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# Screening for malnutrition in emergency laparotomy patients: A comparison of three tools

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**Abstract**

Background: Malnourished patients undergoing emergency laparotomy are at risk of significant morbidity. The optimum screening tool to identify such patients in practice and research is yet to be determined. This study aims to compare the performance of three nutrition risk tools in predicting time without enteral nutrition in this population.

Methods: A prospective cohort study was conducted across two sites (NCT04696367), recruiting patients undergoing National Emergency Laparotomy Audit eligible procedures. Data collected included demographics, diagnosis, procedure, and outcomes. Nutrition risk was assessed using three tools: Malnutrition Universal Screening Tool (MUST) score, Nutritional Risk Index (NRI), Nutritional Risk Score 2002 (NRS-2002). Complications were assessed with the Comprehensive Complication Index. Quality of life was measured at baseline and five days post surgery using EQ-5D-5L.

Results: 59 patients were recruited. Median age was 69 years. 23 participants were judged high risk using MUST score, 13 using NRS and 8 using NRI. Median time to restart enteral intake was 7 days (IQR 7-14). Time without intake was correlated with increasing score using MUST ($r = 0.463$, $p<0.001$) and NRS-2002 ($r = 0.296$, $p = 0.03$), but not NRI ($r = -0.121$, $p = 0.38$). High risk nutritional groups also had increased length of hospital stay, but not complication scores.

Discussion: Patients undergoing emergency laparotomy spend a prolonged time without enteral nutrition. Although all nutritional tools demonstrated some propensity to identify patients at higher risk of needing nutritional support, their performance was variable. Nevertheless, some may be useful in future clinical studies.

## Introduction

Many acute intra-abdominal conditions, such as obstruction or visceral perforation require an emergency laparotomy[1]. These 'high risk' conditions are associated with significant morbidity and mortality[2]. During this time, patients are often nil by mouth and will experience a period of ileus. This ileus effectively causes a Type I intestinal failure i.e. a transient and self limiting reduction of gut function impairing the absorption of macronutrients or fluid and electrolytes, and requiring parenteral supplementation of fluids or nutrients[3]. This malnourished state and prolonged period of catabolism may contribute to the morbidity seen in this setting[4,5].

Given the association between malnutrition and poor outcome, there is interest in how to optimise nutritional assessment and delivery in this setting. In order to stratify patients according to nutritional risk, a range of nutrition risk assessment tools can be used. These can act as triggers for more in-depth nutritional assessment. In the context of acute intestinal dysfunction, the main nutritional intervention available would be parenteral nutrition (PN). Available clinical guidelines provide advice on when parenteral nutrition might best be used in the elective setting, although they are less clear in the emergency setting[6], although a threshold of five or more days without enteral nutrition may be used in practice[6]. If nutrition risk tools were able to identify those at risk of prolonged periods of starvation following emergency laparotomy, then clinicians might be able to take proactive measures to avoid the sequelae of prolonged starvation.

The study aims to compare the performance of three nutrition risk tools in predicting malnutrition resulting in time with or without nutrition.. The secondary aim was to explore the correlation of each tool with other clinical outcomes including complications and length of stay.

## Methods

This pilot cohort study was prospectively registered on clinical trials.gov (NCT04696367) and received ethical approval from the London Bromley NHS Research Ethics Committee (19/LO/1807). It is reported in line with STROBE guidance[7].

*Sites and duration*

This study was delivered in two NHS hospitals which provide emergency surgical services. The study was initially planned to complete recruitment over a three month period beginning January 2020, however this was extended due to disruption related to COVID-19 and completed recruitment in March 2021.

*Inclusion/exclusion criteria*

Adult patients undergoing National Emergency Laparotomy Audit (NELA) eligible procedures and who were able to consent, were eligible to participate. NELA eligible operations are emergency (non-trauma) procedures in which perforation, obstruction or other pathology affecting abdominal gastrointestinal organs are treated[1]. This can be either by laparotomy or laparoscopy. Appendicectomy and cholecystectomy are excluded from this case definition. The NELA eligible procedure had to be the first procedure for that admission.

