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Screening of Nutritional Risk and Nutritional Support in General Surgery Patients: A Survey from Shanghai, China

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To determine the prevalence of nutritional risk in surgical departments and to evaluate the impact of nutritional support on clinical outcomes. The nutritional risk in different surgical diseases and the different way of nutritional support on clinical outcomes in patients at nutritional risk remain unclear. Hospitalized patients from general surgical departments were screened using the Nutritional Risk Screening (NRS) 2002 questionnaire on admission. Data were collected on nutritional risk, complications, and length of stay (LOS). Overall, 5034 patients were recruited; the overall prevalence of nutritional risk on admission were 19.2%. The highest prevalence was found among patients with gastric cancer. At-risk patients had more complications and longer LOS than nonrisk patients. Of the at-risk patients, the complication rate was significantly lower and LOS was significantly shorter in the nutritional-support group than in the no-support group (20.9 versus 30.0%, $P < 0.05$). Subgroup analysis showed reduced complication rates and LOS only in patients with gastric cancer, colorectal cancer, and hepato-pancreato-biliary (HPB) cancer. Significantly lower complication rates relative to nonsupported patients were found among patients who received enteral nutrition or who received support for 5 to 7 days, or daily support entailing 16 to 25 kcal/kg of nonprotein energy. Different surgical diseases have different levels of nutritional risk. The provision of nutritional support was associated with a lower complication rate and a shorter LOS for gastric, colorectal, and HPB cancer patients at nutritional risk. The improper use of nutritional support may not improve outcomes for at-risk patients.

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Malnutrition is a key concern to the surgeon. Nutritional depletion not only adversely affects the clinical surgical condition of a patient, but it may also increase the risk of poor postoperative outcomes.[1–3] Nutritional support has positive effects on the patients with malnutrition, while nutritional therapy may have no benefit for patients with normal nutritional status and could cause ill effects.[4,5] Therefore, it is important for surgeons to assess nutritional status before nutritional therapy is implemented.

There has been a lack of a unified standard of nutrition screening for many years. In addition, most of the used screening scores have not been validated with respect to clinical outcomes, which is the most relevant question for clinicians. Kondrup *et al*[6] established the Nutritional Risk Screening Tool (NRS)-2002, which has been recommended by the European Society of Parenteral and Enteral Nutrition for nutritional screening in hospitalized patients.[7] The suitability of the NRS-2002 in China was first reported by Chen *et al*[8] in a single Chinese hospital in a study that indicated 100% of general surgery patients can use this screening tool; a similar finding was then reported by Jiang *et al*[9] in a national survey, which indicated that the NRS-2002 can be completed by 99.2% of hospitalized surgery patients in China.

The Nutritional Risk Screening Tool is a simple tool for the evaluation of nutritional status and strongly predicts the incidence and severity of postoperative complications in surgical patients.[10,11] Further studies are needed to differentiate between the effects of nutritional risk in different surgical diseases, and the effects of nutritional support on clinical outcomes in patients at nutritional risk need to be confirmed across surgical pathologies. Therefore, we conducted this study in a large cohort of more than 5000 patients. This study design enables screenings to be made for a large number of potentially confounding variables, which adds specificity to observed associations between NRS score and clinical outcome.

Materials and Methods

Patients

A consecutive series of general surgery patients who were hospitalized in our hospital between August 2009 and March 2011 were recruited in the study. The following inclusion criteria were used to identify patients that were eligible for this study: age 18 to 90 years; well-oriented to time and place; could provide a signed informed consent form; and stayed in hospital for at least 3 days. All patients provided written consent for both data collection and publication.

In total, 5042 patients were recruited. There were 2365 male (46.9%) and 2677 female (53.1%) patients with an overall median age of 55.2 years (range, 18–89 years). Of the 5042 patients in the study cohort, 358 had gastric cancer, 603 had colorectal cancer, 720 had benign hepato-pancreato-biliary (HPB) disease, 142 had HPB cancer, 1946 had thyroid or hernia disease, 406 had vascular disease, and the remaining 867 patients had another benign disease.

