“Self-screening for malnutrition risk in outpatient inflammatory bowel disease patients using the Malnutrition Universal Screening Tool”

A thesis submitted in conformity with the requirements for the degree of Master of Science in Clinical Epidemiology, Graduate Department of the Institute of Health Policy, Management and Evaluation at the University of Toronto

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Abstract:

Background
Malnutrition is under-recognized in patients with inflammatory bowel disease (IBD).

Aims
To determine if patient can self-screen nutritional risk using the Malnutrition Universal Screening tool (MUST).

Methods
Adult IBD patients self-assessed nutritional risk with the MUST tool. Health care practitioners (HCPs) assessed risk using the MUST tool and the Nutritional Risk Score 2002 (NRS-2002). Chance-corrected agreement was determined. We also examined the relationship between nutritional status and disease activity.

Results
For patient-administered MUST screening, chance-corrected agreement $\kappa$ (95% CI) was 0.83 (CI 0.74, 0.92) with HCP MUST screening among low-risk and
combined medium- and high-risk patients. Similar results were found when compared to NRS-2002. All patients were able to screen easily. Disease activity was significantly correlated with nutritional risk for Crohn’s but not ulcerative colitis.

Conclusion

Patients can accurately and easily self-screen malnutrition risk using MUST. We require further work to understand how self-screening can influence nutritional management plans.
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Acronyms

HCP = health care provider

MUST = Malnutrition Universal Screening Tool

NRS-2002 = Nutritional Risk Score 2002

IBD = inflammatory bowel disease

IQR = interquartile range

CD = Crohn’s disease

UC = ulcerative colitis

RCT = randomized control trial

OR = odd’s ratio
Chapter 1 – Background

1.1. Introduction

Malnutrition in patients with inflammatory bowel disease (IBD) is common, under-recognized and negatively influences outcomes in patients with ulcerative colitis (UC) or Crohn’s disease (CD) [1]. Broadly speaking, malnutrition is a deficiency in macronutrients or micronutrients that adversely affect physiologic function at the tissue level [1]. There is an intuitive relationship between reduced nutrient absorption and edematous, ulcerated bowel mucosa. However, malnutrition in IBD patients is multi-factorial. This includes anorexia secondary to inflammation and fear of precipitating abdominal symptoms, medication side effects and disease-related protein catabolism [2, 3]. Specific micronutrient deficiencies (both vitamin and mineral) may also occur in patients with IBD, influenced by their general nutritional status, disease activity, and location of disease [4].

IBD patients experience anorexia related to inflammatory cytokine production, including IL-1, IL-6 and TNF-α [5]. Intestinal pain, nausea and diarrhea can further predispose to reduced food intake for symptom relief and the fear of inducing symptoms [3]. Restrictive diets, low residue diets, medication side effects and aphthous oral ulcerations may further contribute to reduced per oral intake [6]. Surgical resections of the small bowel predispose to short bowel syndrome and small bowel bacterial over-growth, further reducing absorption of nutrients [3]. Malnutrition in IBD is compounded by protein catabolism induced by systemic inflammation accelerating loss of skeletal muscle [7]. These factors commonly result in protein energy malnutrition (PEM) [1]. Malnutrition affects both cellular and
humoral immunity by predisposing patients to infectious complications and reduced functional status [8], reduced quality of life [9], in addition to the physiologic effects of specific macro and/or micronutrient deficiencies [10]. Malnourished IBD patients requiring surgery experience increased post-operative morbidity and slower functional recovery [8]. A comprehensive approach to nutritional management of patients with IBD includes monitoring of nutritional parameters for macronutrient and micronutrient deficiency. Nutrient supplements should be provided to avoid the development of nutrient deficiencies [8, 11]. Nutrient deficiencies should be corrected with a well-balanced diet, nutritional supplements and specialized nutritional with oral, enteral or parenteral nutrition [8, 11].

1.2. Prevalence of Malnutrition in IBD

The reported rates of malnutrition in outpatient IBD clinics vary depending on how malnutrition is defined and measured [12]. The literature focuses on protein energy malnutrition and specific micronutrient deficiencies such as Vitamin D [13, 14]. Validated methods of assessing protein energy malnutrition such as the Subjective Global Assessment (SGA) [15] have reported rates of malnutrition as high as 24% in patients with IBD in clinical remission [7] and 64% of patients with active IBD [12]. However, reported prevalence rates of malnutrition are often based on specific anthropometric and laboratory measures, which do not take into account decreased oral intake and disease-related effects on nutritional status [1, 7, 12]. Outpatient studies report that 14% of patients with CD and 6% of patients with UC have a body
mass index of <18.5 kg/m², with reduced skin-fold thickness and arm circumference in up to 62%. However, measures such as skinfold thickness and mid-arm circumference are not practical and rely exclusively on serum protein levels which can be misleading [4].

1.3. Nutritional Screening and Assessment

Nutrition screening, defined by the American Society for Parenteral and Enteral Nutrition (ASPEN), are processes to identify an individual who is at risk for malnutrition. Patients who are at-risk should then undergo detailed nutritional assessment. Thus, the goal of nutrition screening is to determine if an individual has risk factors for malnutrition. If these risk factors are present, then detailed nutritional assessments should be performed by a nutrition support clinician. The clinician will carefully assess dietary intake, medical history, current medical issues, anthropometric data, laboratory data, and findings on physical examination. Specific diseases and conditions may dictate a particular assessment techniques. Moreover, reassessment and monitoring methods are often considered extensions of the assessment process. Resources, training, expertise and presence of nutrition support teams determine the specific methods used to perform a clinical nutrition assessment. Detailed nutrition assessments, in turn, should result in recommendations for nutritional interventional status and further monitoring.

1.4. Challenges in Screening Nutritional Status

Studies have clearly demonstrated that the frequency of malnutrition among IBD cohorts is higher when it is routinely sought, as opposed to usual clinical practice [1].
Unfortunately, validated nutritional assessments are not widely used by health care practitioners (HCPs) in IBD [1]. While the Subjective Global Assessment (SGA) (discussed below) is a commonly recommended method in evaluating malnutrition, it is not often used due to the detailed nature of assessments and advanced clinical expertise. While many other validated screening tools are available, routine malnutrition screening is infrequently performed resulting in both under-detection and under-treatment of malnutrition [1, 12]. In the setting of an academic center, where there is a focus on recruitment for (drug) trials, multiple assessments are performed by attending physicians, medical learners, nurses and clinical research assistants, and allied health professionals, nutritional screening is not a priority [16]. While increasing HCP-directed screening has been the target of various knowledge translation techniques, the results have been disappointing [16, 17].

