from 0 to 7, with values equal to or greater than 3 indicating nutritional risk. PG-SGA is an effective tool for the assessment of tumor patient-specific nutritional status, includes two specific content: patient self-assessment and medical staff assessment, score of 0–1 means no malnutrition and no intervention required; when score is $\geq$ 2 points, it indicate that there is malnutrition and different nutritional interventions need to be carried out according to the severity of malnutrition. The patient's medical history, examination results, anthropometry and other results were collected to construct a complete nutritional medical record. The key nutritional indicators included height, weight and body mass index (BMI). According to patients' nutritional status at admission, patients received different lengths of time of nutritional support therapy, nutrition prescriptions was issued by dietitians and jointly reviewed by clinicians and pharmacists. Nurses were responsible for recording the discomfort and complications of patients. After comprehensive evaluation of postoperative condition, test indicators and gastrointestinal recovery, nutritional requirements and nutritional forms of the patients were jointly evaluated by nutritionists and clinicians.

Nutritional intervention strategy Nutrition support enteral nutrition (EN) was preferred, combined with

parenteral nutrition (PN) or total parenteral nutrition (TPN) when EN was intolerant, the condition did not permit, or the EN could not meet energy and fluid volume and electrolyte requirements. Since the energy consumption of each elderly patient could not be accurately measured, we set 20–30 kcal/(kg·d) as the target amount according to the guideline for energy consumption of elderly inpatients [15–17]. The proportion of the three nutrients was 50–60% carbohydrate, 20–30% fat and 15–20% protein. As for the selection of oral nutritional supplements (ONS), enteral nutrition powder, enteral nutrition suspension and enteral nutritional emulsion were selected according to whether patients had diabetes and tolerance to the products. In addition, if the patient's condition permitted and the family members were able to make their own diet, quantified individual diet could be formulated according to the individual situation of each patient.

Traditional nutritional management

Clinicians used NRS2002 and PG-SGA tools to screen the nutritional risk of hospitalized patients, determined the indications of nutritional support treatment and selected nutritional preparations needed for patients based on own experience. They needed to deal with the complications related to the patient's nutritional support and adjust the nutritional support program alone, and invited nutritionists and clinical pharmacists to consult for treatment assistance if necessary.

Data collection

On admission, the baseline data were collected. The following main outcome indicators were collected one day before surgery, one week and one month after surgery: immune-related indicators (serum levels of CD3, CD4, CD8, CD4/CD8, IgA and IgG) and stress inflammatory factors (serum C-reactive protein (CRP) and interleukin-6 (IL-6) levels). The secondary outcome measures were nutritional indicators (BMI) and postoperative situation (the first flatus time and defecation time after surgery, time to liquid diet, complications, postoperative hospital stay, Clavien-Dindo complication grading system [18], hospitalization cost). The prognostic indicators, 3-year relapse-free survival (RFS), 3-year overall survival (OS) were also analyzed.

Definition of infectious complications

Postoperative infectious complications mainly include: intra-abdominal infection, incision infection, anastomotic leakage, postoperative pneumonia, catheter-related blood stream infection. The diagnostic criteria for infectious complications were: (1) Intra-abdominal infection refers to patients with abdominal symptoms, imaging examinations suggest intra-abdominal infection or abdominal puncture to extract pus, and the result of bacterial culture in ascites is positive; (2) Incision infection refers to the appearance of redness, swelling, heat, pain, and bloody or purulent exudate in the surgical incision; (3) Anastomotic leakage is defined as an upper gastrointestinal angiography showing contrast medium spillage from the gastrointestinal tract and the drainage of digestive juices, purulent fluid, or gas through a drainage tube; (4) Postoperative pneumonia was defined as new or progressive infiltrates, consolidations, or ground-glass opacities on lung X-ray or CT, With respiratory symptoms or positive sputum culture; (5) Catheter-related blood stream infection refers to an infection caused by an intravascular catheter that occurs within 48 h of the patient's application of a central venous catheter, and there is a laboratory report confirming a bloodstream infection or clinical sepsis.