Exclusion criteria included recent discharge from hospital (within 60 days), patients who were unable to provide informed consent, patients with a life expectancy <12 months and prisoners.

*Recruitment*

Potential participants were screened by the clinical team and identified to the research team. A patient information sheet was provided and sufficient time was given before consent was taken. Patients were approached as soon as possible after admission, with a limit of three days post-admission set to minimise recall bias. This meant that patients could be recruited prior to laparotomy, or afterwards. This was intended to avoid missing acutely ill patients who were operated on out of hours.

*Data terms and definition*

*Nutrition tools*

Three nutrition risk tools were selected for comparison in this study. These were:

- **Malnutrition Universal Screening Tool ('MUST').** This is a tool designed for community level assessment, although is used as the routine admission assessment for patients admitted to the two hospitals in this study. This tool assigns points based upon body mass index (BMI), unplanned percentage weight loss in the last 3-6 months and whether or not the patient is acutely ill, with little or no nutritional intake for the past or

projected five or more days[8]. This provides a total score ranging from 0 (low risk), 1 (medium risk - for observation), or 2+ points (high risk, for intervention). In this study, the 'MUST' score was taken as recorded in the nursing charts.

- **Nutritional risk score 2002 (NRS-2002)**. NRS-2002 was designed for use across many hospital specialties and diseases. Its use is recommended by the European Society of Parenteral and Enteral Nutrition [9]. In brief, it includes four screening questions. These relate to a BMI <20.5 kg/m$^2$, weight loss in preceding three months, reduced food intake in the last week, or the patient is critically unwell. If the answer to any of these is 'yes' then the full screening should be performed. If there are no positive responses, the patient is classed as low risk. Follow-up questions relate to weight-loss over preceding 3 months as a percentage of usual weight, percentage of intake in the last week related to usual diet, severity of disease (which includes two points for major abdominal surgery), and age >70 years. A total score ≤3 is considered low risk, 4 is considered "at risk", and 5+ is considered high risk. This was calculated by the researcher.

- **Nutritional Risk Index (NRI)**. This tool was developed from a PN trial in the 1990s and considers current weight, usual weight, and serum albumin[10]. This tool was selected as our group has previously explored this in the acute setting[5]. The resulting index is correlated to risk - >100 = no risk, 97.6-100 = low risk, 83.5-97.5= moderate risk, and <83.5 = severe risk. This was calculated by the researcher.

The 'MUST' score was selected as it is in routine use in the participating hospitals. The NRS-2002 score was selected as it is recommended by the European Society of Parenteral and Enteral Nutrition[9], and the NRI was selected as our research team has used this in previous work in the field[5]. All tools were selected as they used data routinely available at the point of admission without the need for additional tests. As the 'MUST' score is routinely used as a nutrition screening tool at the participating sites, the local clinical and nutrition teams used this to inform any clinical decisions. The NRS-2002 and NRI scores were not documented in the clinical notes and did not inform practice.

*Data items*

Data were collected into an online case report form on a REDCap server hosted at the University of Sheffield[11]. Baseline data collection included demographics, date of admission, date of last enteral intake, Charlson Comorbidity Index[12], and quality of life measure using EQ-5D-5L tool (quality of life on day of admission)[13].The quality of life measure was completed using an interview technique rather than self completion. Baseline haemoglobin, albumin, and measures of renal function were also recorded. In addition, where other biochemical investigations were recorded at baseline (e.g. magnesium, phosphate), these were recorded.

The date and nature of surgery were recorded. Occurrence of complications documented by the clinical team were recorded and categorised according to the Clavien Dindo system[14].

Resumption of enteral intake (including use of nasoenteral feeding), and use of Parenteral Nutrition was also recorded. A further quality of life measure was performed at day five post surgery. This timepoint was selected in keeping with other studies[15,16], where acute admission is shown to have a significant negative impact on health utility, which may not be evidence when measured at later time points. Inpatient mortality and hospital length of stay was also recorded.