NRS and data collection

Nutrition risk screening was performed within the first 24 hours of admission using the NRS 2002. The Nutritional Risk Screening Tool score is calculated by adding the nutritional status score (0–3) to the severity of disease score (0–3); +1 was added to the scores of patients aged $\geq$70 years. An NRS score $\geq$3 was interpreted to mean that the patient was nutritionally at risk, whereas an NRS score $<$3 indicated no nutritional risk.

Other data, including the use of nutritional support, complications, length of hospital stay (LOS), and hospitalization costs, were collected after NRS application. All patients were monitored daily until discharge. Their medical records were reviewed within 24 hours after discharge to verify that all of the information was correct.

Definition of nutritional support

In this study, parenteral nutrition (PN) was defined as the nutrients administered intravenously, which contained a combination of amino acids, carbohydrate or fat, with a nonprotein daily caloric sustenance of at least 10 kcal/kg body weight. Enteral nutrition (EN) was defined as oral nutrient supplements and tube feeding that provided at least 10 kcal/kg/d. Overall, patients who received PN or EN for at least 3 days constituted the nutritional-support group.[12,13]

Table 1 Incidence of undernutrition and nutritional risk by disease type

Type of disease	n	Incidence of undernutrition, n (%)	Incidence of nutritional risk, n (%)	
			<3	≥3
Colorectal cancer	603	135 (22.6)	405 (67.3)	198 (32.7)
Gastric cancer	358	146 (40.1)	182 (50.9)	176 (49.1)[a]
Benign GI disease	401	26 (6.5)	332 (82.8)	69 (17.2)[b]
Benign HPB disease	720	39 (5.4)	573 (79.6)	147 (20.4)[b]
HPB cancer	142	24 (16.7)	84 (59.3)	58 (40.7)[a]
Thyroid/hernia disease	1946	93 (4.8)	1730 (88.9)	216 (11.1)[b]
Vascular disease	406	21 (5.3)	365 (89.9)	41 (10.1)[b]
Other benign diseases	466	24 (5.2)	403 (86.5)	63 (13.5)[b]
Total	5042	509 (10.1)	4074 (80.8)	968 (19.2)

[a] $P < 0.05$ versus colorectal cancer.

[b] $P < 0.01$ versus colorectal cancer, gastric cancer, and HPB cancer, respectively.

Diagnosis of infectious complications

Noninfectious complications were confirmed based on clinical manifestations, laboratory results, and imaging findings. Infectious complications were diagnosed primarily on the basis of culture results, and supported by clinical radiologic, or hematologic evidence of infection, according to the description provided by the American College of Chest Physicians/Society of Critical Care Medicine consensus conference.[14]

Statistical analysis

Statistical analysis was performed using statistical software (SPSS 19.0; SPSS Inc, Chicago, Illinois). A comparison of complication rates between different groups was performed using Pearson's χ^2 test. Results were considered statistically significant if the P value was <0.05. An independent t-test was used to compare the mean LOS in patients with or without nutritional risk.

Results

Patients

Our analysis revealed that nearly 1 in 5 patients were at nutritional risk, with an NRS score ≥3 (Table 1). The highest prevalence was found in patients with gastric cancer, HPB cancer, and colorectal cancer (rates reported in Table 1). Patients who suffered from thyroid, hernia, or vascular diseases had low prevalence of nutritional risk (<12%).

Use of nutritional support (PN or EN) in at-risk and nonrisk patients

The nutritional support rates for different surgical diseases, with or without at-risk status, are shown in Table 2. Of the 591 nonrisk patients that received nutritional support, 232 received PN, 213 received EN, and 146 received PN and EN. Most (376/591; 63.6%) of these nonrisk patients received postoperative support. Relatively few (72/591; 12.2%) received pre-operative support only, and about 1 in 4 (143/591; 24.3%) received both pre-operative and postoperative support. Their mean amount of daily nonprotein calories was 18.7 ± 4.6 kcal/kg and their mean nutritional support time was 5.5 ± 2.3 days.

Table 2 Nutritional support by surgical disease

Type of disease	NRS score, n	Nutritional support, n (%)	
		No	Yes
Colorectal cancer	<3, 405	253 (62.7)	152 (37.3)
	≥3, 198	106 (53.5)	92 (46.5)
Gastric cancer	<3, 182	38 (29.2)	144 (70.8)
	≥3, 176	24 (14.1)	152 (85.9)[a]
Benign GI disease	<3, 332	291 (87.7)	41 (12.3)
	≥3, 69	49 (70.0)	20 (30.0)[b]
Benign HPB disease	<3, 573	521 (91)	52 (9)
	≥3, 147	106 (72.1)	41 (27.9)[b]
HPB cancer	<3, 84	60 (71.9)	24 (28.1)
	≥3, 58	30 (51.7)	28 (48.3)[b]
Thyroid/hernia disease	<3, 1730	1608 (92.9)	122 (7.1)
	≥3, 216	141 (65.3)	75 (34.7)[b]
Vascular disease	<3, 365	350 (95.9)	15 (4.1)
	≥3, 41	34 (82.9)	7 (17.1)[b]
Other benign diseases	<3, 735	653 (88.8)	82 (11.2)
	≥3, 132	96 (72.7)	36 (27.3)[b]
Total	<3, 4074	3483 (85.5)	591 (14.5)
	≥3, 968	537 (55.5)	431 (44.5)

[a] $P < 0.01$, [b] $P < 0.05$ versus colorectal cancer and HPB cancer, respectively.

Table 3 Complications in at-risk and no nutritional risk patients

Complication	Nutritional risk, n	No nutritional risk, n
Infectious		
Pneumonia	37	96
Wound infection	45	125
Intra-abdominal infection	25	63
Sepsis or bacteremia	8	22
Urinary tract infection	13	38
GI infection	6	16
Skin or hypodermis infection	2	7
Catheter-related infection	11	34
Noninfectious		
GI bleeding	20	42
Pleural effusion or pneumothorax	14	25
Severe electrolyte disturbance	8	14
GI obstruction or perforation	29	65
Severe diarrhea	15	22
Anastomosis leakage	21	47
Postoperative bleeding	10	19
Wound dehiscence or impaired healing	6	2
Cardiac, renal, or respiratory dysfunction	30	69
Multiple organ failure	8	12
Deep venous thrombosis	5	8

Of the 431 at-risk patients that received nutritional support (Table 2), 178 received PN, 134 received EN, and 119 received both PN and EN. Only 13.9% (60/431) of at-risk patients received preoperative support, 58.9% (254/431) received postoperative support, and 27.1% (117/431) received both pre-operative and postoperative support. Their mean amount of daily nonprotein calories was 19.1 ± 5.3 kcal/kg and their mean nutrition support time was 5.9 ± 2.1 days. The highest nutritional support rate was found in patients with gastric cancer and the lowest nutritional support rate was found in patients with vascular disease (Table 2).

Difference in complication rates between at-risk and nonrisk patients

Overall, 251 out of 968 patients had complications in the at-risk group and 604 of 4074 patients had complications in the nonrisk group. The incidences of particular complication types are presented in Table 3. The overall complication rate was much lower in the nonrisk group than in the at-risk group (14.8% versus 25.9%, $P < .0001$). The average LOS was shorter in the nonrisk group (9.5 ± 7.7 days) than in the at-risk group (12.2 ± 7.2 days; $P < .0000$). As reported in Table 4, further analysis showed different complication rates between different surgical disease groups. There were no significant differences in complication rates between the at-risk and nonrisk groups of patients with gastric cancer, benign HPB disease, thyroid/hernia disease, vascular disease, or other benign diseases (Table 4).