1.5. Methods to Increase Nutritional Screening

There is poor adherence of health care providers to screen for malnutrition. For IBD, little attention has been paid to the possibility that these patients can screen themselves [16]. IBD is associated with a significant reduction in quality of life, severely affects dietary choices, and also affects many younger persons [9]. This may be a population that may be more inclined to self-screen and more eager in developing their own nutritional care plan. Multiple nutrition screening tools exist to identify patients at risk for malnutrition which patients could use to self-screen [18]. We will review common nutrition risk screening tools in order to postulate which screening tool may be best for self-screening.
2.1. Subjective Global Assessment

The Subjective Global Assessment (SGA) is considered the gold standard but is more of a nutritional assessment method than a true screening tool [15]. It is an assessment technique that combines data from both subjective and objective aspects of the patient’s medical history and physical examination. Medical history is focused on weight change, dietary intake change, presence of gastrointestinal symptoms and changes in activities of daily living [15]. Physical examination is focused on subcutaneous fat loss, muscle wasting and edema (peripheral, sacral edema, ascites) [15]. Patients are then categorized into one of three classes of nutritional status: well-nourished (SGA A), moderately malnourished (SGA B) and severely malnourished (SGA C). The SGA has been validated in a number of diverse patient populations, including IBD patients [1, 6, 11, 19, 20]. It has also been correlated with a number of objective nutritional markers, as well as quality of life measures, morbidity and mortality [21]. For almost three decades, the SGA has been used to assess malnutrition and predict morbidity and mortality in several clinical and surgical settings [22]. In Canada and many countries around the world, the SGA is the “gold standard” method for validation of newer nutritional assessment and screening methods [23]. However, the major criticism of the SGA is that accuracy depends on the observer’s experience. Detsky et al. [15] recommended that practitioners and researchers have training to achieve a consistency and agreement in SGA ratings. Despite that very important recommendation, few investigators have
completed this critical step [24]. Some investigators have undertaken this training but failed to report the results of inter-rater variability testing in research studies[24]. There is little literature reporting on inter-rater reliability (IRR) of the SGA for use as a nutritional assessment tool amongst different types of health care providers[24]. Given our goal to increase the use of nutritional screening in IBD outpatients, the must be a simple tool that is easy enough for patients to self-administer. Concerns about inter-observer variability and advanced training would limit the use of this tool for patient self-screening.

Table 1. Subjective Global Assessment (SGA)

1. **Weight change:**
   - *Please document weight loss:
     - Current weight: ________ kg/lb.
     - Base weight: ________ kg/lb.
     - Ideal Body Weight (IBW): ________ kg/lb.
   - Weight loss in the past 6 months:
     - 0-5% □
     - 5-10% □
     - >10% □

   If the member is a child, has he/she crossed 2 or more growth curves in the last 6 months?
   - Yes □
   - No □

   Weight change in past two weeks:
   - Increase_______ kg/lb.
   - Decrease_______ kg/lb.
   - Stable_______ kg/lb.

2. **Diet intake:**
   - No change or suboptimal intake □
   - Liquid diet □
   - Hypocaloric fluids or starvation □

3. **Gastrointestinal symptoms for >2 weeks:**
   - None □
   - Anorexia and nausea □
   - Vomiting □
   - Diarrhea □

4. **Functional capacity:**
   - Normal □
   - Work capacity diminished by 50% □
   - Ambulatory (i.e. capable of only activities of daily living) □
5. Physiologic stress:
- None
- Minimal
- High

6. Physical signs:
- Loss of subcutaneous fat over:
  - Triceps
  - Chest
- Fluid retention:
  - Edema
  - Ascites
- Muscle wasting:
  - Deltoids
  - Temporal
  - Quadriceps
- Mucosal lesions:
  - Glossitis
  - Skin rash suggestive deficiency

OVERALL RATING
SGA class A=Very Mild risk to well nourished; most categories or significant/continued improvement
SGA class B=Mild/Moderate; No clear sign of normal status or severe malnutrition
SGA class C=Severely Malnourished; most categories/significant physical signs of

2.2. Newer Screening Tools

Several newer nutritional screening methods have been evaluated over the past decade [23]. The Malnutrition Universal Screening Tool (MUST) and the Nutritional Risk Screening 2002 (NRS-2002) were recommended in the most recent guidelines from the European Society for Parenteral and Enteral Nutrition (ESPEN) [21]. They include only a few questions and can be applied in various settings, which potentially increases their utility as tools for patient self-screening. The third nutritional screening tool recommended by ESPEN is the Mini-Nutritional Assessment (MNA) [21], which specifically targets elderly adults. Therefore, we did not review the MNA as many IBD patients are younger.

2.3. Malnutrition Universal Screening Tool MUST

MUST is a validated screening tool for protein energy malnutrition and is the most
common screening tool in several countries. In England, it is widely promoted by the British Association of Parenteral and Enteral Nutrition (BAPEN) [25]. It has been well-validated in inpatient and outpatient populations for identifying patients at elevated risk for malnutrition [26]. MUST was developed by a multi-disciplinary group of health professionals to detect both under-nutrition and obesity in patients with protein-energy malnutrition. It has been validated in different healthcare settings [27]. MUST is based on three criteria. The criteria are BMI, unintentional weight loss and the effects of acute disease on nutritional status. Using these three steps, a score is assigned which corresponds to low, medium or high risk for malnutrition. Each risk category is associated with specific recommendations for further work-up and nutritional intervention [28]. Conceptually, the MUST traces the journey of patients from the past (history of weight loss) to the present (current weight status or BMI) and then into the future anticipated effects of the underlying condition(s). All three components can influence nutritional related outcomes [29]. In situations where anthropometric measurements cannot be measured, patient-reported measurements, surrogate measurements and clinical judgment can be used to reliably estimate malnutrition risk [30]. MUST has been shown to predict length of stay (e.g. up to 2–4 times longer in high versus low-risk patients), discharge destination (e.g. to nursing homes and other hospitals) and mortality [21]. In the community, MUST has been shown to predict rates of hospital admissions and family physician visits. Just as importantly, targeted interventions for at-risk patients improves clinical outcomes [31]. The tool is internally consistent and reliable. It has very-good-to-excellent reproducibility when different observers
assess the same patients in hospitals (in-patients and out-patients), outpatient clinics, pre-operative surgery clinics and care homes (kappa values between 0.8 and 1.0) [16]. The tool has been found to be easy and quick to use, and acceptable to both patients/subjects and healthcare workers [16].

Figure 1. Calculation of Malnutrition Universal Screening Tool (MUST) Score

*How to calculate MUST score?*

**Step 1 BMI score**
- >20: 0 point
- 18.5-20: 1 point
- <18.5: 2 points

**Step 2 weight loss score**
Unintentional weight loss in past 3-6 months
- <5%: 0 point
- 5%-10%: 1 point
- >10%: 2 points

**Step 3 acute disease effect score**
Is the patient acutely ill AND had/will have no nutritional intake for 5 days?
- No: 0 point
- Yes: 2 points

**Step 4 calculate total score**
Add up all the scores from previous steps
- Low risk: 0 point
- Medium risk: 1 point
- High risk: 2 points or more
2.4. NRS-2002

The purpose of the NRS-2002 system is to detect the presence of malnutrition and the risk of developing malnutrition in the hospital setting [23]. It contains the nutritional components of MUST. However, in addition, it grades of severity of disease as a reflection of increased nutritional requirements. It includes four pre-screening questions to eliminate low-risk hospitalized patients. If deemed at risk, patients undergo further screening of nutritional status and assessment of disease processes associated with immobility and catabolism [21]. It also includes older age as a risk factor. The tool was developed by retrospectively examining factors associated with poor outcome, including mortality, length of stay and clinical outcome in over 100 randomized control trials [32]. The NRS-2002 has been used in a large European RCT as a screening method to identify at-risk hospitalized patients, with higher-risk patients experiencing longer lengths of stay and complications[33]. In a large Danish study, nurses and dieticians in three Danish hospitals reported that untrained staff and investigators rarely disagreed about risk status using the tool and were able to screen 99% of newly admitted patients [32]. While primarily used in inpatients, several studies have demonstrated that NRS-2002 is useful in detecting malnutrition and complications in outpatient settings as well [33].
### Table 2. Nutritional Risk Screening (NRS 2002)

<table>
<thead>
<tr>
<th>Initial screening</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Is Body Mass Index &lt; 20?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Has the patient lost weight within the last 3 months?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Has the patient had a reduced dietary intake in the last week?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Is the patient severely ill? (e.g. in intensive therapy)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Yes: If the answer is 'Yes' to any question, the screening in Table 2 is performed.
No: If the answer is 'No' to all questions, the patient is re-screening at weekly intervals. If the patient e.g. is scheduled for a major operation, a preventive nutritional care plan is considered to avoid the associated risk status.