*Outcomes*

Time without enteral intake was calculated as the number of days between last enteral intake, and the earliest of resumption of diet (soft or solid food) or start of nasoenteric feeding. This was a surrogate for return of gastrointestinal function. A Comprehensive Complication Index (CCI) was calculated for each patient, based on the number of and severity of complications experienced, using previously described methods[17]. Length of hospital stay was defined as the number of days between admission and hospital discharge. Change in health utility was calculated using the two measurements of quality of life.

*Statistical analysis*

Analyses were performed in R[18], using Fishers exact or Kruskal-Wallis test as appropriate. Correlations were performed using Pearson's correlation. Charlson comorbidity scores were split into 0-2, 3-4, and 5+, in keeping with other literature[19]. **Day 0 was calculated as the first day the patient stopped eating.** Quality of life scores were cross-walked to United Kingdom population values using the Euroqol crosswalk calculator[20]. This converts the score into a utility value, where 1 = best health imaginable, 0 = dead, and <0 indicates a state worse than death. Statistical significance was set at p=0.05 *a priori*.

*Sample size*

As a pilot study, a sample size of 60 was selected. This would allow the detection of a modest correlation between two continuous variables ($r \geq 0.25$) at the two-sided 5% significance level.

## Results

*Participants*

Data was collected on 60 patients, however during data cleaning, of whom one was subsequently found to be ineligible and was therefore removed. This left 59 patients for assessment. Clinical outcomes data was collected for all patients, post-operative QoL measurement was completed for 42 (71.1%).

The median age of participants was 69 years old, 36 were female, and 31 (52.5%) had a small bowel related pathology (typically adhesive obstruction). Characteristics are summarised in Table 1. In the study 23 (38.9%), 13 (22.0%) and 8 (13.5%) were classified as being in the highest malnutrition risk categories according to 'MUST', NRS-2002, and NRI respectively. Notably, agreement between tools appeared to vary, with high 'MUST' scores assessed as low risk on the other tools, and vice versa. This is shown in Figure 1.

Ten patients (16.9%) received PN during their hospital stay. These accounted for 6 of the 23 patients (26.1%) identified as high risk by 'MUST', 5/13 (38.4%) of the NRS 2002 high risk group and 1/8 (12.5%) of the high risk NRI group. In terms of low risk patients receiving PN, 2 were classed as low risk by 'MUST', 6 as low risk by NRI, and 3 as low risk by NRS 2002.

*Duration NBM*

The median time spent without enteral intake was 7 days (IQR 7-14). For patients classified as high risk this was 14 days (IQR 11-22), 14 days (IQR 11-24) and 10 days (6-16) for the MUST , NRS 2002, and NRI grade respectively. Days without enteral intake was positively correlated with 'MUST' score and NRS-2002, but not with NRI (Table 2). Figure Two summarises the duration without enteral intake by nutritional risk group.

***Parenteral Nutrition***

**Parenteral nutrition (PN) was used in 10 patients. The median time from admission to PN commencement was 6 days, ranging from 3-41 days. In the highest risk groups, the median time to PN was 6,8, and 41 days for 'MUST', NRS 2002, and NRI respectively.**

***Intensive care admission***

**Nineteen patients were admitted to ITU. Patients judged high risk were more likely to be admitted to ITU than low risk according to 'MUST' (56.5% vs 13.3%, p=0.002), NRI (62.5% vs 16.6%, p = 0.019), and NRS 2002 (76.9% vs 16.1%, p<0.001).**

*Complications*

Three patients died during the study. The median CCI for the population was 21 (IQR 0-29). No correlation was found between the CCI and any of the risk tools (Table 2).

*Length of stay*

The median hospital length of stay was 11 days (IQR 8 - 20). All scores showed a significant correlation, with a positive correlation between length of stay and ‘MUST’/NRS 2002 scores, and a negative correlation with NRI (expected as lower NRI is associated with worse nutritional status) (Table 2).

