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# Assessment of a novel screening score for nutritional risk in predicting complications in gastro-intestinal surgery☆

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**Summary**

*Background & aims:* Malnutrition is a recognized risk factor for perioperative morbidity, but there is currently no standardized definition of malnutrition. The Nutrition Risk Screening 2002 score was recently proposed to identify patients at nutritional risk who may benefit from nutritional support therapy, and has been officially adopted by the European Society of Parenteral and Enteral Nutrition. The aim of this study was to assess the value of the Nutrition Risk Screening 2002 score in predicting the incidence and severity of postoperative complications in gastrointestinal surgery.

*Methods:* We prospectively evaluated 608 patients admitted for elective gastrointestinal surgery. Nutritional risk was defined by the Nutrition Risk Screening 2002 score and correlated to the incidence and severity of postoperative complications. Complications were classified using an established surgical complication classification.

*Results:* The overall incidence of nutritional risk was 14%. We observed a significantly higher complication rate of 40% (35 out of 87) in patients at nutritional risk, compared to 15% (81 out of 521) in patients with a normal score ($p < 0.001$). The incidence of severe complications was significantly higher in patients at nutritional risk (54% versus 15%; $p < 0.001$). The odds ratio to develop a complication was 2.8 in patients at risk ($p = 0.001$), and 3.0 in patients with malignant disease ($p < 0.001$). The median length of stay in nutritional risk patients was significantly longer (10 versus 4 days, $p < 0.001$).

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*Conclusion:* The prevalence of nutritional risk patients in gastrointestinal surgery is high. We showed that nutritional risk screening using the NRS 2002 strongly predicts the incidence and severity of complications.


## Introduction

Preoperative malnutrition is an established risk factor of perioperative morbidity and mortality.[1–7] Malnutrition in gastrointestinal (GI) surgery is caused by decreased oral food intake, tumor-related cachexia, impaired digestive capacity due to bowel resections, but also by obstruction of the GI tract, pre-existing chronic diseases, and socioeconomic factors. Elderly and handicapped patients living alone without sufficient familial and institutional support are particularly at risk to develop malnutrition.[8]

While the majority of preoperative risk factors associated with an increased perioperative morbidity and mortality cannot be corrected, malnutrition is potentially reversible through an adequate nutritional support therapy.[9–12] Therefore, malnutrition is an attractive target to reduce morbidity and costs in surgery. It has been demonstrated that preoperative improvement of the patient's nutritional status and early postoperative nutritional support significantly decrease postoperative complications.[7,9,13–15]

An important shortcoming in the interpretation of the available data is the lack of a standardized definition of malnutrition. As a consequence the reported prevalence of malnutrition in GI surgery reveals a wide range from 30% to 50%,[4–6,9] mostly depending on the score used. The variability of selection criteria to define malnutrition prevents conclusive comparisons among different centers and studies. In addition most of the currently used screening scores are not validated with respect to clinical outcome as stated by the American Society for Parenteral and Enteral Nutrition Board of Directors.[16]

One attempt to overcome these shortcomings is the development of a novel screening system by a working group of the European Society of Parenteral and Enteral Nutrition (ESPEN). The Nutritional Risk Score 2002 (NRS 2002) is based on oral food intake, weight loss, patient's age, body mass index (BMI), and severity of the underlying disease.[17] These variables have been identified after a meticulous analysis of the current literature. All available randomized controlled trials about nutritional support therapy have been assessed, with a particular focus on nutritional criteria and clinical outcome. The NRS 2002 has been validated against 128 controlled trials of nutritional support therapy. The main advantages of the NRS 2002 are its easy applicability in daily clinical practice, high reliability and reproducibility. In 2003, the NRS 2002 was officially adopted by the ESPEN to screen patients for malnutrition in the hospital.[18]

So far, this score has never been applied prospectively in a GI surgery patient cohort, and there are no prospective data available on the correlation of the score and patient's outcome. To address these shortcomings we used an objective classification of surgical complications and correlated the incidence and severity of the complications to the findings of the NRS 2002.

The primary aim of this study was to evaluate the value of the NRS 2002 in predicting the incidence and severity of postoperative complications in a wide range of GI surgery procedures. Secondary aims were to evaluate the applicability of the NRS 2002 in the clinical setting, and to prospectively assess the prevalence of patients at nutritional risk in electively admitted patients scheduled for GI surgery.