Statistical analysis

SPSS 25.0 package (SPSS Inc., Armonk, NY, United States) was used to perform the analysis. PSM module was used to perform propensity score matching (PSM) according to 1:1. The normal distribution of the measurement data was expressed by means ± standard deviation (SD). The independent T-test was used for comparison of normal distribution measurement data, and non-parametric test was used for comparison of non-normal distribution measurement data. The Chi-square test or Fisher's exact test were used to compare the categorical variables between the two groups. The RFS and OS were compared between the two groups by Kaplan–Meier and log-rank tests. $P < 0.05$ was considered statistically significant.

Results

General information

A total of 258 elderly tumor stage I/II/III GC patients were included (NST group, n = 125; TN group, n = 133). There were statistically significant differences in history of diabetes, surgical site and tumor stage between two groups (all $P < 0.05$, Table 1). After PSM, 73 pairs of patients were finally matched, and there was no statistically significant difference in age, gender, BMI, history of diabetes and hypertension, NRS2002/PG-SGA score, nutritional status, and ASA grade between 2 groups (all $P > 0.05$), suggesting that there was no significant difference in body status between the two groups. There was no statistical difference in surgical site, methods of reconstruction of digestive tract, scope of lymph node dissection and tumor stage ($P > 0.05$), further indicating that there was no significant difference in disease status between two groups and it was comparability (Table 2).

Table 1 Comparison of the general patient data between two groups

Basic data	TN group (n = 133)	NST group (n = 125)	P-value
Age (year, n)			
60–69	79	88	0.17
70–79	47	31	
80–89	7	6	
Gender (Male/Female, n)	89/44	95/30	0.11
BMI (kg/m^2)	21.8 ± 3.0	21.9 ± 3.0	0.49
Diabetes (n)			
Yes	29	15	0.04
No	104	110	
Hypertension (n)			
Yes	40	26	0.09
No	93	99	
Nutritional status (n)			
Normal	106	87	0.06
Malnourished	27	38	
ASA grade (n)			
I	93	82	0.46
≥ II	40	43	
Surgical site (n)			
Proximal	16	22	0.04
Distal	62	39	
Full stomach	55	64	
Scope of lymph node dissection (n)			
D1	9	12	0.41
D2	124	113	
Tract reconstruction (n)			
Billroth II	18	27	0.10
Roux-en-Y	115	98	
Tumor stage (n)			
I	38	48	< 0.01
II	62	33	
III	33	44	

TN traditional nutrition, *NST* nutrition support team, *BMI* body mass index, *NRS2002* nutritional risk screening, *PG-SGA* patient-generated subjective global assessment, *ASA* American Society of Anesthesiologists

Compliance with nutritional support in two groups

Compliance in this study refers to patients' compliance with medical advice and guidance related to nutritional support, which includes the type of EN and PN taken, the amount of energy and fluid required, and compliance with the schedule. In the NST group, one patient stopped PN infusion due to fever caused by PN infusion, two patients had reduced PN infusion due to progressive liver transaminase elevation, Two patients were intolerant to EN. In TN group, two patients had reduced PN due to central venous catheter infection and inability to tolerate PN, one patient had skin rash due to PN, and one patient delayed early postoperative feeding due to diarrhea caused by EN.

Changes in the related immune indices in the two groups

There were statistically significant differences in terms of the serum level of CD3 and CD4 postoperative one month and IgG level postoperative one week between NST group and TN group (all $P < 0.05$), while there was no significant difference in other indices. In the intragroup comparison, the levels of serum CD3, CD4, CD8, IgA and IgG in the TN group postoperative one week and the levels of serum CD4 and CD8 postoperative one month showed statistically significant differences compared with those before surgery (all $P < 0.05$). The levels of CD3, CD4, CD8, IgA and IgG in NST group postoperative one week were significantly different from those before operation (all $P < 0.05$), and the levels of serum

Table 2 Comparison of the general patients' data between two groups after propensity score matching (PSM)