*Change in health utility*

The median change in health utility pre to post op was 0.01 (IQR -0.13 to 0.28). NRS 2002 shows a significant correlation between worsening health utility scores and increasing nutritional risk. No association was noted for the other risk tools (Table 2). Figure 3 demonstrates the associated change in complication scores for each risk group.

## Discussion

This study has assessed three nutrition risk tools in emergency laparotomy. It demonstrates inconsistency in patient classification between these tools and variable associations with outcomes of interest. This work adds to the literature by exploring the correlation between tools and key clinical outcomes, in order to inform future research in the field.

In comparing the three tools, NRS 2002 appears to have a good profile for future research studies; increasing score correlates with increasing time without enteral nutrition, increasing length of stay, and with a negative impact on change in health utility. The latter finding appears to be in contrast with similar work in vascular surgery[21]. The NRI score correlated only with length of stay, suggesting this is not the best of the three tools to use for this population. The lack of correlation of any tools with complications might reflect that nutrition is only a part of the overall risk prediction for this group[22]. There is no doubt from the wider literature that nutritional risk is associated with worse outcomes[23]. Correlations in this study were moderate at best, but this might be expected given the difficulties of quantifying nutritional status and the multifaceted nature of the outcomes. There is also the risk of some sampling and selection bias with less critically ill patients potentially being easier to recruit. It is also expected that the sickest patients would receive additional interventions to help quicken recovery, which would further attenuate the association between baseline risk and subsequent outcomes.

**This study also highlights several challenges related to these tools. 'MUST' was originally devised as a community screening tool. It has demonstrated prognostic ability in the emergency surgery setting for nutritional support need and mortality[5,24]. However, there is an element of subjectivity in assessment on the item related to whether acute disease might impact on ability to eat. The data here show that emergency laparotomy clearly does have this effect, but this may not be recognised by nursing staff who perform this. The NRS 2002 score was developed using a consensus approach, and has since been validated in hospitalised patients[25]. Given the acute nature of surgical illness, it is possible that patients may not pass the initial screen which includes low BMI, weight loss, and impaired intake for the previous week. This means that patients might be incorrectly classified as low risk. Finally, the NRI tool was developed as part of a trial of pre-operative PN[10]. This study identified patients who were waiting for scheduled surgery, typically for cancer, and randomised them to pre-operative PN or standard care. Low serum albumin and weight loss were found to be important predictors of outcome in this study. It is unlikely in current emergency practice that patients presenting with low albumin will have chronic protein deficiency.This may be a blunt tool in the emergency setting as weight loss may not be established, and sepsis not yet severe enough to lower albumin. It is concerning that these tools cannot consistently stratify people into the highest or lowest risk groups. The baseline methods of assessment may not adequately cover acute aspects of malnutrition and gut dysfunction. It is possible that a tool specific for emergency surgery is required.**

Other studies have compared the performance of different nutrition tools in predicting outcome following surgery. Recent work looking at anthropometric type measures in emergency laparotomy found that sarcopenia and myosteatosis were associated with worse short and long term outcomes[26]. A prospective study of 101 patients assessed the subjective global assessment (SGA) and prognostic nutrition index (PNI) in predicting clinical outcomes[4]. This found that increasing SGA was associated with higher rates of most complications. A prospective cohort study of elective general surgery patients compared 'MUST' with three other methods of assessing for malnutrition. It found that none of the tools correlated with clinical outcomes, but worse nutritional state correlated with increased length of stay[27]. Overall, the literature shows that many different tools have been assessed in surgery, with limited repetition across them to build a large and consistent picture. The tools used generally complement the findings shown here.

