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Effect of targeted individualized nutrition support on patients with severe diseases during hospitalization

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Abstract

To evaluate effect of targeted individualized nutrition support on therapeutic effect and safety of patients with severe diseases during hospitalization. All patients were divided into control group and the observation group according to the time of admission. All enrolled patients received symptomatic treatment and intensive care. The control group received only basic nutrition support. There was no significant difference in NRS2002 score between the two groups at admission. Before intervention, there were no significant differences of total serum protein, serum albumin, hemoglobin content, liver and kidney functions and immune indexes between both groups. After intervention, the total serum protein, serum albumin and hemoglobin content of observation group was significantly higher than those of control group. The incidence of adverse events and complications of observation group was significantly lower than control group during hospitalization. The targeted individualized nutrition support could improve nutritional status of patients with severe surgical diseases during hospitalization.

Keywords: nutrition support; NRS2002; liver and kidney functions; safety.

Practical Application: Malnutrition is a highly prevalent condition in the inpatient setting, particularly in older patients with multiple morbidities, the medical community has struggled to find efficient, evidence-based approaches for its prevention and treatment.

1 Introduction

Patients underwent major surgery often show different degrees of organ failure or dysfunction due to the severity of the disease. The metabolic functions are changed, which easily leads to malnutrition. In particular, the nutritional status of patients with weak physical constitution is significantly worsened during hospitalization, which affects the therapeutic effect directly (Qian et al., 2017). The inadequate intake and utilization barriers of energy seriously impede the outcome and prognosis of the disease, therefore, it is critical to provide appropriate nutrition support to patients with severe diseases during active treatment (Wu et al., 2017). It has been shown that the incidence of malnutrition in hospitalized patients in China is as high as 10%-60%, which is even higher for patients with severe diseases (Diab et al., 2017). At present, the nutrition support therapy has become an indispensable part of clinical support therapy for patients with severe diseases. However, whether individualized nutrition support could reduce the severity of disease and improve the prognosis of patients with severe diseases was still unknown. Therefore, this study is aimed at exploring the effect of individualized nutrition support on improving the therapeutic effect and safety of patients with severe diseases during hospitalization.

2 Methods

2.1 Patients

Ninety-eight patients with severe diseases hospitalized in ICU of our hospital from January 2018 to January 2020 were selected. All patients were divided into the control group and the observation group according to the time of admission into ICU.

Inclusion criteria were, 1) patients from the department of general surgery or thoracic surgery; 2) critical patients with APACHEII score ≥10 points at admission (Lin et al., 2019).

Exclusion criteria were, 1) patients with severe malnutrition; 2) patients with severe internal environmental disorders, such as severe acid-base balance disorders and electrolyte disorders; 3) patients with severe heart, liver or renal insufficiency; 4) patients with NRS score below 3 points; 5) patients do not corporate with treatment. This study was approved by the Ethics Committee of our hospital. Informed consent was obtained from all the patients or their families.

2.2 Intervention

All enrolled patients received symptomatic treatment and intensive care. The control group received only basic nutrition support, while the observation group received nutrition support according to *Guidelines for nutritional Support for Critical Patients* (Singer et al., 2019), and individualized nutrition support based on Nutritional Risk Screening (NRS2002) score at admission. Both groups were followed up for 4 weeks.

2.3 Control group

The treatment includes anti-infection, maintaining stable blood pressure, blood glucose control, protecting gastric

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mucosa, and maintaining water and electrolyte balance, reduce phlegm. The Harris-Benedict formula was used to calculate the patients' basal energy expenditure (BEE) in detail and then the nutritional status of the patients was evaluated according to the PG-SGA. The total score was calculated to determine whether the patient needed nutritional support and what kind of nutritional support to give. Intravenous infusion of the nutrition bag was provided as (composition: 50% glucose injection, 20% fat milk injection, compound amino acid injection, fat-soluble vitamin for injection, water-soluble vitamin for injection, potassium chloride solution, vitamin C injection, magnesium sulfate injection). Calorie requirements: starting from low calorie, 20-25 kcal/kg, gradually increasing to 35 kcal/kg in the later stage. The ratio of sugar to fat was 1:1.