## Methods

### Patients

A consecutive series of 608 patients undergoing various elective GI operations at the University Hospital of Zurich were prospectively assessed between April 2004 and February 2005. Preoperative nutrition risk assessment was performed within the first 24 h of admission using the NRS 2002. All patients provided written consent for data collection and publication. The data acquisition is done on a routine basis for quality control reasons. Therefore, ethical board approval was not necessary according to our local policy.

### Nutritional assessment

The NRS 2002 was performed according to the recommendations by Kondrup et al.[17] Nutritional risk is evaluated by two components: impaired nutritional status and severity of disease. Nutritional status was evaluated by three variables: body mass index (BMI), recent weight loss, and food intake during the week before admission. For severity of disease, as an indicator of stress metabolism and increased nutritional requirements, a score between 1 and 3 was given according to the recommendations. A data collection sheet was used to obtain information about changes in the usual body weight, food intake and severity of disease according to the ESPEN guidelines.[18] Patients were questioned by the responsible resident on the ward. The patient's height and weight were assessed by the nursing staff using a calibrated scale. Patients with a total score of three or more were considered at nutritional risk according to the recommendations of the score.

### Assessment of complications

A standardized complication classification system recently published by our group was used to monitor postoperative complications.[19] The grading of the severity of complications is based on the therapy used to correct a specific complication. Briefly, grade I complications include minor deteriorations from the normal postoperative course without the need of any specific treatment. Grade II complications can be treated solely by drugs, blood transfusion, physiotherapy and nutritional support. Grade III complications require interventional treatment. Grade IV complications are life-threatening complications requiring ICU management. Grade V is defined as death of the patient. Postoperative complications were monitored daily by one of the co-authors. The classification of complications was prospectively applied to each patient, and each complication was graded according the information available in the patient's individual medical chart. If a patient had more than one complication, only the highest ranked complication was used for the analysis.

### Statistical analysis

Statistical analysis was performed using SPSS Inc. Chicago, IL, USA. All results are given as median and range. Comparison of complication rates within different groups was performed using Pearson chi-square test. Results were considered statistically significant if the *p*-value was below 0.05. Multiple logistic regression analysis was performed to compute odds ratios for different variables. Independent *t*-test was used to compare the mean length of stay (LOS) in patients with or without nutritional risk. Furthermore, Pearson correlation analysis was used to investigate the correlation between LOS and the NRS 2002 score.

## Results

### Patients

There were 320 male (53%) and 288 female (47%) patients with a median age of 51.2 years (range 18.0–89.8 years). The median height was 170 cm (range 141–198 cm) and the median weight was 75 kg (range 37–220 kg). The BMI ranged from 12 to 66 $kg/m^2$, with a median BMI of 25.6 $kg/m^2$. This reflects the heterogeneous patient cohort, which included patients with advanced cancer, as well as morbidly obese patients undergoing bariatric surgery. Forty-two patients underwent bariatric surgery for morbid obesity. Their median BMI was 43 $kg/m^2$ compared to 25 $kg/m^2$ in the remaining 566 patients. The median length of stay (LOS) was 6 days (range 1–40 days).

Seventy-seven patients underwent hepatobiliary/pancreatic resections, 48 patients upper GI surgery, 111 patients colorectal procedures, 42 patients bariatric surgery, 123 patients proctological operations, 27 patients endocrine surgery, 87 patients hernia surgery, 51 patients cholecystectomies, and 41 patients underwent living related kidney transplantation. One hundred and thirty-six patients underwent surgery for cancer; the remaining 472 patients were operated for different benign diseases.

### What is the prevalence of nutritional risk in elective GI surgery patients using the novel classification system?

The assessment of the nutritional risk by using the NRS 2002 was carried out rapidly in the clinical routine, and only a few minutes were necessary to complete the score sheet for each patient.

There were 87 patients (14%) at nutritional risk according to NRS 2002. The highest prevalence was found in patients undergoing hepatobiliary surgery (27%), upper GI surgery (27%), transplantation (22%) and colorectal surgery (21%). Patients undergoing minor surgery, e.g. hernia repair and cholecystectomies, revealed a prevalence of nutritional risk below 10%. The prevalence of nutritional risk and complications within the different surgical groups are shown in Table 1.