It is conceivable that approaches to reinstatement of diet might have altered the In this study, the relatively small sample size is a trade off between ability to detect signals related to key outcomes and logistical manageability. The study demonstrated a link between measures of nutrition and patient-important outcomes, but was not of sufficient size to define the cut-off at which tools would reliably trigger an enhanced intervention. The study had aimed to recruit 60 patients, although it was necessary to remove one patient for eligibility reasons after closure. This does not significantly diminish the signals of association seen. The study also suffered logistical issues related to COVID-19, recruitment suspension and loss of research staff. As a result, a planned 90-day quality of life follow up was deemed infeasible and abandoned. Finally, given the relatively low complication rate, and the slightly lower than anticipated mortality rates, it is possible that this study has selected a patient population that is less moribund than in general. The likelihood of this is increased by the need to obtain informed consent prior to data collection. Other approaches to recruitment in those temporarily lacking capacity to consent, such as those in published trials might offer a means to overcome this[28]. The study was, however, prospective in design, meaning that data could be captured close to the patient event, ensuring low rates of missing data. It assessed a range of nutrition risk tools, and compared these with validated outcomes measures including quality of life, which is lacking in many similar studies.

As a pilot study, implications for clinical practice are limited. However, the median time without intake was 7 days in this study, meaning that no risk score was able to accurately identify at admission those who might need nutritional support down the line. Current guidance recommends the deployment of nutritional intervention (PN) by the five day threshold[6]. Given this, most patients should have received some form of intervention, but only ten did. This was also a common finding in the UK National Audit of Small Bowel Obstruction[29]. However, this is unlikely to be due to problems with access to nutritional support[30]. We hypothesise that one of the reasons that doctors fail to intervene (or do so late) is because they tend to focus on the individual steps of surgical care (e.g. diagnosis, surgery, recovery), whilst failing to maintain oversight of the whole clinical picture, including events prior to admission. This phenomenon, termed 'Incremental Oversight', results in a failure to appreciate the length of time patients have been without nutrition. Since the baseline assessment of nutrition with any screening tool does

not take into account what is a changing, dynamic situation, doctors should consider this finding and reflect on the nutritional state of their patients throughout their admission.

For researchers, the findings suggest that NRS 2002 may offer the best choice of the three tools examined here, particularly given its association with change in health utility. However this needs further validation in an appropriately sized study. These data could inform the sample size for a study to estimate more accurate correlations between this tool and the key clinical outcomes, including the validation of a high-risk subgroup for whom intervention is necessary. NRS 2002 might be preferred as a randomisation stratifier in future trials. **Future work may also look at the combined prognostic value of nutrition risk assessment with the NELA mortality risk score. Additionally, comparison of nutrition risk and time without enteral nutrition with preoperative anthropometry such as psoas muscle area is also of interest. This may lead to a novel malnutrition score for emergency laparotomy patients.**

In summary, in patients undergoing emergency laparotomy, increasing MUST or NRS 2002 scores correlate with increasing time without enteral intake. NRS 2002 appears to demonstrate additional correlations with outcomes which require further investigation.

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**Figures and tables**

*Figure 1: Comparison of case classification by different tools. NRI = Nutritional Risk Index, NRS 2002 = Nutritional Risk Score 2002, MUST grade = Malnutrition Universal Screening Tool.*

*Figure 2: Time spent without enteral intake according to risk group, with a dashed horizontal bar denoting the five day threshold for intervention recommended in clinical guidelines. NRI = Nutritional Risk Index, NRS 2002 = Nutritional Risk Score 2002, MUST grade = Malnutrition Universal Screening Tool.*

*Figure 3: Change in Health Utility according to nutrition risk group. NRI = Nutritional Risk Index, NRS 2002 = Nutritional Risk Score 2002, MUST grade = Malnutrition Universal Screening Tool.*

| Characteristic | Overall, N = 59 | Female, N = 36[1] | Male, N = 23[1] |
|---|---|---|---|
| **Age (years)** | 69 (62, 76) | 70 (59, 77) | 68 (64, 74) |
| **Charlson Comorbidity Index** | | | |
| Charlson Comorbidity Score 0-2 | 19 (32%) | 12 (33%) | 7 (30%) |
| Charlson Comorbidity score 3-4 | 27 (46%) | 17 (47%) | 10 (43%) |
| Charlson Comorbidity score 5+ | 13 (22%) | 7 (19%) | 6 (26%) |
| **Diagnosis** | | | |
| Benign colonic | 12 (20%) | 7 (19%) | 5 (22%) |
| Benign Small Bowel | 31 (53%) | 19 (53%) | 12 (52%) |
| Hernia | 5 (8.5%) | 2 (5.6%) | 3 (13%) |
| Intra-abdominal sepsis | 2 (3.4%) | 1 (2.8%) | 1 (4.3%) |
| Malignant pathology | 9 (15%) | 7 (19%) | 2 (8.7%) |
| **Operation Type** | | | |
| Adhesiolysis | 12 (20%) | 7 (19%) | 5 (22%) |
| Colonic resection | 20 (34%) | 15 (42%) | 5 (22%) |
| Hernia repair | 4 (6.8%) | 2 (5.6%) | 2 (8.7%) |
| Small bowel procedure | 21 (36%) | 11 (31%) | 10 (43%) |
| Source control | 2 (3.4%) | 1 (2.8%) | 1 (4.3%) |
| **MUST Grade** | | | |
| Low risk | 30 (51%) | 15 (42%) | 15 (65%) |
| Medium risk | 6 (10%) | 6 (17%) | 0 (0%) |
| High risk | 23 (39%) | 15 (42%) | 8 (35%) |
| **NRS 2002 Grade** | | | |
| 0-3 = Low risk | 31 (53%) | 15 (42%) | 16 (70%) |
| 4 = At risk | 15 (25%) | 10 (28%) | 5 (22%) |
| 5-7 = High risk | 13 (22%) | 11 (31%) | 2 (8.7%) |
| **NRI Grade** | | | |
| >100 = No risk | 30 (51%) | 16 (44%) | 14 (61%) |
| 97.6-100 = Mild risk | 8 (14%) | 6 (17%) | 2 (8.7%) |
| 83.5-97.5 = Moderate risk | 13 (22%) | 9 (25%) | 4 (17%) |
| <83.5 = Severe risk | 8 (14%) | 5 (14%) | 3 (13%) |

[1] Statistics presented: median (IQR); n (%)

*Table 1: Characteristics of participants. NRI = Nutritional Risk Index, NRS 2002 = Nutritional*

*Risk Score 2002, 'MUST' grade = Malnutrition Universal Screening Tool.*

| Tool | Time NBM | Complications | Length of stay | Change in health utility |
|---|---|---|---|---|
| MUST | r = 0.463<br>CI: 0.225 to 0.648<br>p < 0.001* | r = 0.188<br>CI: -0.071 to 0.424<br>p = 0.15 | r = 0.259<br>CI: 0.004 to 0.483<br>p = 0.04* | r = -0.226<br>CI: -0.496 to 0.083<br>p = 0.14 |
| NRS 2002 | r = 0.296<br>CI: 0.0334 to 0.521<br>p = 0.03* | r = 0.092<br>CI: -0.167 to 0.340<br>p = 0.48 | r = 0.321<br>CI: 0.071 to 0.533<br>p = 0.01* | r = -0.401<br>CI: -0.629 to -0.111<br>p = 0.008* |
| NRI | r = -0.121<br>CI: -0.374 to 0.149<br>p=0.38 | r = -0.152<br>CI -0.393 to 0.108<br>p = 0.25 | r = -0.533<br>CI: -0.694 to -0.321<br>p = <0.001* | r = -0.009<br>CI: -0.295 to 0.312<br>p = 0.95 |

*Table 2: Correlation (r) between tools and key outcomes. NRI = Nutritional Risk Index, NRS 2002 = Nutritional Risk Score 2002, MUST grade = Malnutrition Universal Screening Tool. CI= 95% confidence interval. * denotes statistically significant value.*