<table>
<thead>
<tr>
<th>Final screening</th>
<th>Impaired nutritional status</th>
<th>Severity of disease (= increase in requirements)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent Score 0</td>
<td>Normal nutritional status</td>
<td>Absent Score 0 Normal nutritional requirements</td>
</tr>
<tr>
<td>Mild Score 1</td>
<td>Weight loss &gt; 5% in 3 months or Food intake below 50-75% of normal requirement in preceding week</td>
<td>Mild Score 1 Hip fracture* Chronic patients, in particular with acute complications: cirrhosis*, COPD*. <em>Chronic hemodialysis, diabetes, oncology.</em></td>
</tr>
<tr>
<td>Moderate Score 2</td>
<td>Weight loss &gt; 5% in 2 months or BMI 18.5 - 20.5 + impaired general condition or Food intake 25-50% of normal requirement in preceding week</td>
<td>Moderate Score 2 Major abdominal surgery* Stroke* <em>Severe pneumonia, hematologic malignancy.</em></td>
</tr>
<tr>
<td>Severe Score 3</td>
<td>Weight loss &gt; 5% in 1 month (&gt;15% in 3 months) or BMI &lt; 18.5 + impaired general condition or Food intake 0-25% of normal requirement in preceding week in preceding week</td>
<td>Severe Score 3 Head injury* Bone marrow transplantation* <em>Intensive care patients (APACHE&gt;10).</em></td>
</tr>
</tbody>
</table>

Score: + Score: = Total score:

Age if ≥70 years: add 1 to total score above
2.5. **Aims.**

Our overall goal is to increase detection and treatment of malnutrition in IBD patients. Our aim in this study is determine whether patients can reliably and easily self-determine their nutritional risk.

While the physician community in Canada has concentrated on the Subjective Global Assessment (SGA) which was developed by Canadian researchers [15], the SGA is an assessment tool rather than a screening tool, and requires expertise in nutritional assessment, thus limiting the ease of use. The absence of objective values predisposes to high inter-rater variability. In contrast, MUST is a simple, three-step screening tool validated for HCPs in varied populations including medical, surgical and oncological patients [25, 30]. It was designed to be used by non-nutritionists, and has a low inter-rater variability. It utilizes a simple scoring system that identifies patients at risk of malnutrition and then provides recommendations regarding nutritional intervention or referral [25]. Given the simplicity of the MUST score and its widespread use in outpatient populations, we posit that the MUST score may be an ideal risk-screening tool for patient self-screening.

2.6. **Hypothesis.**

Given the favourable characteristics of the MUST scoring system, this screening tool appears to be ideal for self-screening.

We hypothesize that self-screening for malnutrition risk with the MUST will have substantive agreement compared to gold standard HCP testing. We further hypothesize that it will be easy to use by patients. We also hypothesize that there will also be high agreement between patient-generated MUST score and other
validated risk screening tools. We have chosen to compare it to the NRS-2002, as
this score can be calculated easily by performing the core three steps of the MUST
along with determination of co-morbidities by direct questioning and chart review.
If our hypothesis is correct, this will be an important step in increasing the detection
of malnutrition in IBD patients.

2.7. Validity

The concept of validity is central to our study. Validity, in the simplest terms, is the
extent to which a concept, conclusion or measurement is well-founded and
corresponds accurately to the real world [35]. More specifically, the validity of a
measurement tool is considered to be the degree to which the tool measures what it
claims to measure. While validity can be measured utilizing several techniques, an
important concept in validity theory is construct validity[36]. Construct validity is
an overarching concept to assess the validity of a measurement procedure to
measure a given construct. In our proposed study, the measurement procedure is
the patient generated MUST tool and the construct is malnutrition. That is, we aim
to begin to demonstrate the construct validity of patient generated MUST scoring in
measuring malnutrition risk, in outpatients with IBD. As discussed in preceding
sections, there is sound evidence that nutritional status is influenced by the severity
of inflammatory bowel disease. If increasing disease activity and worsening
malnutrition risk are highly correlated, it would contribute to establishing construct
validity of self-screening. Additionally, several laboratory markers are indicative of
malnutrition, and are discussed in the following sections. Therefore, if we find a
strong association between nutritional markers and malnutrition risk, this would
further add to the construct validity of self-screening.

There are also several other types or sub-types of validity, which include criterion, concurrent, divergent and predictive validity [37]. Criterion validity establishes validity of the new tool by comparison to an accepted or gold standard tool. Concurrent validity establishes validity by demonstrating the new tool will measure the same construct as a similar tool. Divergent validity establishes validity of the new tool by demonstrating the new tool will identify the opposite construct when compared to a tool intended to measure the opposite construct. Predictive validity establishes validity by demonstrating a tool predicts outcomes consistent with the construct. The choice of other techniques to determine the validity of patient generated MUST screening is dependent on two main factors in our study. The first is the theoretical relationship between the new measurement and the construct [37]. Given that the specific assessments in the patient generated MUST screening tool are the same as the HCP tool, the patient generated risk has intuitive value in measuring malnutrition risk. The second factor is the degree to which the “older” or “gold-standard” measurement technique actually measures malnutrition risk[37]. Both the HCP MUST screening tool and the HCP NRS-2002 screening tool are considered excellent tools in measuring malnutrition risk. Both are well studied and predict outcomes associated with malnutrition. Therefore, an excellent method for establishing construct validity is criterion validity. Criterion validity is particularly useful when conducting a study in a new context, which is the case here where the new “context” is having patients determine their own nutritional risk score, as opposed to the HCP. Criterion validity is generally a simpler, more cost-effective, of
establishing of construct validity than other sub-types of validity testing [37].
Chapter 3 – Methods

3.1. Study Overview.

Study Location – This study was performed at University Hospital, Victoria Hospital and St. Joseph’s Healthcare Centre in London, Ontario. Patients that met study criteria were approached for enrolment sequentially. Clinicians and HCPs were unaware of the results of patient-administered MUST scores.

Population – Adults (>18 years) diagnosed with IBD, who were actively being followed at the multi-disciplinary IBD clinics in London, Ontario.

Inclusion criteria: (1) Age greater than 18 years (2) Diagnosed with Crohn’s disease or ulcerative colitis (3) Followed in outpatient IBD clinic.