2.4 Observation group

Individualized nutrition support was implemented based on the control group. NRS2002 score and BEE were evaluated. When the NRS2002 score was lower than 3 points, the nutrition bag was provided by as (composition: 50% glucose injection, 20% fat milk injection, compound amino acid injection, fat-soluble vitamins for injection, water-soluble vitamins for injection, potassium chloride solution, vitamin C injection, magnesium sulfate injection). The ratio of sugar and fat was 1:1. Enteral nutrition suspension (TPF) (Nutricia Pharmaceutical (Wuxi) Co., Ltd., national drug approval H20030011, 1.5 kcal*500 ml) was selected, supported by nasogastric tube feeding. Enteral nutrition preparations include Ruitin and alanyl glutamine, parenteral nutrition support includes fat milk (C8-24, C14-24), compound amino acids (18AA-V, 18AA-II), fat-soluble vitamins, water-soluble vitamins, etc., and immunologic nutrients are known as thymosin. Enteral nutritional support was performed simultaneously in the patients through nasointestinal tube. On the first day, a glucose saline solution with a concentration of 5% was slowly injected at a rate of 20-40 ml/h, and on following day, a maintenance nutrient solution was injected at a rate of 20-40 ml/h. Subsequently, the infusion rate was adjusted to the patient's tolerance level, with a maximum of 80 ml/h and a dose of 1000 ml/time. NRS2002 assessment was conducted again one week later. When the score is more than 3 points and gastrointestinal function was recovered to a certain extent. The nutritional treatment plan should be adjusted according to the patients' tolerance.

2.5 Observation outcomes

NRS2002 scores were recorded and compared between the two groups before and after nutrition support intervention. Weight score, physique score, stress score and disease score were selected in the PG-SGA evaluation for calculation, 0~3 points meant health, 4~8 points were classified as mild/severe malnutrition, and the score above 8 points was considered severe malnutrition. The changes of liver and kidney functions of the patients before and after intervention were analyzed. Total bilirubin, alanine aminotransferase and alanine aminotransferase were measured. Immune-related indicators, including IgA (immunoglobulin A), IgM (immunoglobulin M), IgG (immunoglobulin G), total value of CD3-T lymphocytes, and CD4/CD8- induced T cells/inhibited T cells were recorded. Adverse events and complications of nutrition support during hospitalization include diarrhea, urinary retention, intestinal obstruction and infection were recorded.

2.6 Statistical analysis

All data were analyzed using SPSS22.0 software, and the measurement data were represented with (x±s) and compared with Student t test. The counting data were represented with (%) and evaluated with Chi-square test. $P < 0.05$ was considered as statistically significant.

3 Results

3.1 Basic characteristics

Ninety-eight patients with severe diseases hospitalized in ICU in our hospital from January 2018 to January 2020 were included. All patients were divided into the control group and the observation group according to the time of admission into ICU. There were 49 patients in each group. In the control group, there were 26 males and 21 females, aged 35-72 (59.84 ± 5.32) years. Nutritional Risk Screening (NRS2002) score of the control group at admission was (4.16 ± 0.38) points. In the observation group, there were 28 males and 19 females, aged 38-78 (60.12 ± 5.89) years. Nutritional Risk Screening (NRS2002) score of the observation group at admission was (4.20 ± 0.43) points. There were no significant differences of gender, age and nutritional status at admission between both groups ($P > 0.05$) (Table 1).

3.2 Changes of nutritional status of the two groups

Before nutrition support, there were no significant differences of total serum protein, serum albumin, hemoglobin and prealbumin content between both groups ($P > 0.05$). After intervention, all indicators of the observation group were significantly improved compared with the control group ($P < 0.05$) (Table 2) (Figure 1). After nutrition support intervention, the NRS2002 score of the observation group was (1.46 ± 0.33) points, which was

Table 1. Comparison of basic characteristics of the two groups.

Group	Cases	Gender Composition (men/women)	Mean Age (years)	NRS2002 at Admission (points)	PG-SGA score
Control group	49	27/22	59.84 ± 5.32	4.16 ± 0.38	4.16 ± 0.38
Observation group	49	29/20	60.12 ± 5.89	4.20 ± 0.43	4.20 ± 0.43
x^2/t		0.340	0.247	0.488	0.488
P		0.560	0.806	0.627	0.627

P, significant difference value.

Table 2. Changes of nutritional status of the two groups.