### What is the incidence of nutritional risk in patients undergoing surgery for cancer?

There was a significant correlation between the incidence of nutritional risk and malignancy. Significantly more patients admitted for cancer surgery were at nutritional risk (40%), while patients with benign diseases had only a low incidence of nutritional risk (8%). Absolute numbers are given in Table 2. The high score in cancer patients was only partially explained by the points given for severity of disease (cancer patients received two points for their disease). The mean score for impaired nutritional status in cancer patients was also higher with a mean of 0.8 points versus a mean of 0.1 points in non-cancer patients ($p < 0.01$; independent *t*-test).

### What is the impact of nutritional risk on the incidence and severity of complications?

Complications were documented in 19% ($n = 116$) of the patients. The most common complications were of infectious nature (54%). Twenty-eight wound infections, 14 urinary tract infections, 9 sepsis, 5 pneumonias, and 7 intraperitoneal abscesses were recorded. Although infections made major contributions to the overall morbidity, most of them were classified as grade 1 and 2.

In addition to all infectious complications, there were 13 postoperative bleedings, 8 anastomotic leakages, 5 pulmonary embolism, 3 myocardial infarctions/severe arrhythmia, 4 diarrhea, one hepatic encephalopathy, one deep venous thrombosis, and 17 wound openings.

The grading of the complications according to their severity revealed 38 patients with a grade 1 complication,

**Table 1** Incidence of nutritional risk and complications in different types of surgery

| Type of surgery | *n* (%) | Overall complications (%) | Nutritional risk patients (%) |
|---|---|---|---|
| Bariatric | 42 (6.9) | 12 (28.6) | 3 (6.7) |
| Hepatobiliary | 77 (12.7) | 21 (27.3) | 21 (27.3) |
| Hernia | 87 (14.3) | 13 (14.9) | 8 (9.2) |
| Cholecystectomy | 51 (8.4) | 4 (7.8) | 5 (9.8) |
| Colorectal | 111 (18.3) | 30 (27.0) | 23 (20.7) |
| Endocrine | 27 (4.4) | 3 (11.1) | 0 (0) |
| Proctology | 123 (20.2) | 6 (4.8) | 5 (4.0) |
| Transplantation | 41 (6.7) | 12 (29.3) | 9 (21.9) |
| Upper GI | 48 (7.9) | 15 (31.2) | 13 (27.1) |
| Total | 608 (100) | 116 (19.1) | 87 (14.3) |

**Table 2** Incidence of nutritional risk in patients with malignant and benign disease

| | Nutritional risk | | *p*-value |
|---|---|---|---|
| | No | Yes | |
| Malignant disease (*n*) | 82 | 54 | <0.001 |
| Benign disease (*n*) | 439 | 33 | |
| Total | 521 | 87 | |

Chi square = 92.1, $p < 0.001$.

**Table 4** Correlation of complication grades and nutritional risk

| Complication grade | Nutritional risk | | Total |
|---|---|---|---|
| | No | Present | |
| 1 | 32 | 6 | 38 |
| 2 | 37 | 10 | 47 |
| 3 | 6 | 8 | 14 |
| 4 | 6 | 9 | 15 |
| 5 | 0 | 2 | 2 |
| Total | 81 | 35 | 116 |

Number of patients with different complication grades stratified by nutritional risk. Using the chi-square test we found that nutritional risk patients had significantly more severe complications than no risk patients (chi-square = 21.3, $p < 0.001$).

47 patients with a grade 2, 14 patients with a grade 3, and 15 patients with a grade 4, respectively. Two patients died (grade 5). The overall mortality rate was therefore 0.3%.

Postoperative complications were significantly more frequent in nutritional risk patients (40%) versus patients without nutritional risk (15%; $p < 0.01$; chi-square test). Absolute numbers are given in Table 3. Furthermore, complications of patients at nutritional risk were significantly more severe ($p < 0.001$) and required more interventions or reoperations. The incidence of severe complications (grade 3—5) in at-risk patients was 54% versus 15% in patients without nutritional risk ($p < 0.001$). Absolute numbers of complication grades and prevalence of complications are given in Table 4. Both patients who died were at nutritional risk. They suffered from postoperative sepsis and consecutive multi-organ failure. There was no death in the non-risk group.