Exclusion criteria: (1) Pregnancy (2) Inpatients (3) Unable to complete MUST because of physical or mental incapacity (4) Unable to comprehend English.

Intervention – Patient self-administered nutritional risk screening using the MUST.

Comparison – 1) HCP-administered nutritional risk screening using the MUST (accepted standard). 2) HCP-administered nutritional risk screening using the NRS-2002

3.2. Study Participants

The study was conducted in outpatient, academic, multi-professional IBD clinics in London, Ontario. Research ethics approval was obtained. Patients above the age of 18 years, diagnosed with IBD, were consecutively recruited. Patients were excluded from enrolment if they were pregnant, unable to complete the MUST self-screening tool due to mental or physical impairment, or difficulties with written or verbal English. Patients were brought in to the clinic room. They were recruited by a member of the HCP team. This included medical students, medical residents, clinic nurses, research assistants or the attending physicians. The patients were given forms in which they were asked to record demographic information and disease specific information. They then performed the self-screening tool. They also completed a questionnaire regarding ease-of-use that contained four categories: very easy, easy, difficult and very difficult [16] (Figure 2). Body mass index (BMI) calculations were performed using a BMI chart. Each room contained electronic weight scales accurate to 0.1 lbs. The patients estimated their height measurements. No other instructions were given, including no information on weighing technique such as whether their shoes or jackets should be on or off. Patients completed the questionnaire in isolation [16]. Once the patients had completed the screening tool, which included self-calculation of the MUST score, the tool was placed in a sealed envelope. Low, medium and high nutritional risk was defined as a MUST score = 0, 1, or > 1, respectively. Then the HCP entered the room and administered the MUST tool and NRS-2002, including height measurements using a stadiometer.
The HCP also assessed disease activity using the Partial Mayo Index (PMI) for UC [35] and the Harvey Bradshaw Index (HBI) for CD [36]. The PMI is a simpler version of the complete Mayo score and is scored from 0-9. The complete Mayo score is one of the most commonly used activity indices in placebo-controlled clinical trials for UC. Each is composed of four categories (bleeding, stool frequency, physician assessment and endoscopic appearance) rated from 0–3 that are summed to give a total score that ranges from 0–12 [35]. Several trials have utilized just the non-endoscopic components of this index (i.e. PMI) to assess disease activity and response to therapy in the outpatient clinic setting. Theses studies have demonstrated that the PMI accurately determines disease activity [35]. The Harvey Bradshaw Index is simpler version of the Crohn's Disease Activity Index (CDAI). The CDAI is a research tool used to quantify the symptoms of patients with CD. The CDAI is important in research studies for measuring effects of medications used to treat Crohn's disease. Most major drug studies use the CDAI in order to define response or remission of disease. The need for a seven-day patient diary is a major drawback for our current study design. The Harvey-Bradshaw index was devised in 1980 as a simpler version of the CDAI for data collection purposes. It consists only of clinical parameters: 1) General well-being (0 = very well, 1 = slightly below average, 2 = poor, 3 = very poor, 4 = terrible); 2) Abdominal pain (0 = none, 1 = mild, 2 = moderate, 3 = severe); 3) Number of liquid stools per day; 4) Abdominal mass (0 = none, 1 = dubious, 2 = definite, 3 = tender); 5) Complications, with one point for each [37]. A score of less than 5 is generally considered to represent clinical remission; 5-7 indicates mild disease; 8-16 moderate disease; and >16 severe
disease. The Harvey-Bradshaw Index (HBI) is designed to make data collection and computation easier. It is purported, on the basis of a 0.93 correlation coefficient, to give essentially the same information as CDAI [37].

Patients were asked to perform blood-work, including complete blood count (CBC), erythrocyte sedimentation rate (ESR), C reactive protein (CRP), protein markers (albumin and pre-albumin) and various other micronutrient markers. No extra clinic time was assigned for recruitment and study participation.
Figure 2. Malnutrition Universal Screening Tool Patient Survey

Step 1
Calculate your body mass index (BMI)
A. Measure your weight (in pounds) _______ pounds
B. Estimate or measure your height (in feet and inches) _______ feet and inches
C. Use the chart (Appendix 1) to estimate your BMI

If your BMI is less than 19, you score 2 points
If your BMI is 19 or 20, you score 1 point
If your BMI is greater than 20, you score 0 points

Score:

Step 2
Calculate your weight loss score.
A. What is current weight? _______ pounds
B. Estimate how much weight you have lost in the last 3-6 months? _______ pounds
C. Use the chart (Appendix 2) to estimate your percentage weight loss

If less than 5% weight loss, your score is 0 points
If 5-10% weight loss, your score is 1 point
If greater than 10% weight loss, your score is 2 points.

Score:

Step 3
Do you feel acutely sick right now?
Yes
No

Has your intake of food been poor for the last 5 days or likely to be poor for the next 5 days?
Yes
No

If you answered yes to both questions then score 2 points. Otherwise, your score is 0 points.

Score:

Step 4
Add Scores together
Overall score:
0 = Low risk of malnutrition
1 = Medium risk of malnutrition
2 or greater = High risk of malnutrition

Step 5
How easy was this survey? Please circle

Very easy  Easy  Difficult  Very difficult
3.3. Primary Outcomes

Our primary outcome was substantive chance-corrected versus just moderated agreement between the patient-generated MUST score and HCP-generated MUST score. We examined agreement using two-category classification for MUST score of low risk (MUST = 0) versus combined medium- and high-risk score (MUST ≥ 1). Two-category classification was more relevant than three-category classification because the mere presence of medium risk should mandate a full nutritional assessment. With that said, we also examined for chance corrected agreement between on all three categories.

3.4. Secondary Outcomes

We also tested for a chance-corrected agreement of two-category classification for patient-generated MUST score of low risk (MUST = 0) and medium/high risk (MUST ≥ 1), compared to corresponding two-category classification of NRS-2002 (low/mild risk NRS-2002 score 0 or 1 versus medium or high risk NRS 2002 ≥ 2).

We examined the association between the HCP generated MUST scores and the measure of disease activity, using the partial Mayo score [35] for UC and Harvey Bradshaw Index score for CD [36], using analysis of variance.

3.5. Statistical Analysis

Primary outcome:

The chance-corrected agreement (κ) of malnutrition risk categorization was
assessed using the grading system of Landis and Koch. They characterized values of 0 as indicating no agreement, 0–0.20 as slight agreement, 0.21–0.40 as fair agreement, 0.41–0.60 as moderate agreement, 0.61–0.80 as substantial agreement and 0.81–1 as almost perfect agreement [16, 39]. The primary outcome was chance-corrected agreement of two-category classification for MUST score of low risk (MUST = 0) versus combined medium- and high-risk score (MUST ≥ 1). We also performed analysis for all three categories (low-, medium- and high-risk scores), for a 95% confidence interval [38], assuming that the scores were continuous.

**Sample size calculation:**

Sample size requirements were 127 subjects when testing a κ (two categories) of 0.75 (substantive agreement) against null hypotheses κ = 0.45 (moderate agreement), assuming a malnutrition prevalence of 15% with 80% power and p = 0.05 (two-tailed).