Variable	TN group (n = 73)	NST group (n = 73)	P-value
Age (year, n)			
60–69	51	55	0.60
70–79	19	17	
80–89	3	1	
Gender (Male/Female, n)	54/19	59/14	0.27
BMI (kg/m^2)	22.1 ± 2.7	22.1 ± 2.8	0.60
Diabetes (n)			
Yes	14	7	0.17
No	59	66	
Hypertension (n)			
Yes	19	15	0.43
No	54	58	
Nutritional status (n)			
Normal	60	57	0.53
Malnourished	13	16	
ASA grade (n)			
I	45	49	0.49
≥ II	28	24	
Surgical site (n)			
Proximal	6	13	0.16
Distal	33	25	
Full stomach	34	35	
Scope of lymph node dissection (n)			
D1	3	4	0.70
D2	70	69	
Tract reconstruction (n)			
Billroth II	12	10	0.64
Roux-en-Y	61	63	
Tumor stage (n)			
I	25	27	0.76
II	26	28	
III	22	18	

TN traditional nutrition, *NST* nutrition support team, *BMI* body mass index, *NRS2002* nutritional risk screening, *PG-SGA* patient-generated subjective global assessment, *ASA* American Society of Anesthesiologists

CD3, CD4 and CD8 postoperative one month showed statistically significant differences compared with those before surgery in NST group (all $P < 0.05$). There was no significant difference in the above indices postoperative one month compared with those before surgery (Table 3).

The inflammatory mediator levels and nutritional indices in two groups

In terms of stress inflammatory factors, there was no significant difference in serum CRP and IL-6 levels preoperative one day, postoperative one week and one month between two groups ($P > 0.05$). In the intra-group comparison, there were statistically significant differences in serum CRP level postoperative one week and serum IL-6 level postoperative one month in the TN group ($P < 0.05$), serum CRP and IL-6 level in NST group were statistically postoperative one week ($P < 0.05$), and serum CRP level postoperative one month was also statistically significant, all compared with preoperative in the same group (Table 3). In terms of nutritional indicators, there were significant differences in BMI between the two groups postoperative one month ($P < 0.05$). In the intra-group comparison, BMI in the TN group and NST group was no significantly decreased postoperative one week and one month compared with that before surgery respectively ($P > 0.05$, Table 4).

Postoperative indicators and long-term prognosis of two groups

There were no significant differences in recovery time of the first flatus and defecation, time to liquid diet, C-D grade and hospitalization cost between the NST group and TN group ($P > 0.05$). Although there was no significant difference in overall postoperative complications between the two groups, further analysis of complications subdivided into infectious complications and non-infectious complications showed that the rate of infectious complications in the TN group was significantly higher than that in the NST group ($P < 0.05$, Table 5). Furthermore, there was no statistically significant differences in 3-year RFS or 3-year OS between NST group and TN group ($P > 0.05$, Figs. 1, 2).

Discussion

In TN management mode, there is no full-time physician responsible for the patient's nutritional support. Clinicians usually evaluate the nutritional status and grasp the indications of the patient's nutritional support alone. Due to the lack of systematic learning of nutrition theory, the selection of PN has become non-standard, and there is a lack of comprehensive understanding of the complications of the patient's nutritional support. The NST originated from the successful application of parenteral nutrition by Dr. Dudrick's team, who showed that PN infusion could be used to treat short bowel syndrome induced by beagle models, and was subsequently applied to humans [19]. The formula of PN is complex, and infusion often brings different degrees of complications. Therefore, the implementation, monitoring and adjustment of treatment plan cannot be separated from the close collaboration of multiple disciplines, thus the concept of NST came into being.

Through daily to weekly discussions, the team develops an individualized nutritional treatment plan for patients.