## Does severity of disease and nutritional status predict complications?

The NRS 2002 is based on nutritional status and severity of the underlying disease. The severity of the underlying disease was introduced to the score to account for the increased need of nutritional requirements resulting from critical illness. We assessed both components separately in order to test whether there is an independent correlation between nutritional status/severity of the underlying disease and complications, respectively. Using the chi-square test, the complication rate was significantly related to nutritional status (chi-square = 54.3; $p < 0.001$) and severity of disease (chi-square = 41.4; $p < 0.001$). This result reinforces the fact that increased stress metabolism and impaired nutritional status do predispose for complications. To adjust for confounding factors we used multiple logistic regression analysis and computed odds ratios to develop perioperative complications for different variables. The odds ratio to develop a postoperative complication was 2.8 (CI 1.5—5.1) in nutritional risk patients. In patients suffering from a malignant disease, the odds ratio for a complication was 3.0 (CI 1.8—4.8). Age (>70 years) and gender revealed no statistically significant difference in the multivariate analysis (Table 5). Again, nutritional status and severity of the disease were independently associated with postoperative complications.

**Table 3** Incidence of complications in relation to nutritional risk

| | Complications | | *p*-value |
|---|---|---|---|
| | No | Yes | |
| At risk patients (*n*) | 52 | 35 | <0.001 |
| No risk patients (*n*) | 440 | 81 | |
| Total | 492 | 116 | |

Chi square = 29.4, $p < 0.001$.

## What is the impact of nutritional risk on the length of hospital stay?

We tested the impact of an increased nutritional risk on the duration of the hospital stay. The median hospital stay for the overall patient group was 6 days (range 1—40 days). While patients without nutritional risk had a mean hospital stay of 5 days (SD 4.3 days, median 4 days), patients at nutritional risk had a significantly longer mean hospital stay of 13 days (SD 8.6 days, median 10 days, $p < 0.001$) (Fig. 1). The correlation between LOS and nutritional risk was also assessed by Pearson correlation analysis. The Pearson coefficient was 0.58, which represents a significant correlation ($p = 0.01$). Furthermore, correlations were assessed using non-parametric Spearman's rho analysis. The Spearman rho coefficient was 0.69 ($p = 0.01$).

**Table 5** Multiple logistic regression analysis: odds ratio's for developing complications

| | OR (95% CI) | *p*-value |
|---|---|---|
| Age >70 years | 0.65 (0.3—1.3) | 0.219 |
| Female sex | 0.87 (0.6—1.3) | 0.524 |
| Malignant disease | 2.98 (1.8—4.8) | <0.001 |
| Nutritional risk | 2.75 (1.5—5.1) | 0.001 |
| Nutritional status[a] | 4.51 (2.3—8.5) | <0.001 |
| Severity of disease[a] | 3.64 (2.1—6.2) | <0.001 |

Odds ratio (OR) and 95% confidence interval (CI).

[a] The odds ratio's for 'nutritional status' and 'severity of disease' are for each increase in score unit while all other variables are categorical.

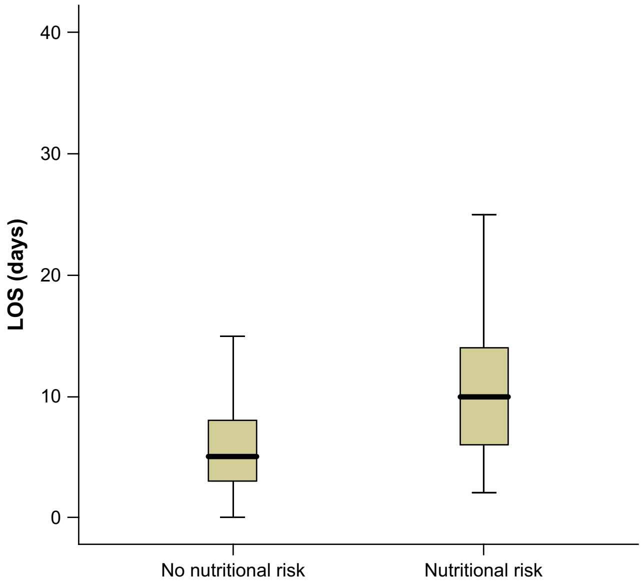


**Figure 1** The correlation between nutritional risk and length of hospital stay. Boxplots showing median and interquartile range. Nutritional risk patients had a significantly longer median length of stay (LOS) of 4 versus 10 days ($p < 0.001$; independent *t*-test).

## Discussion

It has been increasingly recognized that postoperative morbidity is not solely related to the type of surgery. Pre-existing risk factors, such as severe cardiovascular and pulmonary disease, liver cirrhosis and malnutrition promote the development of complications. Malnutrition is potentially reversible, and thus, early recognition and effective treatment may play a pivotal role in reducing postoperative complications. Here, we prospectively applied for the first time a novel screening score, the NRS 2002, to a consecutive series of elective GI surgery patients with the aims of assessing the prevalence of preoperative nutritional risk and its correlation with the incidence and severity of postoperative complications. Complications were assessed using a validated surgical complication classification.[19]

This study clearly showed that nutritional risk correlates with the incidence as well as the severity of postoperative complications. The overall prevalence of nutritional risk was 14% in the whole patient group. Patients with benign disease undergoing minor surgery had a low nutritional risk rate of less than 10%. In contrast, patients undergoing major surgery had an increased prevalence of nutritional risk between 21% and 27%. These prevalence rates are in accordance with other studies reporting malnutrition rates between 30 and 50%.[20,21] The incidence of malnutrition is especially high in cancer patients.[22] This could be confirmed by our results with an incidence of 40% nutritional risk in cancer patients. The NRS 2002 was able to detect patients at nutritional risk who were likely to develop postoperative complications. This finding is a cornerstone for nutritional support therapy, since there is evidence in the literature that nutritional support therapy may be beneficial in malnourished patients with GI cancer.[15,22]

Various aspects of nutritional deficiencies leading to malnutrition are known, but malnutrition is still poorly defined. This lack of consensus on definition and stratification of malnutrition hampers its accurate assessment and treatment, and finally impedes substantial progress to reduce postoperative morbidity. Several nutritional scores are currently used, but most of them have major shortcomings. The Prognostic Nutritional Index, which is defined by serum albumin levels and BMI, does not assess short-term changes of the nutritional status, or disease related stress metabolism.[23] The Subjective Global Assessment score is based on anamnestic criteria of the nutritional status, physical examination and performance status. This score is widely used. The main disadvantage is the high interobserver variability that is closely related to the training of the respective examiner and the subjective classification of the patients.[24]

The NRS 2002 has been designed as a simple screening score to reliably identify patients at nutritional risk who will benefit from nutritional support therapy. From all available studies on nutritional support therapy, the best criteria have been identified and integrated into the score. While most other screening scores have been developed exclusively for cancer patients, the NRS 2002 can be used for all kind of hospitalized patients. Severity of disease and impaired nutritional status are separately assessed. The grading of the two components allows a stratification of the severity of malnutrition. The non-restrictive use for all kind of patients, its easy applicability, and the reliable and safe identification of patients at nutritional risk makes the NRS 2002 very attractive for a wide range of indications.

One should note that the NRS 2002 is not a perfect assessment of malnutrition. The purpose of a screening score is to predict the outcome due to nutritional factors, and whether nutritional therapy is likely to influence this. The NRS 2002 does not solve the problem of a lacking standard for malnutrition. However, it appears to be reliable to identify patients at risk of developing nutrition related complications. The routine implementation of a nutrition risk screening tool is the first step towards a proper assessment in every patient with a potential nutritional risk. Another limitation of this study is the lack of detailed information about patient co-morbidity, perioperative and anesthetic care, such as type of anesthesia, postoperative analgesia and temperature control, which could possibly influence the incidence of perioperative complications.

The combination of the NRS 2002 with a validated complication classification recently published by our group enables for the first time an objective correlation of nutritional risk and severity of complications. We could also evaluate separately the impact of the severity of disease and impaired nutritional status. This novel approach reinforces the value of the NRS 2002, since complications and its related severity can be predicted by using a simple preoperative scoring system. To our knowledge this is the first study, which reports a strong correlation between the nutritional screening and the clinical outcome assessed by an objective score for surgical complications.

In conclusion, we have prospectively validated a novel screening score for nutritional risk and its correlation with postoperative complications. The combination of the NRS

2002 with a surgical complication classification enabled the precise assessment of patients at nutritional risk and predicted the incidence and severity of complications related to the severity of nutritional risk. The main message of this study should probably mostly rely on the implementation of the NRS 2002 as a new screening score in GI surgery, and the standardized way of reporting complications by the use of a new complication classification.

## Conflict of interest statement

All authors of the paper have no conflict of interest.

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