**Secondary outcomes:**

Similarly, we also tested for the chance-corrected agreement of two-category classification for a MUST score of low risk (MUST = 0) compared to corresponding 2-category classification of NRS-2002 (low risk NRS-2002 score 0 or 1 versus NRS 2002 ≥ 2). We also performed further analysis for all three categories for chance-corrected agreement of three-category classification for MUST compared to corresponding three-category classification of HCP MUST and HCP NRS-2002 (low risk NRS-2002 score 0 or 1, medium 2, or high ≥3). For UC and CD patients, we examined the association between the health care provider MUST scores, the Partial Mayo Index [35] and Harvey Bradshaw Index score [36], using analysis of variance.
Logistic regression was used to examine univariable associations between patient demographic data, disease characteristics and laboratory values with malnutrition risk scores categorized as either low or moderate and above. Backwards elimination was used to find a subset of patient demographic and disease characteristics or laboratory values that were independently associated with medium or high malnutrition risk scores. Odds ratios for age were reported as odds of having increased nutritional risk based on increasing decade. Odds ratios for the laboratory values were reported as increased odds of having increased nutritional risk based on increasing quartile range (QR). All the statistical analysis was performed by Dr. Rahman using the SAS University Edition. An external review of the statistics was performed by LW Stitt Statistical Services.

3.6. Recruitment and Feasibility

The study recruitment benefited from the patient population enrolled in extensive clinical trials at the IBD clinics at Western University. Given that our study posed no risks to the population studied and did not interfere with ongoing clinical trials, we anticipated no difficulty in reaching our target sample size in two months. No extra time was assigned for recruitment and study participation. We posited that if patient-directed screening was to occur in a widespread fashion, it could not result in interruptions to clinic flow.
3.7. Time Schedule of Interventions, Study procedures, Data Management and Visits for Participants

Shown in Figure 4 (study schematic) and Table 3 (time and event table).

Figure 4. Study Schematic

Adults greater than the age of 18, followed at the inflammatory bowel disease clinic

Self-screening of nutrition risk using the MUST

Assessment of nutrition risk using the MUST
### Table 3. Schedule of Events

<table>
<thead>
<tr>
<th>Study Procedures</th>
<th>Visit 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informed consent</td>
<td>*</td>
</tr>
<tr>
<td>Inclusion</td>
<td>*</td>
</tr>
<tr>
<td>Exclusion</td>
<td></td>
</tr>
<tr>
<td>Medical history</td>
<td>*</td>
</tr>
<tr>
<td>Questionnaire</td>
<td>*</td>
</tr>
<tr>
<td>Safety evaluation.</td>
<td>*</td>
</tr>
<tr>
<td>Self-screening MUST</td>
<td>*</td>
</tr>
<tr>
<td>HCP-directed MUST</td>
<td>*</td>
</tr>
<tr>
<td>Hematology/Clinical Chemistry</td>
<td>*</td>
</tr>
<tr>
<td>Adverse events</td>
<td>*</td>
</tr>
</tbody>
</table>

#### 3.8. Blinding

Both the patients and the HCP were blinded to the malnutrition screening results of the other party.

#### 3.9. Instructions to HCP:

Patients were not briefed on MUST screening methods. HCPs received a teaching session on MUST screening and were observed performing MUST screening on three outpatients in an IBD clinic prior to the study. In total, one medical student, two gastroenterology fellows, two registered practical nurses and one clinical research assistant were trained by Dr. Rahman.
3.10. Data Collection Methods

For every patient referred to the study, a screening checklist was completed by the research assistant to determine study eligibility. For enrolled patients, the only study visit occurred at index assessment.

3.11. Data monitoring

No data monitoring occurred, as no harm was expected. Patients were given contact information of the principal investigator if there were any concerns.

3.12. Research ethics approval

For our two sites, the study was approved by the local Research Ethics Board prior to the study being conducted.

3.13. Protocol changes

Any changes in the clinical trial protocol were written and submitted to REB as a protocol amendment to determine if they changed the risk to participants. All modifications of the trial were written and filed with the REBs, the principal site investigators and study participants (depending on the nature/consequence of the amendment). After our initial protocol was submitted, we added addendum to determine the NRS-2002 score, which was the only protocol amendment. Determination of the NRS-2002 scores was recommended by the thesis committee.
3.14. Consent

All participants received verbal and printed information about the study, and signed a written informed consent form before initiation. Enrolment in the study was voluntary, and declining to participate in no way affected the care provided to the patient. Patients were informed of their right to withdraw at any time.

3.15. Confidentiality

All information collected was stored in a locked room with limited access, or on a password-protected computer file. All patient identifiers, including name and identification number, were removed. Only the 5-digit randomization number was recorded.

3.16. Ancillary and Post-Trial care

Upon completion of the trial, patient follow-up continued in appropriate manner at the discretion of the most responsible physician.

3.17. Method of sample recruitment

Patients were approached free of coercion, understanding that, by choosing not to participate, their clinical care would not be altered, and that they would be given as much time as necessary to consider whether or not they wish to provide consent.

3.18. Risks versus benefits

We anticipated no risks to the patient. The only benefit to the patient is that they
knew the malnutrition risk score, which is not routinely measured and, if deemed
malnourished, they received intervention as appropriate (i.e., referral to a dietician).

3.19. Ethical issues/concerns

No special population groups were enrolled as per our inclusion criteria.
Chapter 4 – Results

4.1. Demographics

There were 154 patients studied over two months. In total, 64% (n=98) had CD. The median age was 43 years, and there were 101 females. For clinical data, there were no missing data points. There were 16 patients for which there was partially missing laboratory data. Using the HCP MUST score, there were 55.1% (n = 85) at low risk for malnutrition (MUST score = 0), 15.6% (n = 24) at medium risk for malnutrition (MUST score = 1) and 29.9% (n = 46) at high risk for malnutrition (MUST ≥ 2). Overall, 43.3% of patients were at medium or high risk for malnutrition, which is keeping with malnutrition rates at tertiary centres.

Table 4a. Baseline Patient Characteristics, and Laboratory Values

<table>
<thead>
<tr>
<th></th>
<th>Ulcerative Colitis</th>
<th>Crohn's Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of patients with UC or CD (%) (n=154)</td>
<td>36.4% (n=56)</td>
<td>63.6% (n=98)</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>44.1</td>
<td>43.3</td>
</tr>
<tr>
<td>Percentage of male sex(%) (n=53)</td>
<td>37.7% (n=20)</td>
<td>62.3 % (n=33)</td>
</tr>
<tr>
<td>Sex (female) (n=101)</td>
<td>35.6% (n=36)</td>
<td>64.4% (n=65)</td>
</tr>
<tr>
<td>Mean Harvey Bradshaw Index (HBI) Score (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>-</td>
<td>5.7 (4.7)</td>
</tr>
<tr>
<td>Medium</td>
<td>-</td>
<td>4.9 (3.6)</td>
</tr>
<tr>
<td>High</td>
<td>-</td>
<td>9.3 (7.3)</td>
</tr>
<tr>
<td>Mean Partial Mayo Index (PMI) Score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>3.0 (2.5)</td>
<td>-</td>
</tr>
<tr>
<td>Medium</td>
<td>2.8 (2.6)</td>
<td>-</td>
</tr>
<tr>
<td>High</td>
<td>4.5 (4.3)</td>
<td>-</td>
</tr>
</tbody>
</table>
Percentage of patient at medium or high malnutrition risk using the MUST screening tool | 48.9% (n=47) | 40.9% (n=18)