Table 3 Comparison of immune indices and inflammatory factors between two groups

Variable	TN group (n = 73)			NST group (n = 73)		
	POD	POW	POM	POD	POW	POM
CD3 (/μL)	1876.0 ± 550.4	1429.6 ± 486.3[b]	1653.1 ± 465.7[a]	1883.2 ± 546.1	1433.9 ± 489.2[b]	1659.6 ± 468.7[ab]
CD4 (/μL)	919.3 ± 289.6	752.2 ± 230.4[b]	781.8 ± 249.0[ab]	922.2 ± 291.4	750.1 ± 230.9[b]	783.7 ± 249.7[ab]
CD8 (/μL)	750.9 ± 273.7	622.1 ± 221.0[b]	660.4 ± 209.9[b]	755.1 ± 272.8	621.4 ± 222.6[b]	658.3 ± 209.6[b]
CD4/CD8	1.5 ± 0.8	1.4 ± 0.7	1.3 ± 0.6	1.5 ± 0.8	1.4 ± 0.8	1.3 ± 0.6
IgA (g/L)	2.7 ± 1.2	2.2 ± 0.9[b]	2.4 ± 0.9	2.6 ± 1.2	2.2 ± 0.9[b]	2.4 ± 0.9
IgG (g/L)	12.7 ± 1.2	9.2 ± 2.0[ab]	10.6 ± 2.2	12.7 ± 1.1	9.2 ± 2.1[ab]	10.5 ± 2.3
CRP (mg/L)	7.9 ± 3.9	17.3 ± 2.5[b]	6.5 ± 3.4	8.3 ± 3.7	17.2 ± 2.5[b]	6.7 ± 3.4[b]
IL-6 (pg/mL)	2.8 ± 1.5	4.0 ± 3.6	2.6 ± 1.3[b]	2.9 ± 1.5	3.6 ± 2.3[b]	2.5 ± 1.3

POD preoperative one day, *POW* postoperative one week, *POM* postoperative one month, *CRP* C-reactive protein, *IL-6* interleukin-6. [a]Represents comparison between groups at the same time, $P < 0.05$; [b]represents comparison between postoperative and preoperative within the same group, $P < 0.05$

Table 4 Comparison of nutritional indicators between two groups

BMI (kg/m^2)	TN group (n = 73)			NST group (n = 73)		
	POD	POW	POM	POD	POW	POM
< 18.5	12	17	16[a]	7	9	5[a]
18.5–22.9	31	36	30[a]	36	41	36[a]
≥ 23.0	30	20	27[a]	30	23	32[a]

BMI body mass index, *POD* preoperative one day, *POW* postoperative one week, *POM* postoperative one month

[a] Represents comparison between groups at the same time, $P < 0.05$

Table 5 Comparison of postoperative indicators between two groups

Variable	TN group (n = 73)	NST group (n = 73)	P-value
First flatus time (days)	2.1 ± 1.5	2.2 ± 1.5	0.47
First defecation time (days)	4.3 ± 1.7	4.3 ± 1.7	0.44
liquid diet time (days)	3.0 ± 1.6	3.0 ± 1.7	0.11
Complications (n)	10	6	0.29
Infectious complications	9	1	0.02
Non-infectious complications	1	5	0.21
C-D grade (n)			
I–II	8	5	0.70
III–IV	2	1	
Hospitalization cost (RMB)	69,722.4 ± 15,461.6	69,726.5 ± 15,540.6	0.62

C-D grade, Clavien-Dindo complication grading system

Further, one study has reported NST intervention may affect the improvement of activities of daily living (ADL) in older patients undergoing in-patient rehabilitation [20]. We believe that the key to a team running smoothly and benefiting patients is communication, each member of the team has different responsibilities, and the focus and information obtained in their work are also different, through regular joint rounds and discussions, it is conducive to the mutual exchange of information and the improvement of team collaboration. In addition, nutrition education throughout the whole process of pre-operative, post-operative and post-discharge is also a content that cannot be ignored, through regular study, we pass on the knowledge we have learned to patients and their families, thereby so as to change their misunderstandings about postoperative diet and awareness of nutritional support.

Some studies have shown that the incidence of malnutrition in patients with malignant tumor can be as high as 40–80%, especially in GC and esophageal cancer [21–24]. The elderly GC patients have low organ reserve, the insufficient nutrients will affect the metabolism

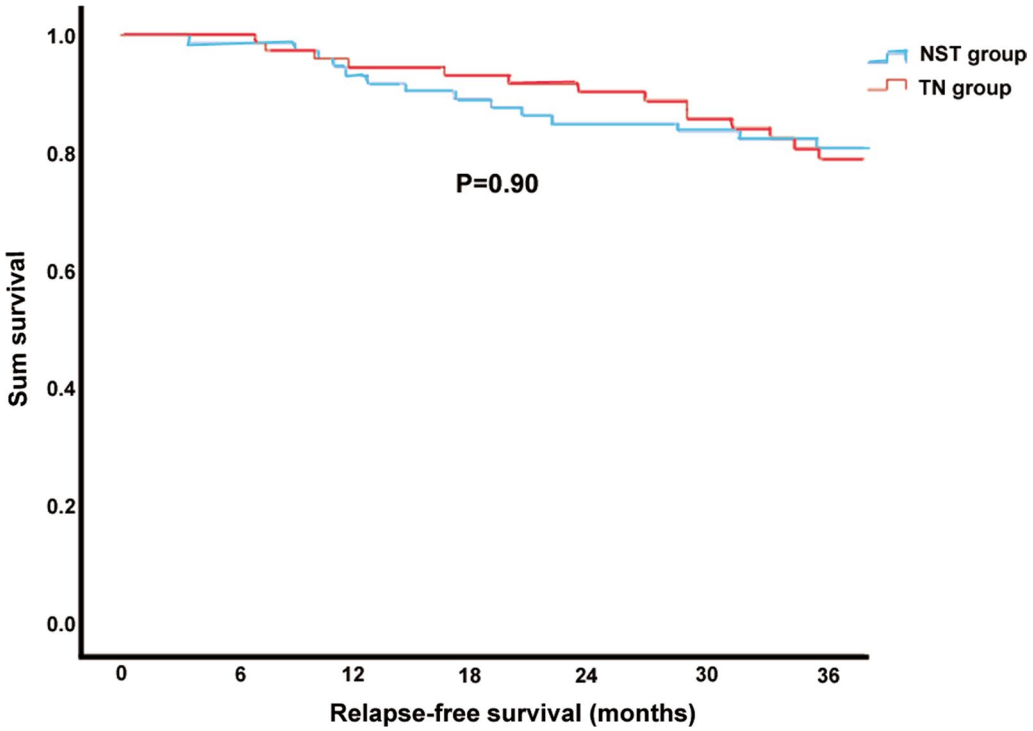

Fig. 1 Three-year relapse-free survival of two group

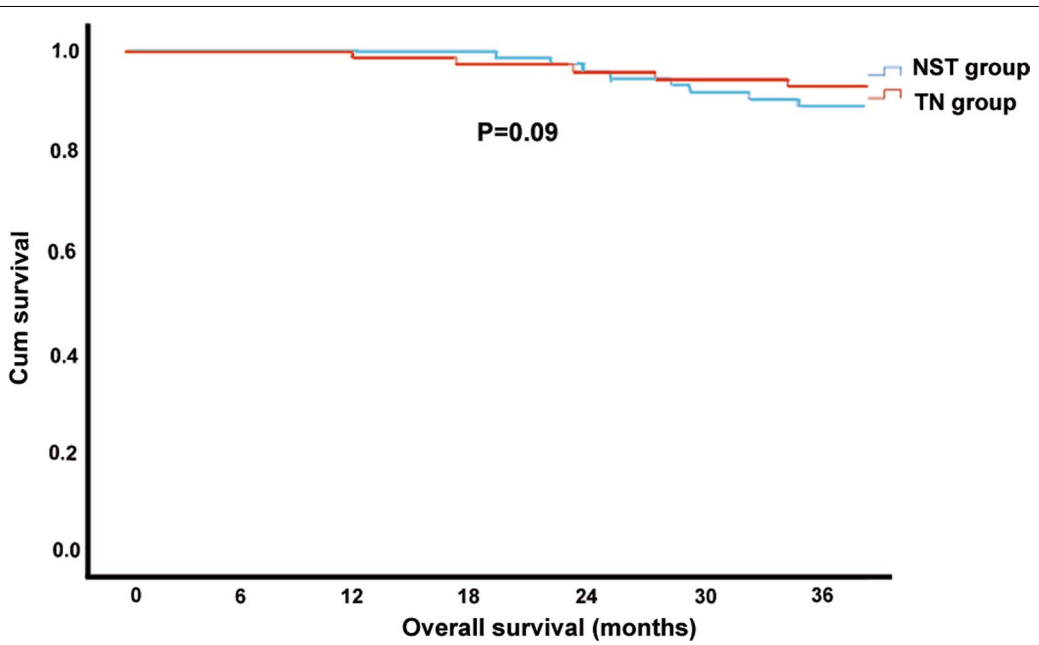

Fig. 2 Three-year overall survival of two group

of immune cells, leading to the prominent of immune function decline. Liu et al. have reported that the postoperative early enteral nutrition program could reduce the incidence of postoperative complications and improve clinical outcomes [25]. In this study, the immunity related-indices CD3, CD4, IgA and IgG showed a

general trend of decreasing after surgery and then gradually increasing. The last follow-up level of those indices in NST group was closer to the preoperative level. There were significant differences in postoperative levels of CD3 and CD4 between NST and TN groups. Although not all observed immune indexes were different, this also suggested that NST could help to improve the immune indexes of elderly gastric cancer patients in the short term after surgery. Notably, CD3, CD4, CD8 and immunoglobulin are commonly used to evaluate immune function [26].

In the analysis of postoperative recovery, the severity of postoperative complications in the TN group and NST group was not significantly different, although there was no significant difference in the overall complication rate between the two groups, the incidence of infectious complications in NST group was significantly lower than that in TN group, so we can think that the implementation of NST could reduce the occurrence of postoperative infectious complications under the condition that the hospitalization cost is roughly the same. At present, the research on nutritional support for GC patients mainly focuses on the short-term outcomes such as postoperative intestinal recovery and hospital stay [27, 28]. This study further explored the survival difference of patients receiving different nutritional support methods. It was found that there was no significant difference in the long-term prognosis between the two different nutritional management methods, which was inconsistent with the conclusions of previous studies that malnutrition was one of the independent risk factors for poor prognosis of elderly GC patients [29]. It may be related to the limited number of cases included in this study.

Conclusion

This study confirmed that the NST intervention model could improve the immune function and reduce the incidence of infectious complications, which has important clinical significance for the nutritional management of elderly GC patients in the future. However, this study also has some shortcomings. Although the PSM analysis method was used in this study, the bias caused by unknown confounding factors could not be controlled. This study was a retrospective study with a small sample size, and the further clarification is still needed in a multi-center, large-sample prospective randomized controlled study.

Abbreviations

NST: Nutrition support team; GC: Gastric cancer; TN: Traditional nutrition; PSM: Propensity score matching; OS: Overall survival; ASA: American Society of Anesthesiologists; NRS: Nutrition risk screening; PG-SGA: Patient-generated subjective global assessment; BMI: Body mass index; ALB: Albumin; EN: Enteral nutrition; PN: Parenteral nutrition; TPN: Total parenteral nutrition; ONS: Oral nutritional supplements; CRP: C-reactive protein; IL-6: Interleukin-6; C–D: Clavien–Dindo; RFS: Relapse-free survival; OS: Overall survival; NNS: Nutrition nurse specialist; ADL: Activities of daily living.

Acknowledgements

None.

Author contributions

LZ, JZ and QH conceived and designed of study; QH provided administrative support; LZ and WS provided materials and samples; JC, LZ and JZ participated in data collection. JC, LZ and WS participated in data analysis and interpretation of the results. All authors agreed to the final version of the manuscript. All authors read and approved the final manuscript.

Funding

This study was supported by the Science and Technology Program of Fujian Province (No. 2020Y0028) and the Kelun Nutrition Research Program (No. 101020120209).

Availability of data and materials

All data generated or analyzed were included in this published article.

Declarations

Ethics approval and consent to participate

This study was approved by the Branch for Medical Research and Clinical Technology Application, Ethics Committee of the First Affiliated Hospital of Fujian Medical University (MTCA, ECFAH of FMU [2015] No.084). Informed consents were received from all patients. All methods were carried out in accordance with relevant guidelines and regulations in the ethics and consent to participate under declaration section.

Consent for publication

The patient agreed to publish their information in BMC Surgery.

Competing interests

The authors declare that they have no competing interests.

Author details

[1]Department of Gastrointestinal Surgery, The First Affiliated Hospital of Fujian Medical University, No.20 Chazhong Road, Fuzhou 350005, Fujian, People's Republic of China. [2]The First Clinical Medical College, Fujian Medical University, Fuzhou 350122, Fujian, People's Republic of China.

Received: 21 February 2022 Accepted: 17 August 2022
Published online: 03 October 2022

References

1. Venerito M, Link A, Rokkas T, Malfertheiner P. Review: gastric cancer-clinical aspects. Helicobacter. 2019;24(Suppl 1): e12643.
2. Smyth EC, Nilsson M, Grabsch HI, van Grieken NC, Lordick F. Gastric cancer. Lancet. 2020;396(10251):635–48.
3. Gao K, Wu J. National trend of gastric cancer mortality in China (2003–2015): a population-based study. Cancer Commun. 2019;39(1):24.
4. Pilleron S, Sarfati D, Janssen-Heijnen M, Vignat J, Ferlay J, Bray F, Soerjomataram I. Global cancer incidence in older adults, 2012 and 2035: a population-based study. Int J Cancer. 2019;144(1):49–58.
5. Joharatnam-Hogan N, Shiu KK, Khan K. Challenges in the treatment of gastric cancer in the older patient. Cancer Treat Rev. 2020;85: 101980.
6. Sahin U, Tureci O, Manikhas G, Lordick F, Rusyn A, Vynnychenko I, Dudov A, Bazin I, Bondarenko I, Melichar B, et al. FAST: a randomised phase II study of zolbetuximab (IMAB362) plus EOX versus EOX alone for first-line treatment of advanced CLDN18.2-positive gastric and gastro-oesophageal adenocarcinoma. Ann Oncol. 2021;32(5):609–19.
7. Catenacci DV, Rosales M, Chung HC, Yoon HH, Shen L, Moehler M, Kang YK. MAHOGANY: margetuximab combination in HER2+ unresectable/

metastatic gastric/gastroesophageal junction adenocarcinoma. Future Oncol. 2021;17(10):1155–64.
8. Lopez-Basave HN, Morales-Vasquez F, Ruiz-Molina JM, Namendys-Silva SA, Vela-Sarmiento I, Ruan JM, Rosciano AE, Calderillo-Ruiz G, Diaz-Romero C, Herrera-Gomez A, et al. Gastric cancer in young people under 30 years of age: worse prognosis, or delay in diagnosis? Cancer Manag Res. 2013;5:31–6.
9. Chen X, Zeng Y, Huang Y, Xu J, Meng W, Wang X, Zhu C, Zhu G, Mao C, Shen X. Preoperative Cachexia predicts poor outcomes in young rather than elderly gastric cancer patients: a prospective study. Cancer Manag Res. 2019;11:8101–10.
10. Dias Rodrigues V, Barroso de Pinho N, Abdelhay E, Viola JP, Correia MI, Brum Martucci R. Nutrition and immune-modulatory intervention in surgical patients with gastric cancer. Nutr Clin Pract. 2017;32(1):122–9.
11. Kiuchi J, Komatsu S, Kosuga T, Kubota T, Okamoto K, Konishi H, Shiozaki A, Fujiwara H, Ichikawa D, Otsuji E. Long-term postoperative nutritional status affects prognosis even after infectious complications in gastric cancer. Anticancer Res. 2018;38(5):3133–8.
12. Omura Y, Toiyama Y, Okugawa Y, Yamamoto A, Yin C, Kusunoki K, Kusunoki Y, Shigemori T, Ide S, Kitajima T, et al. Crohn's-like lymphoid reaction is associated with oncological prognosis and nutritional status in patients with pathological stage II/III gastric cancer. Ann Surg Oncol. 2020;27(1):259–67.
13. Rabito EI, Marcadenti A, da Silva FJ, Figueira L, Silva FM. Nutritional risk screening 2002, short nutritional assessment questionnaire, malnutrition screening tool, and malnutrition universal screening tool are good predictors of nutrition risk in an emergency service. Nutr Clin Pract. 2017;32(4):526–32.
14. Cong M, Song C, Xu H, Song C, Wang C, Fu Z, Ba Y, Wu J, Xie C, Chen G, et al. The patient-generated subjective global assessment is a promising screening tool for cancer cachexia. BMJ Support Palliat Care. 2020;12:e39.
15. Volkert D, Beck AM, Cederholm T, Cruz-Jentoft A, Goisser S, Hooper L, Kiesswetter E, Maggio M, Raynaud-Simon A, Sieber CC, et al. ESPEN guideline on clinical nutrition and hydration in geriatrics. Clin Nutr. 2019;38(1):10–47.
16. Volkert D, Berner YN, Berry E, Cederholm T, Coti Bertrand P, Milne A, Palmblad J, Schneider S, Sobotka L, Stanga Z, et al. ESPEN guidelines on enteral nutrition: geriatrics. Clin Nutr. 2006;25(2):330–60.
17. Wei J, Chen W, Zhu M, Cao W, Wang X, Shi H, Dong B, Sun J, Chen H, Zhou Y, et al. Guidelines for parenteral and enteral nutrition support in geriatric patients in China. Asia Pac J Clin Nutr. 2015;24(2):336–46.
18. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004;240(2):205–13.
19. Dudrick SJ, Palesty JA. Historical highlights of the development of total parenteral nutrition. Surg Clin North Am. 2011;91(3):693–717.
20. Sakai T, Maeda K, Wakabayashi H, Nishioka S, Seki H. Nutrition support team intervention improves activities of daily living in older patients undergoing in-patient rehabilitation in Japan: a retrospective cohort study. J Nutr Gerontol Geriatrics. 2017;36(4):166–77.
21. Hebuterne X, Lemarie E, Michallet M, de Montreuil CB, Schneider SM, Goldwasser F. Prevalence of malnutrition and current use of nutrition support in patients with cancer. JPEN J Parenter Enteral Nutr. 2014;38(2):196–204.
22. Guo ZQ, Yu JM, Li W, Fu ZM, Lin Y, Shi YY, Hu W, Ba Y, Li SY, Li ZN, et al. Survey and analysis of the nutritional status in hospitalized patients with malignant gastric tumors and its influence on the quality of life. Support Care Cancer. 2020;28(1):373–80.
23. Heneghan HM, Zaborowski A, Fanning M, McHugh A, Doyle S, Moore J, Ravi N, Reynolds JV. Prospective study of malabsorption and malnutrition after esophageal and gastric cancer surgery. Ann Surg. 2015;262(5):803–7.
24. Wang P, Chen X, Liu Q, Liu X, Li Y. Good performance of the Global Leadership Initiative on Malnutrition criteria for diagnosing and classifying malnutrition in people with esophageal cancer undergoing esophagectomy. Nutrition. 2021;91–92: 111420.
25. Liu ZH, Su GQ, Zhang SY, Zhang JB, Huang XR. Study on early postoperative nutritional support in elderly patients with gastric cancer. Chin J Gastrointes Surg. 2013;16(11):1063.
26. Lu L, Xie M, Wei S, Xiong Z. Effect of enteral nutrition during preoperative and early postoperative periods on immunologic function and postoperative nutritional status in old patients with gastric cancer. Chin J Clin Oncol 2014.
27. Chen R, Yin W, Gao H, Zhang H, Huang Y. The effects of early enteral nutrition on the nutritional statuses, gastrointestinal functions, and inflammatory responses of gastrointestinal tumor patients. Am J Transl Res. 2021;13(6):6260–9.
28. Ma BQ, Chen SY, Jiang ZB, Wu B, He Y, Wang XX, Li Y, Gao P, Yang XJ. Effect of postoperative early enteral nutrition on clinical outcomes and immune function of cholangiocarcinoma patients with malignant obstructive jaundice. World J Gastroenterol. 2020;26(46):7405–15.
29. Fujiya K, Kawamura T, Omae K, Makuuchi R, Irino T, Tokunaga M, Tanizawa Y, Bando E, Terashima M. Impact of malnutrition after gastrectomy for gastric cancer on long-term survival. Ann Surg Oncol. 2018;25(4):974–83.

Publisher's Note