Difference in LOS between at-risk and nonrisk patients

The mean LOS was significantly shorter in the nonrisk group (Table 5). Further analysis showed differences between different surgical diseases. Among patients with gastric cancer, benign HPB disease, thyroid/hernia disease, vascular disease, and other benign diseases, there were no significant differences in LOS between the at-risk group and nonrisk group (Table 5).

Difference in complication rate between at-risk patients with versus without nutritional support by surgical disease

Complication rates for disease subgroups among at-risk patients are presented in Table 4. Among patients with gastric cancer, colorectal cancer, and HPB cancer, complications were less frequent in the nutritional support group than in the no-support

Table 4 Impact of nutritional risk on complication rate

Type of disease	Complication rate, % (ratio)		OR (95% CI)	*P* value
	At-risk	No risk		
Colorectal cancer	30.8 (61/198)	19.0 (77/405)	1.620 (1.213–2.165)	0.0012
Gastric cancer	23.9 (42/176)	18.1 (33/182)	1.316 (0.877–1.975)	0.1828
Benign GI disease	27.5 (19/69)	17.5 (56/332)	1.633 (1.040–2.563)	0.0386
Benign HPB disease	19.0 (28/147)	14.3 (82/573)	1.331 (0.902–1.964)	0.1544
HPB cancer	50.0 (29/58)	25.0 (21/84)	2.000 (1.274–3.140)	0.0022
Thyroid/hernia disease	19.0 (41/216)	10.4 (180/1730)	1.824 (1.340–2.483)	0.0002
Vascular disease	31.7 (13/41)	22.0 (80/365)	1.447 (0.887–2.359)	0.1547
Other benign diseases	28.6 (18/63)	18.4 (74/403)	1.556 (1.001–2.416)	0.0583
Total	25.9 (251/968)	14.8 (604/4074)	1.749 (1.537–1.991)	<0.0001

Table 5 Impact of nutritional risk on LOS

Type of disease	Nutritional risk		*P* value
	Yes	No	
Colorectal cancer	16.2 ± 7.2	14.8 ± 8.1	0.0393
Gastric cancer	17.4 ± 7.9	16.1 ± 7.5	0.1111
Benign GI disease	12.1 ± 4.4	11.6 ± 5.7	0.4924
Benign HPB disease	8.9 ± 3.7	8.2 ± 4.5	0.0821
HPB cancer	19.8 ± 5.6	17.7 ± 6.1	0.0389
Thyroid/hernia disease	6.4 ± 2.0	6.1 ± 2.8	0.1270
Vascular disease	7.2 ± 2.9	6.9 ± 3.4	0.5874
Other benign diseases	8.9 ± 3.3	8.4 ± 4.1	0.3570
Total	12.2 ± 7.2	9.5 ± 7.7	<0.0001

group. Complication frequency was similar between nutritionally supported and not nutritionally supported among patients with HPB benign disease, thyroid/hernia disease, vascular disease, and other surgical disease between the nutritional support group and the no-support group (Table 6).

Difference in LOS between nutritional-support and no-support subgroups in nutritionally at-risk patients with different surgical diseases

The LOS values in the at-risk patients are presented in Table 5. The LOS of patients with gastric, colorectal, and HPB cancer was much shorter in the nutritional support group than in the no-support group. Values of LOS did not differ between the nutritional support and the no-support subgroups among patients with benign HPB disease, thyroid/hernia disease, vascular disease, and other surgical diseases (Table 7).

Complication rates in relation to types of nutritional support versus no support in nutritionally at-risk patients

As reported in Table 8, the overall complication rate was significantly lower in patients who received EN or PN + EN than in patients who did not receive nutritional support. Complication rates were similar between patients who received PN and patients who did not receive any nutritional support. The overall complication rate was significantly lower in patients who received nutrition support for 5 to 7 days than in patients who did not receive any nutritional support. No differences in complication rates were found between patients who received nutritional support for 3 to 4 days or >8 days compared with patients who did not receive nutritional support. The overall complication rate was significantly lower in patients who received 16 to 20 or 21 to 25 kcal/kg daily supplementation than in nonsupported patients. No differences in the complication rate were found between patients who received <16 or >25 kcal/kg supplementation versus the nonsupported group (Table 8).

Discussion

The prevalence of nutritional risk rate in general surgery has been shown to range from 6 to 30%.[11,15] In this study, the nutritional risk rate was 19.2%, which was higher than previous European reports but lower than some reports from China. Different disease compositions, various specialties, regions, and departments may have resulted in differences between the various studies. We observed a higher prevalence of nutritional risk in some malignant diseases than in benign diseases, with the highest prevalence of nutritional risk being found in gastric cancer patients, confirming prior work pointing to cancer and gastrointestinal diseases as significant risk factors for malnutrition.[15,16] Our findings also support prior studies that reported a higher prevalence of nutritional risk among older patients.[9,15]

The undernutrition rate was lower than the nutritional risk rate in various surgical diseases,

Table 6 Impact of nutritional support on complications by disease type

Type of disease	Incidence of complication, % (ratio)		OR (95% CI)	*P* value
	No nutritional support	Nutritional support		
Colorectal cancer	39.6 (42/106)	19.6 (19/92)	1.919 (1.206–3.053)	0.0036
Gastric cancer	45.8 (11/24)	20.4 (31/152)	2.247 (1.314–3.843)	0.0139
Benign GI disease	30.6 (15/49)	20.0 (4/20)	1.531 (0.579–4.048)	0.3706
Benign HPB disease	20.8 (22/106)	14.6 (6/41)	1.418 (0.620–3.245)	0.3965
HPB cancer	63.3 (19/30)	32.1 (10/28)	1.773 (1.006–3.125)	0.0346
Thyroid/hernia disease	19.1 (27/141)	18.7 (14/75)	1.026 (0.573–1.835)	0.8324
Vascular disease	32.4 (11/34)	28.6 (2/7)	1.132 (0.573–1.835)	0.6806
Other benign diseases	29.8 (14/47)	25.0 (4/16)	1.191 (0.458–3.098)	0.6800
Total	30.0 (161/537)	20.9 (90/431)	1.436 (1.147–1.797)	0.0022

Table 7 Impact of nutritional support on LOS in different surgical diseases

Type of disease	Hospital stay, d		
	No nutritional support	Nutritional support	*P* value
Colorectal cancer	17.1 ± 7.6	15.1 ± 6.6	0.0475
Gastric cancer	21.4 ± 10.8	16.8 ± 7.2	0.0077
Benign GI disease	12.5 ± 4.2	11.2 ± 4.8	0.2672
Benign HPB disease	9.0 ± 3.3	8.8 ± 4.4	0.7654
HPB cancer	21.2 ± 5.9	18.3 ± 4.9	0.0412
Thyroid/hernia disease	6.5 ± 2.1	6.2 ± 1.8	0.2954
Vascular disease	7.2 ± 3.0	7.1 ± 2.7	0.9355
Other benign diseases	9.0 ± 3.2	8.8 ± 3.5	0.8337

Table 8 Complication rates for patients given PN or EN nutritional support compared to the no support groups among at-risk patients

Support parameter	Nutritional support, % (ratio)		
	Yes	No	*P* value
Approach			
PN	25.8 (46/178)	30.0 (161/537)	0.2914
EN	15.7 (21/134)		0.0090
PN+EN	19.3 (23/119)		0.0190
Time			
3–4 days	24.8 (25/101)	30.0 (161/537)	0.2888
5–7 days	18.8 (48/256)		0.0008
>7 days	23 (17/74)		0.2135
Daily energy			
<16 kcal/kg	27.2 (21/77)	30.0 (161/537)	0.6264
16–20 kcal/kg	20.3 (25/123)		0.0318
21–25 kcal/kg	18.2 (35/192)		<0.0001
>25 kcal/kg	23.1 (9/39)		0.3614

which indicates that some patients with a normal body mass index could be at nutritional risk. Hence, simple anthropometric parameters may underestimate the nutritional risk of hospitalized patients and miss many patients who should be given nutritional support.

We found that fewer than half of the patients who were at nutritional risk received nutritional support. The highest nutritional support rate was found in patients with gastric cancer and the lowest was found in patients with vascular disease. Unfortunately, we found that not all surgical patients at risk received nutritional support, particularly among patients with benign disease. On the other hand, 14.3% patients who were not at nutritional risk—most commonly gastric cancer patients—received nutritional support.

The present results indicate that nutritional support was not applied adequately in our hospital, a finding that is consistent with that of a prior multicenter investigation in China and studies in other countries. There are several possible reasons for this inadequacy, such as a lack of appropriate and timely nutritional status screenings and a lack of clinical experience-based application. The average ratio of PN to EN was 1.2:1, which indicated that the use of PN was slightly more prevalent than EN in our hospital. Although the proportion of EN application is higher than other domestic research reports, it remains below levels in European and American countries.

Many studies have shown that patients at nutritional risk had elevated complication and mortality rates and longer LOS compared with nonrisk patients.[10,16–18] Our results verified these findings, but showed differences between different surgical diseases. In some benign diseases, such as HPB disease and vascular disease, there was no significant difference in complication rates or LOS between at-risk patients and nonrisk patients. We also found that nutritional risk did not increase complication rates or LOS in patients with gastric cancer. This finding is relevant to the high nutritional support rate for this disease, which may lead to improvements in clinical outcome.

The most important aspect of nutritional risk screening is to guide the application of nutritional support. Whether at-risk patients can benefit from nutritional support is a key issue for clinicians. Jie *et al*[19] reported that nutritional support (especially EN) is beneficial to patients who are nutritionally at risk, as it is associated with a lower complication rate. In contrast, nutritional support is not beneficial to the nonrisk patients, as defined by the NRS-2002. In this study, we found that nutritional support decreased the complication rate and hospital stay in at-risk patients. We found that nutritional support can significantly improve the clinical outcome in patients with gastric, HPB, or colorectal cancers, but not in patients with other surgical diseases, such as benign HPB disease, thyroid/hernia disease, or vascular disease, These results suggest that an NRS ≥3, the standard cutoff for nutritional support, may not be applicable to all surgical disease types. For some benign diseases, it may be that only patients with higher scores benefit from nutritional support. However, this hypothesis requires further verification.

When the effects of different support approaches, different support times, and different nonprotein energy levels were analyzed separately, significantly lower complication rates relative to nonsupported patients were only found among patients who

received EN or who received support for 5 to 7 days or daily support entailing 16 to 25 kcal/kg of nonprotein energy. These results indicate that improper use of nutritional support apparently does not improve the outcome of at-risk patients.

It should be noted that the NRS-2002 is not a perfect screening tool. The largest shortcoming of the NRS-2002 is that the classification of diseases is not detailed or clear. Investigators often do not know how to assess disease severity according to the NRS-2002, which limits the clinical application of the screening tool. The disease spectrum needs to be extended and detailed based on more randomized controlled trials. Another problem, as mentioned above, is that a score ≥ 3 as the standard cutoff for nutritional risk may not be applicable to all diseases. Further large sample and multicenter studies are needed to confirm whether different diseases need a different standard.

In conclusion, although the NRS-2002 may be an appropriate screening tool with which to evaluate and examine the nutritional risk of patients undergoing treatment in surgical departments in that the score is associated with the clinical outcome of surgical patients, a single cutoff value for all patients appears to be inadequate. The present data may serve as a clinical reference for health care professionals in their nutritional support decisions, although this screening tool requires further improvements.

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