Laboratory markers-mean value (SD)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Patient</th>
<th>HCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-albumin mg/L</td>
<td>0.28 (0.07)</td>
<td>0.25 (0.09)</td>
</tr>
<tr>
<td>Albumin g/L</td>
<td>43.6 (4.1)</td>
<td>41.6 (4.4)</td>
</tr>
<tr>
<td>Vitamin D nmol/L</td>
<td>81.3 (33.3)</td>
<td>69.5 (32.4)</td>
</tr>
<tr>
<td>Vitamin B12 pmol/L</td>
<td>396.0 (266.9)</td>
<td>351.2 (250.8)</td>
</tr>
<tr>
<td>Vitamin B6 nmol/L</td>
<td>72.0 (93.1)</td>
<td>61.4 (81.1)</td>
</tr>
<tr>
<td>Creatinine umol/L</td>
<td>71.3 (20.2)</td>
<td>66.6 (22.9)</td>
</tr>
<tr>
<td>Erythrocyte Sedimentation Rate – ESR mm/hr</td>
<td>15.8 (14.3)</td>
<td>23.6 (18.3)</td>
</tr>
<tr>
<td>C-reactive protein-CRP mg/L</td>
<td>7.5 (19.1)</td>
<td>13.2 (19.7)</td>
</tr>
<tr>
<td>White Blood Count-WBC 10⁹/L</td>
<td>7.2 (2.5)</td>
<td>8.1 (3.8)</td>
</tr>
<tr>
<td>Hemoglobin-Hb g/L</td>
<td>132.1 (19.8)</td>
<td>123.0 (18.8)</td>
</tr>
<tr>
<td>Platelets 10⁹/L</td>
<td>272.0 (81.2)</td>
<td>303.9 (141.7)</td>
</tr>
</tbody>
</table>

MUST=Malnutrition Universal Screening Tool

4.2. Primary outcome.

For patient-administered MUST screening, the chance-corrected agreement $\kappa$ (95% CI) was 0.83 (CI 0.74, 0.92) when comparing low-risk and combined medium- and high-risk patients to HCP screening.

Table 5. MUST Score agreement between Patient & Health Care Professional – Low nutritional risk (MUST=0) versus Combined medium/high risk (MUST>0)

<table>
<thead>
<tr>
<th>HCP</th>
<th>Patient</th>
<th>Medium/High (&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (0)</td>
<td>79</td>
<td>8</td>
</tr>
<tr>
<td>Medium/High (&gt;)</td>
<td>5</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>54.6%</td>
<td>43.5%</td>
</tr>
<tr>
<td></td>
<td>45.5%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Kappa (95% CI): 0.83 (0.74, 0.92)

Legend:
MUST=malnutrition universal screening tool
HCP= health care provider

4.3. Secondary outcomes

4.3.1. MUST Three-group comparison

Weighted κ analysis comparing all three risks groups yielded a κ (95% CI) of 0.85 (CI 0.77, 0.93) between patient and HCP MUST screening.

Table 6. MUST Score agreement between Patient & Health Care Professional – Low nutritional risk (MUST=0) versus Medium risk (MUST=1) versus High risk (MUST>1)

<table>
<thead>
<tr>
<th>HCP MUST score</th>
<th>Patient MUST score</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (0)</td>
<td>Medium (1)</td>
<td>High (&gt;1)</td>
<td></td>
</tr>
<tr>
<td>Low (0)</td>
<td>79</td>
<td>4</td>
<td>4</td>
<td>56.5%</td>
</tr>
<tr>
<td>Medium (1)</td>
<td>3</td>
<td>20</td>
<td>2</td>
<td>16.2%</td>
</tr>
<tr>
<td>High (&gt;1)</td>
<td>2</td>
<td>0</td>
<td>40</td>
<td>27.3%</td>
</tr>
<tr>
<td></td>
<td>54.6%</td>
<td>15.6%</td>
<td>29.9%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Weighted kappa (95% CI): 0.85 (0.77, 0.93)

Legend:
MUST=malnutrition universal screening tool
HCP= health care provider
4.3.2. MUST versus NRS-2002

For patient-administered MUST screening, the chance-corrected agreement $\kappa$ (95% CI) was 0.83 (CI 0.74, 0.92) when comparing low-risk and combined medium- and high-risk patients to HCP NRS-2002 screening was 0.73. Weighted $\kappa$ analysis comparing all three risks groups yielded a $\kappa$ (95% CI) of 0.75 (CI 0.77, 0.93) between patient and HCP screening.

Table 7. Score agreement between Patient & Health Care Professional – Patient-generated low MUST nutritional risk (0) and combined medium/ high MUST nutritional risk ($\geq 1$) versus low risk HCP NRS-2002 score (0 or 1) and combined medium/ high risk ($\geq 2$)

<table>
<thead>
<tr>
<th>HCP</th>
<th>Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (0)</td>
</tr>
<tr>
<td>Low (0)</td>
<td>73</td>
</tr>
<tr>
<td>Medium/High (&gt;0)</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>54.6%</td>
</tr>
</tbody>
</table>

Kappa (95% CI): 0.73 (0.62, 0.83)

Legend:
MUST=malnutrition universal screening tool
HCP= health care provider
NRS-2002=Nutritional Risk Score 2002
Table 8. Score agreement between Patient & Health Care Professional – Patient-generated low MUST nutritional risk (0), medium MUST nutritional risk (1) and MUST high nutritional risk (≥2) versus low risk HCP NRS-2002 score (0 or 1), medium NRS-2002 nutritional risk (2) and NRS-2002 high nutritional risk (≥3)

<table>
<thead>
<tr>
<th>HCP MUST score</th>
<th>Patient MUST score</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (0)</td>
<td>Medium (1)</td>
<td>High (&gt;1)</td>
<td></td>
</tr>
<tr>
<td>Low (0)</td>
<td>73</td>
<td>7</td>
<td>3</td>
<td>53.9%</td>
</tr>
<tr>
<td>Medium (1)</td>
<td>2</td>
<td>16</td>
<td>2</td>
<td>13.0%</td>
</tr>
<tr>
<td>High (&gt;1)</td>
<td>9</td>
<td>1</td>
<td>41</td>
<td>33.1%</td>
</tr>
</tbody>
</table>

Weighted kappa (95% CI): 0.75 (0.65, 0.85)

Legend:
MUST = malnutrition universal screening tool
HCP = health care provider
NRS-2002 = Nutritional Risk Score 2002

4.33 MUST and correlation with nutritional variables and disease activity

For CD patients, the average Harvey Bradshaw Index score for low, medium and high nutritional risk was 5.7, 4.4 and 9.3, respectively. For UC patients, the average partial Mayo score for low, medium and high nutritional risk was 3.0, 2.8 and 4.5, respectively. Elevated MUST scores were strongly associated with the elevated Harvey-Bradshaw Index scores (p = 0.005) for CD patients, but not with partial Mayo scores (P = 0.597) for UC patients.
Univariable analysis revealed significant associations of elevated MUST scores (moderate and high risk categories) with several variables, including pre-albumin, albumin, 25-hydroxy vitamin D, erythrocyte sedimentation rate (ESR) and haemoglobin. We noted significant associations between the odds of having elevated nutritional risk with increasing quartile ranges (QR) of albumin [OR 0.54(0.36,0.92), p=0.004], pre-albumin [OR 0.65 (0.45.0.92), p=0.016], Vitamin D [OR 0.68; (0.47, 0.99), p=0.042], ESR [OR 1.65 (1.15, 2.37), p=0.007], and haemoglobin [OR 0.62 (0.44,0.87)]. The reported OR’s are less than one, with the exception of ESR, meaning that increasing QR’s for these values were associated with lower odds of increased nutritional risk.