Group	Cases	Total Serum Protein (g/L)		Serum Albumin (g/L)		Hemoglobin (g/L)		Prealbumin (mg/L)	
		Before Intervention	After Intervention	Before Intervention	After Intervention	Before Intervention	After Intervention	Before Intervention	After Intervention
Control group	49	38.85 ± 5.12	55.07 ± 4.24	20.63 ± 3.88	29.28 ± 3.09	41.12 ± 4.74	58.04 ± 3.42	164.25 ± 1.53	167.33 ± 1.29
Observation group	49	37.92 ± 5.74	68.14 ± 3.85	20.70 ± 3.52	36.06 ± 4.23	40.69 ± 4.62	76.31 ± 3.20	164.82 ± 1.62	196.52 ± 1.14
t		0.846	15.975	0.094	9.060	0.455	27.306	1.791	118.690
P		0.397	0.000	0.926	0.000	0.650	0.000	0.077	0.000

P, significant difference value. t: significant difference value for t test.

Table 3. Changes in liver and kidney functions of the two groups.

Group	Cases	Total Bilirubin (μmol/L)		Alanine Transaminase (U/L)		Alanine Transaminase (U/L)	
		Before Intervention	After Intervention	Before Intervention	After Intervention	Before Intervention	After Intervention
Control group	49	45.33 ± 4.58	28.66 ± 3.75	82.06 ± 8.78	73.26 ± 6.56	94.82 ± 9.97	75.64 ± 6.23
Observation group	49	46.10 ± 4.92	21.03 ± 2.94	83.13 ± 8.72	40.23 ± 7.14	94.65 ± 9.82	40.02 ± 6.75
t		0.802	11.209	0.605	23.846	0.085	27.145
P		0.425	0.000	0.546	0.000	0.932	0.000

P, significant difference value. t: significant difference value for t test.

Table 4. Changes of immune indicators of the two groups after intervention.

Group	Cases	IgA (g/L)	IgM (g/L)	IgG (g/L)	CD_3 (%)	CD_4/CD_8
Control group	49	18.34 ± 3.26	1.74 ± 0.26	15.48 ± 0.56	60.15 ± 4.64	1.41 ± 0.16
Observation group	49	5.22 ± 0.17	1.78 ± 0.23	15.39 ± 0.42	68.76 ± 5.20	1.72 ± 0.28
t		28.134	0.807	0.900	8.648	6.729
P		0.000	0.422	0.370	0.000	0.000

P, significant difference value. t: significant difference value for t test.

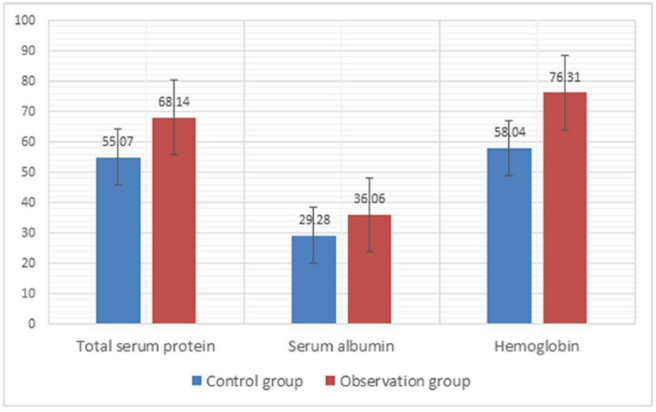

Figure 1. Nutritional status of the two groups after intervention.

significantly lower than that of the control group (2.25 ± 0.45) point (t = 9.910, $P = 0.000$).

3.3 Changes of liver and kidney functions of the two groups

Before intervention, there was no significant difference in liver and kidney functions between the two groups ($P > 0.05$). After intervention, the total bilirubin, alanine transaminase and alanine transaminase levels in the observation group were significantly lower than those in the control group ($P < 0.05$) (Table 3).

3.4 Changes of immune indicators of the two groups

After nutrition support intervention, the improvement of IgA, CD3, CD4/CD8 and other immune indicators in the observation group were better than the control group (Table 4) ($P < 0.05$).

3.5 Adverse events and complications

In the observation group, there were 2 cases of diarrhea, 1 case of urinary retention and 1 case of intestinal obstruction, and the incidence of adverse events and complications was 8.16% (4/49). In the control group, there were 3 cases of diarrhea, 4 cases of urinary retention, 2 cases of intestinal obstruction and 3 cases of infection. The incidence of adverse events and complications of control group was 24.49% (12/49), which was significantly higher than the observation group ($x^2 = 9.761$, $P = 0.002$) (Figure 2).

4 Discussion

Malnutrition is a highly prevalent condition in the inpatient setting, particularly in older patients with multiple morbidities,

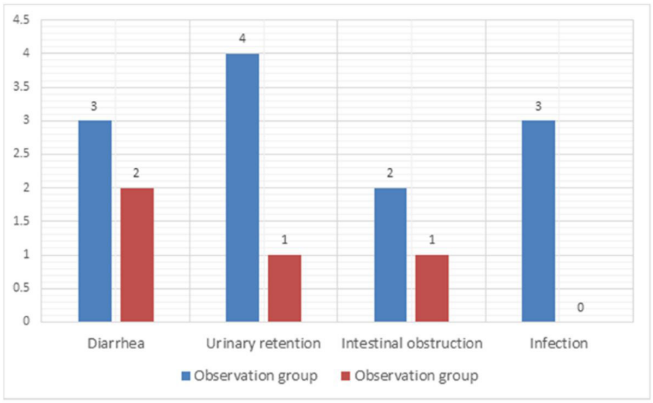

Figure 2. Adverse events and complications of the two groups.

the medical community has struggled to find efficient, evidence-based approaches for its prevention and treatment (Merker et al., 2019). Evidence-based medicine is an approach to medical practice intended to optimise decision-making by emphasizing the use of evidence from well-designed and well-conducted research - typically randomised trials and meta-analyses from such trials. Evidence-based clinical nutrition should use the exact same criteria for classifying evidence by its epistemological strength and requiring that only the strongest types can also yield strong recommendations (Cardenas, 2016). This study evaluated the effect of targeted individualized nutrition support on the therapeutic effect and safety of patients with severe diseases during hospitalization. It was found the targeted individualized nutrition support could improve the nutritional status, liver and kidney functions, immune indicators and reduce adverse events and complications.

It is well known from previous studies that protein-energy malnutrition is a strong and independent risk factor associated with mortality, prolonged length of stay in the hospital and higher rates of complications including infections (Felder et al., 2016; Felder et al., 2015). In the absence of exogenous supplementation, the patients will show a negative nitrogen balance, which are secondary hypoalbuminemia and malnutrition, with reduced immune functions, increased risks of brain tissue damage and multiple organ failure (Wang et al., 2018). The poor nutritional status of hospitalized patients with severe disease will lead to a significant increase of complications such as infection or even death. It is of great significance to grasp the right time and choose the right nutrition support methods to maintain the basic functions of cells, improve the functions of organs and tissues, and promote rehabilitation for hospitalized patients with severe diseases (Zheng et al., 2019). With the progress of the studies, nutrition support intervention has gradually transformed from a auxiliary means in the traditional sense into basic therapies for patients with severe diseases, which included parenteral nutrition support, enteral nutrition support, immune nutrition support and others (Cui et al., 2018; Shin et al., 2018). Nutrients play an important role in maintaining body functions, especially for patients with severe diseases. Inadequate nutrient intake and impaired utilization can directly induce or aggravate systemic inflammatory responses, exacerbating organ failure (Ahmad et al., 2019). At present, enteral and parenteral nutrition support methods are widely applicated (Nunes & Piuvezam 2019). The focus of nutrition support research at present is how to implement a safe and effective nutrition support program to promote the recovery of patients with severe disease.

Combining the actual conditions of patients with targeted individualized nutrition support and basing NRS2002 score and BEE values of patients at admission, the comprehensive parenteral and intramural nutrition support was provided to high-risk patients. Nasogastric tube feeding was provided to patients with favorable conditions, and nasojejunal nutritional tube feeding was administered to patients with pancreatic surgery under gastroscopy. Glutamine, fatty acids, arginine, dietary fiber and other special nutrients were supplemented to some patients with low immunity.

Previous studies have shown when parenteral nutrition supplied via the vein is performed, the risk of potential catheter complications, hepatobiliary complications, infection increase (Benton et al., 2018). Therefore, it is important to pay attention to the changes of illness condition during treatment, and reasonably choose nutrient solution and support dose. Enteral nutrition support plays a positive role in promoting gastrointestinal peristalsis, improving blood circulation and hormone secretion, and can effectively maintain intestinal mucosal barrier and structural and functional integrity, which is suitable for patients with basically stable vital signs (Joosten et al., 2019). The addition of special nutrients stimulates an immune response in immune cells which help reduce inflammation. The gradual recovery of eating through the mouth upon improvement of the nutritional status of patients is of great significance to promote the recovery and improve the prognosis of patients. Our results showed that the nutrition status, liver and kidney function, and immune indicators of the observation group were significantly improved with the intervention of targeted individualized nutrition support, which indicated that the program of this group could effectively improve the nutritional status of patients with severe diseases, improve their immune functions, and contribute to the improvement of clinical therapeutic effect. In addition, the adverse events and complications in the observation group were lower than the control group during hospitalization, confirming the clinical safety of targeted individualized nutrition support.

There were still some limitations of this study. The follow-up time of the study was only four weeks. The sample size of this study was relatively small. Therefore, further study with longer follow-up and larger sample size was still needed.

5 Conclusion

In conclusion, the targeted individualized nutrition support could improve the nutritional status of patients with severe surgical diseases during hospitalization, which might safely improve the therapeutic effect.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Gansu Provincial Cancer Hospital [BSR20182158]. Informed consent was obtained from all the patients or their families.

Conflict of interest

There are no potential conflicts of interest to disclose.

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None.

Author contributions

LW is resposible for the guarantor of integrity of the entire study, study concepts & design, definition of intellectual content, literature research, clinical studies, experimental studies, data acquisition & analysis, statistical analysis, manuscript preparation & editing; KDY is resposible for the study design, definition of intellectual content, literature research, clinical studies, experimental studies, data acquisition & analysis, manuscript review. All authors read and approved the final manuscript.

References

Ahmad, A., Akram, W., Shahzadi, I., Wang, R., Hu, D., Bashir, Z., Jaleel, W., Ahmed, S., Tariq, W., Li, G., Wu, T., Ahmad Yasin, N., & Shafique, S. (2019). Benzenedicarboxylic acid upregulates O48814 and Q9FJQ8 for improved nutritional contents of tomato and low risk of fungal attack. *Journal of the Science of Food and Agriculture*, 99(14), 6139-6154. http://dx.doi.org/10.1002/jsfa.9836. PMid:31152450.

Benton, K., Thomson, I., Isenring, E., Mark Smithers, B., & Agarwal, E. (2018). An investigation into the nutritional status of patients receiving an Enhanced Recovery After Surgery (ERAS) protocol versus standard care following Oesophagectomy. *Supportive Care in Cancer*, 26(6), 2057-2062. http://dx.doi.org/10.1007/s00520-017-4038-4. PMid:29368029.

Cardenas, D. (2016). What is clinical nutrition? Understanding the epistemological foundations of a new discipline. *Clinical Nutrition ESPEN*, 11, e63-e66. http://dx.doi.org/10.1016/j.clnesp.2015.10.001. PMid:28531428.

Cui, P., Pang, Q., Wang, Y., Qian, Z., Hu, X., Wang, W., Li, Z., Zhou, L., Man, Z., Yang, S., Jin, H., & Liu, H. (2018). Nutritional prognostic scores in patients with hilar cholangiocarcinoma treated by percutaneous transhepatic biliary stenting combined with 125I seed intracavitary irradiation: A retrospective observational study. *Medicine*, 97(22), e11000. http://dx.doi.org/10.1097/MD.0000000000011000. PMid:29851859.

Diab, Y. A., Ramakrishnan, K., Ferrell, B., Chounoune, R., Alfares, F. A., Endicott, K. M., Rooney, S., Corcoran, J., Zurakowski, D., Berger, J. T., Shankar, V., & Nath, D. S. (2017). IV Versus Subcutaneous Enoxaparin in Critically Ill Infants and Children: Comparison of Dosing, Anticoagulation Quality, Efficacy, and Safety Outcomes. *Pediatric Critical Care Medicine*, 18(5), e207-e214. http://dx.doi.org/10.1097/PCC.0000000000001126. PMid:28296662.

Felder, S., Braun, N., Stanga, Z., Kulkarni, P., Faessler, L., Kutz, A., Steiner, D., Laukemann, S., Haubitz, S., Huber, A., Mueller, B., & Schuetz, P. (2016). Unraveling the Link between Malnutrition and Adverse Clinical Outcomes: Association of Acute and Chronic Malnutrition Measures with Blood Biomarkers from Different Pathophysiological States. *Annals of Nutrition & Metabolism*, 68(3), 164-172. http://dx.doi.org/10.1159/000444096. PMid:26855046.