Using backwards elimination for the multivariable logistic regression model, however, we only noted significant association between increased quartile ranges (QR) of albumin [OR 0.51 (0.34, 0.75), P < 0.001], Vitamin D [OR 0.66, (0.45, 0.97), p = 0.032], and creatinine [OR 0.68, (0.46, 1.00) p = 0.050]. As all odds ratios were lower than one, decreased albumin, Vitamin D, and creatinine increased the odds of higher nutritional risk (OR’s 1.96, 1.51 and 1.47, respectively).
Table 9a. Univariable associations with MUST Score

| Univariable associations with MUST Score (odds ratios are based on the odds of exposure a Moderate/High Score) | Must Score | Diagnosis – UC | Sex – Male | Age | Pre-albumin (mg/L) | Albumin (g/L) | Vitamin D (nmol/L) | Vitamin B12 (pmol/L) | Vitamin B6 (nmol/L) | Creatinine (umol/L) | Erythrocyte Sedimentation Rate – ESR (mm/hr) | C-reactive protein-CRP (mg/L) | White Blood Count-WBC (10^9/L) | Hemoglobin-Hb (g/L) | Platelets (10^9/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low (n=87) | Moderate/High (n=67) | Odds Ratio (95% CI) | P Value (via Logistic Regression) | | | | | | | | | | | | |
| Diagnosis – UC | 36 (41.4%) | 20 (29.9%) | 0.60 (0.31, 1.18) | 0.142 | | | | | | | | | | | | |
| Sex – Male | 30 (34.5%) | 23 (34.3%) | 1.01 (0.52, 1.97) | 0.984 | | | | | | | | | | | | |
| Age | 44.9 (15.9) | 44.8 (16.3) | 1.00 (0.81, 1.22) | 0.968 | | | | | | | | | | | | |
| Pre-albumin (mg/L) | 0.28 mg/L (0.07) | 0.25 (0.09) | 0.65 (0.45, 0.92) | 0.016 | | | | | | | | | | | | |
| Albumin (g/L) | 43.6 (4.1) | 41.6 (4.4) | 0.54 (0.36, 0.92) | 0.004 | | | | | | | | | | | | |
| Vitamin D (nmol/L) | 81.3 (33.3) | 69.5 (32.4) | 0.68 (0.47, 0.99) | 0.042 | | | | | | | | | | | | |
| Vitamin B12 (pmol/L) | 396.0 (266.9) | 351.2 (250.8) | 0.83 (0.59, 1.20) | 0.295 | | | | | | | | | | | | |
| Vitamin B6 (nmol/L) | 72.0 (93.1) | 61.4 (81.1) | 0.88 (0.63, 1.24) | 0.463 | | | | | | | | | | | | |
| Creatinine (umol/L) | 71.3 (20.2) | 66.6 (22.9) | 0.79 (0.56, 1.12) | 0.189 | | | | | | | | | | | | |
| Erythrocyte Sedimentation Rate – ESR (mm/hr) | 15.8 (14.3) | 23.6 (18.3) | 1.65 (1.15, 2.37) | 0.007 | | | | | | | | | | | | |
| C-reactive protein-CRP (mg/L) | 7.5 (19.1) | 13.2 (19.7) | 1.41 (0.94, 2.10) | 0.101 | | | | | | | | | | | | |
| White Blood Count-WBC (10^9/L) | 7.2 (2.5) | 8.1 (3.8) | 1.35 (0.96, 1.90) | 0.090 | | | | | | | | | | | | |
| Hemoglobin-Hb (g/L) | 132.1 (19.8) | 123.0 (18.8) | 0.62 (0.44, 0.87) | 0.006 | | | | | | | | | | | | |
| Platelets (10^9/L) | 272.0 (81.2) | 303.9 (141.7) | 1.34 (0.96, 1.86) | 0.086 | | | | | | | | | | | | |

QR=quartile range
Table 9b. Stepwise regression modeling using backward elimination technique

Multivariable: Used backwards elimination allowing for removal at the 5% level of significance. As a result of missing values, 16 of the 154 cases could not be used (odds ratios are based on the odds of a Moderate/High Score).

<table>
<thead>
<tr>
<th>Albumin (g/L)</th>
<th>Odds Ratio (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.51 (0.34, 0.75)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>(for every QR increase)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vitamin D (nmol/L)</th>
<th>Odds Ratio (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.66 (0.45, 0.97)</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>(for every QR increase)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Creatinine (umol/L)</th>
<th>Odds Ratio (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.68 (0.46, 1.00)</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td>(for every QR increase)</td>
<td></td>
</tr>
</tbody>
</table>

C=0.71, Hosmer & Lemeshow $\chi^2=14.621, p=0.067$ (Non-significant -> No evidence of a lack of fit)

Legend:
( )=standard deviation value
UC=Ulcerative colitis
ESR=erythrocyte sedimentation rate
CRP=C reactive protein
WBC=white blood cell count

4.3.4. Patient Ease of Screening

All patients were able to screen themselves. Overall, 96% of patients reported the MUST questionnaire as either very easy or easy to understand and complete. Discrepancies between patient and HCP MUST scores between the three classification risk groups occurred in only 7.8% of patients (n = 12). Discrepancies between HCPs and patients in screening using the MUST score were related to weight loss scores in seven patients and acute disease effect in four patients. There was one case of patient miscalculation.
Chapter 5 – Discussion

We report a large percentage of patients (43.3%) who were at elevated nutritional risk using the MUST screening tool. We demonstrate near perfect agreement between patient-administered MUST risk screening and HCP MUST screening in outpatient IBD outpatients. Patient can self-screen well. Just as importantly, almost all patients reported that self-screening was either very easy or easy to use. We observed that high nutritional risk with using the patient generated MUST correlated with elevated active disease in CD, but interestingly not for UC, even though the Partial Mayo Index score was higher in severely malnourished patients. This may be related to lower sample size of the UC population versus CD, as over two-thirds of our sample had CD. However, CD affects the entire gastrointestinal tract, including the small bowel, which is not the case UC, which only affects the large bowel. Therefore CD can affect absorption of nutrients more profoundly, compared to UC, which may also explain this observation.

The correlation of MUST score with lower levels of disease activity is interesting. We demonstrated correlations with severe malnutrition and elevated measures of disease activity for both UC and CD. However, there appears to be a floor or basement effect in which low- or medium-risk MUST score does not delineate IBD activity. The low number of patients classified as medium risk may also explain this observation.