Felder, S., Lechtenboehmer, C., Bally, M., Fehr, R., Deiss, M., Faessler, L., Kutz, A., Steiner, D., Rast, A. C., Laukemann, S., Kulkarni, P., Stanga, Z., Haubitz, S., Huber, A., Mueller, B., & Schuetz, P. (2015). Association of nutritional risk and adverse medical outcomes across different medical inpatient populations. *Nutrition (Burbank, Los Angeles County, Calif.)*, 31(11-12), 1385-1393. http://dx.doi.org/10.1016/j.nut.2015.06.007. PMid:26429660.

Joosten, K. F. M., Eveleens, R. D., & Verbruggen, S. (2019). Nutritional support in the recovery phase of critically ill children. *Current Opinion in Clinical Nutrition and Metabolic Care*, 22(2), 152-158. http://dx.doi.org/10.1097/MCO.0000000000000549. PMid:30585805.

Lin, C., Hu, Z., Yuan, G., Su, H., Zeng, Y., Guo, Z., Zhong, F., Jiang, K., & He, S. (2019). HIF1α-siRNA and gemcitabine combination-based GE-11 peptide antibody-targeted nanomedicine for enhanced therapeutic efficacy in pancreatic cancers. *Journal of Drug Targeting*, 27(7), 797-805. http://dx.doi.org/10.1080/1061186X.2018.1552276. PMid:30481072.

Merker, M., Gomes, F., Stanga, Z., & Schuetz, P. (2019). Evidence-based nutrition for the malnourished, hospitalised patient: one bite at a time. *Swiss Medical Weekly*, 149, w20112. http://dx.doi.org/10.4414/smw.2019.20112. PMid:31401806.

Nunes, A. C. F., & Piuvezam, G. (2019). Nutritional supplementation of vitamin A and health-related outcomes in patients with multiple sclerosis: a protocol for a systematic review and meta-analysis of randomized clinical trials. *Medicine*, 98(25), e16043. http://dx.doi.org/10.1097/MD.0000000000016043. PMid:31232938.

Qian, L. J., Gao, Y., Zhang, Y. M., Chu, M., Yao, J., & Xu, D. (2017). Therapeutic efficacy and safety of PCSK9-monoclonal antibodies on familial hypercholesterolemia and statin-intolerant patients: a meta-analysis of 15 randomized controlled trials. *Scientific Reports*, 7(1), 238. http://dx.doi.org/10.1038/s41598-017-00316-3. PMid:28331223.

Shin, B. C., Chun, I. A., Ryu, S. Y., Oh, J. E., Choi, P. K., & Kang, H. G. (2018). Association between indication for therapy by nutrition support team and nutritional status. *Medicine*, 97(52), e13932. http://dx.doi.org/10.1097/MD.0000000000013932. PMid:30593213.

Singer, P., Blaser, A. R., Berger, M. M., Alhazzani, W., Calder, P. C., Casaer, M. P., Hiesmayr, M., Mayer, K., Montejo, J. C., Pichard, C., Preiser, J. C., van Zanten, A. R. H., Oczkowski, S., Szczeklik, W., & Bischoff, S. C. (2019). ESPEN guideline on clinical nutrition in the intensive care unit. *Clinical Nutrition, 38*(1), 48-79. http://dx.doi.org/10.1016/j.clnu.2018.08.037. PMID: 30348463.

Wang, Y., Zheng, J., Gao, Z., Han, X., & Qiu, F. (2018). Investigation on nutritional risk assessment and nutritional support status of surgical patients with colorectal cancer. *Journal of B.U.ON. : official journal of the Balkan Union of Oncology*, 23(1), 62-67. PMid:29552761.

Wu, X., Liu, Q., Zhang, R., Wang, W., & Gao, Y. (2017). Therapeutic efficacy and safety of laparoscopic surgery versus microsurgery for varicocele of adult males: a meta-analysis. *Medicine*, 96(34), e7818. http://dx.doi.org/10.1097/MD.0000000000007818. PMid:28834886.

Zheng, R., Devin, C. L., Pucci, M. J., Berger, A. C., Rosato, E. L., & Palazzo, F. (2019). Optimal timing and route of nutritional support after esophagectomy: a review of the literature. *World Journal of Gastroenterology*, 25(31), 4427-4436. http://dx.doi.org/10.3748/wjg.v25.i31.4427. PMid:31496622.