While extensive literature has been published describing malnutrition parameters, the prevalence rates of malnutrition range widely, affecting up to 70% of patients [1, 12]. The wide variance is partially related to different populations of
IBD patients studied, but also because of poor and unreliable measurement tools to classify malnutrition [1]. For instance, several studies have been performed utilizing parameters such as skin fold thickness or mid-arm circumference, which has limited utility in measuring malnutrition [1]. Furthermore, many studies focused on laboratory measures to indicate poor protein status, such as serum albumin and pre-albumin [1]. Lower albumin level is often used as a surrogate nutritional marker of chronic protein-energy malnutrition [1, 40]. Lower pre-albumin levels is also used as surrogate marker as well, but in a shorter time frame. However, pre-albumin and albumin are negative acute phase proteins that decline in response to inflammation, independent of malnutrition [1, 41]. Like other studies, we have noted an association between reduced albumin [12] and malnutrition risk in multi-variable analysis, but these changes may be more related to active inflammation [1, 42].

Efforts to the increase nutritional risk screening or assessment in IBD clinics have failed likely because of our clinical focus on disease control and time pressures. This use nutritional assessment techniques has been challenging in real-world medicine [1]. To address this issue, we asked if patients could self-screen using the MUST. By using this simple nutritional risk scoring system, we avoided potential pitfalls of other assessment methods such as the SGA, which requires clinical expertise and experience. We hypothesized that if a patient can accurately self-screen, with ease, and without interfering with the flow of the clinic, we could potentially increase nutritional risk screening. We have demonstrated impressive chance-corrected agreement scores between patients and HCPs in the ability to self-
screen. The study was performed in high-volume IBD clinics with no extra time assigned for recruitment and study participation. Certain alterations were taken in developing our patient-directed screening survey, including the use of only estimated height (versus actual measured height in the HCP assessment), which is different than other studies [16, 34]. While this may predispose to discrepancies, it is more practical in high-volume clinical medicine.

By self-screening, our patients are alleviated HCPs from performing screening, and thus, partially addresses failures in increasing malnutrition risk screening by HCPs. It also allowed patients to be more engaged in their care, and they may have been more inclined to participate in forming their nutritional care plan. The relatively young age of patients may also predispose to better uptake of self-screening. If widely adopted, HCPs will be able to quickly determine which patients require further assessment and individualized nutritional support. Patient self-screening is not a new concept in medicine, and has demonstrated benefits in many disease processes, including breast cancer screening [16]. Even if some patients choose not to participate in self-screening, HCPs may be more inclined to perform the screening if patients are unable or unwilling to perform self-screening. The most important aspect in recognizing malnutrition in our patients is to think about it. In our clinics currently, patients record their score on the face sheet which the physician views at the time of assessment.

The concept of validity is central to our study interpretation. As discussed in the introduction, validity is the extent to which a measurement tool is considered to be the degree to which the tool measures what it claims to measure. Construct
validity is the overarching term used to assess the validity of a measurement procedure to measure a given construct. In our study, the measurement procedure is the patient-generated MUST score and the construct is malnutrition. By demonstrating a statistically significant association between elevated disease activity in Crohn's disease and malnutrition risk, which is well described phenomenon, this contributes to us establishing construct validity of self-screening with the MUST. We describe statistically significant associations between lower albumin levels and elevated nutritional risk. Although interpretation of albumin levels is complicated as a nutritional marker, as discussed above, this association further establishes the construct validity of self-screening in measuring malnutrition. We demonstrated substantive agreement between patient-generated MUST scoring and HCP MUST scoring system. The HCP MUST scoring system is a well established tool for measuring malnutrition risk. The near perfect chance corrected agreement by two categories between patient and HCP MUST establishes criterion validity. The strong agreement between patient MUST screening and HCP NRS-2002, another well established tool, further contributes to criterion validity. Overall, our study begins to demonstrated that self-screening with MUST is valid for IBD patients. There are however limitations. For instance, we only assess patient HCP malnutrition risk at one point in time which prevents us from assessing predictive validity, which is major limitation in our study, and discussed further in following sections.

Introduction of electronic formats of self-screening that have been validated using the MUST may further increase the uptake of self-screening moving forward,
particularly given the younger age of patients with IBD [16, 34]. Mandatory self-screening is another option, and may be more successful here than in other populations, given these demographics and food choices are a significant issue for IBD patients. Even if patients choose to only self-screen intermittently, they may be more likely to participate when they feel their own nutritional status is an active issue, which may partially explain the high percentage of patients at elevated risk for malnutrition reported in this study.

Considerably easier than assessing protein-energy malnutrition is the identification of micronutrient deficiencies. Logistic regression analysis revealed a significant association between elevated MUST scores and lower 25-hydroxy vitamin D levels (p = 0.032). An etiological relationship between vitamin D and several disorders, including CD, has recently been proposed and is being intensely researched [46]. Vitamin D appears to have several important functions beyond bone health, including effects on immune-modulation [46]. Current guidelines recommend screening and treating vitamin D deficiency in patients with IBD[46]. To routinely screen CD patients for B12 and folate deficiency is reasonable, especially in patients with terminal ileal disease or if taking sulfasalazine [1].

There were only a few discrepancies between patient and HCP MUST scores between the three classification risk groups. These discrepancies could be improved by using electronic formats, by automatically calculating BMI and overall score.

There are several limitations in our study. Given the novel nature of patient-directed MUST screening, we ideally would have measured or performed test-retest reliability. However, given the short time period between index patient screening
and repeat screening, this was not possible. We also acknowledge that patients may have been inclined to give similar answers to the HCP to the ones they had initially recorded. As the study was performed at a tertiary academic centre introduces selection bias as these patients may be more informed about their disease processes and experienced in volunteering for studies.

Based on a single study or a few studies, one cannot conclude a measurement procedure has absolutely established construct validity. Rather, this is an ideal. With each additional study that shows a measurement procedure to have strong construct validity, especially in a wide range of contexts or situations, the claim of strong construct validity becomes greater. We have tested for validity primarily using criterion validity, given the intimate relationship between patient-generated MUST screening (the new measurement procedure) and HCP-directed screening (the established measurement procedure). This is a point-assessment study, however, which did not allow us to test for agreement over time or correlate with longer consequences of malnutrition. This may be consideration for future studies in which we compare the results of self-screening to HCP screening over multiple visits and examine the consequences of malnutrition over time.

Furthermore, the kappa statistic used to test inter-rater agreement makes no distinction among various types and sources of disagreement. Because it is affected by prevalence, it may not be appropriate to compare kappa between different studies or populations. Kappa tends to overestimate agreement in highly prevalent conditions which was the case in this study. Although kappa provides more information than a simple calculation of the raw proportion of agreement judgments,
the question of what level of kappa should be acceptable for health research is controversial. Additionally, kappa does not adjust for guessing.

Chapter 6 – Future Directions

In conclusion, this study of IBD patients attending tertiary, academic outpatient clinics demonstrate that using the MUST screening tool is valid and easy to perform. We require further work to understand how self-screening will influence nutritional management plans in patients identified at elevated risk, and how this will influence HCP-directed nutritional screening in patients who are unable to self-screen. We further need to determine if self-screening results in actionable nutritional interventions or monitoring that will influence patient outcomes.
References: