Can screening on admission identify children who are malnourished?

By

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Abstract

Background: Children are at high risk for malnutrition during hospital admission. Over half of children admitted to hospital will exhibit signs of nutrition deterioration such as weight loss. Screening for malnutrition is a critical step in the nutrition care process, however there is currently a lack of validated screening tools specifically for children in Alberta. Multiple screening tools have been proposed for pediatric use globally, but none are validated in a Canadian population. There is insufficient information available to select one screening tool over the others for widespread use. A rigorous process of selection and validation is required to determine which of the available pediatric nutrition screening tools is appropriate for use in a specific population.

Objectives: The aim of this paper is to first, compare available pediatric nutrition screening tools and select two appropriate for use in an Alberta institute. The second aim is to compare the two selected tools in a validation study at the Stollery Children's Hospital in Edmonton, Alberta, and propose one appropriate for implementation into clinical care.

Methods: A literature review identified five nutrition screening tools created and validated for use in children admitted to hospital. Of those five tools, two were believed to be appropriate for use in Alberta; the Pediatric Nutrition Screening Tool (PNST), and the Screening Tool for Risk on Nutritional Status and Growth (STRONGkids). These two tools were evaluated to determine which was best able to identify malnutrition risk on admission with acceptable sensitivity, specificity, and agreement with the Subjective Global Nutritional Assessment (SGNA). Patients admitted to surgery and medicine units at an Alberta pediatric hospital were approached to participate (n=165). Both screening tools were completed on each patient by a nurse and a nutrition risk score was calculated based

on recommended cut-offs. The SGNA was then completed by a trained dietitian, blinded to the results of the screen. Statistics: Sensitivity and specificity were calculated for both screening tool against the SGNA. A Receiver Operator Characteristic (ROC) curve was used to assess alternate cut-offs for each tool. Results: Based on the SGNA, 29% of patients were malnourished on admission. Using the recommended cut-offs STRONGkids identified 56% and 16% as at moderate and severe nutrition risk respectively with a sensitivity of 89%, specificity of 35%, and Cohen's K of 0.483. PNST identified 26% as at nutrition risk with a sensitivity of 58%, specificity of 88%, and Cohen's K of 0.601. Using adjusted cut-offs based on ROC curve analysis, the PNST improved to a sensitivity of 87%, specificity of 71%, and Cohen's K of 0.681, and STRONGkids improved to a sensitivity of 80%, specificity of 61%, and Cohen's K of 0.5. Those who were malnourished based on the SGNA stayed in hospital 2.9 days longer than those well-nourished ($p < 0.05$). Children identified as at nutrition risk by both tools using original and adjusted cut-offs had significantly longer lengths of hospital stay.

Conclusion: This study showed neither tool was able to identify children at nutrition risk with acceptable concurrent validity in this population. When the nutrition risk cut-offs were adjusted to better fit the study population, both tools had better agreement with the SGNA. The PNST with adjusted cut-offs had the strongest concurrent validity and appears to be the tool best suited for use in Alberta pediatric hospitals. Selection of a nutrition screening tool is the first step in creation of pediatric nutrition care algorithm to guide clinicians and positively impact the nutrition care of children while admitted to hospital.

Preface

This thesis is an original work by Laura Elizabeth Carter. The research project, *Screening for pediatric malnutrition at hospital admission: Which screening tool is best?*, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project Name "Pediatric Malnutrition Screening", No. Pro00071081. June 8, 2017. The research project, *Barriers to oral food intake for children admitted to hospital*, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project Name "NUTR401 - Barriers to adequate oral intake for pediatric patients admitted to hospital", No. Pro00068846. November 11, 2016.

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ASPEN: American Society for Parenteral and Enteral Nutrition

AUC: area under the curve

BMI: body mass index

ESPEN: European Society for Parenteral and Enteral Nutrition

ICD: International Statistical Classification of Disease and Related Health Problems

LOS: length of stay

MUAC: mid upper arm circumference

NPV: negative predictive value

PNRS: Pediatric Nutrition Risk Score

PNST: Pediatric Nutrition Screening Tool

PYMS: Pediatric Yorkhill Malnutrition Score

PPV: positive predictive value

Sens: Sensitivity

SGNA: Subjective Global Nutritional Assessment

STAMP: Screening Tool for the Assessment on Malnutrition in Pediatrics

STRONGkids: Screening Tool for Risk on Nutritional Status and Growth

Spec: Specificity

OR: Odds Ratio

RD: Registered Dietitian

ROC: Receivers Operator Characteristic

WFH: weight for height

WHO: World Health Organization

Chapter 1: Literature review

1.1 Introduction

It is well established that children have high protein and energy requirements for growth and development, and malnutrition during childhood can have life-long effects on health[1]. Malnutrition on admission to Canadian pediatric hospitals is reported to be between 8-51%[2,3], with the wide range being due in part to a lack of standardized methodology for identifying and defining pediatric malnutrition. Some studies rely on World Health Organization (WHO) anthropometric measures with defined Z-score cut-offs[4], while others rely on an in-depth dietitian assessment using a validated tool such as the Subjective Global Nutritional Assessment (SGNA)[2]. It is important to identify and define malnutrition early for children admitted to hospital due to negative outcomes associated with pediatric malnutrition. Children who are malnourished have longer hospital stays, delayed wound healing, increased infection risk, increased morbidity and mortality, and increased cost on the health care system when compared to well-nourished children[2,5-10]. Long term consequences include delayed development, functional impairment, and poor academic performance[11,12]. Without proper identification using a standardized method, there is a risk of missing children who would benefit from nutrition interventions.

Traditionally, definitions of malnutrition focused on describing the effects of malnutrition, but do not take into account the variety in etiology[13]. In a landmark American Society for Parenteral and Enteral Nutrition (ASPEN) publication, pediatric malnutrition was defined using five domains; 1) anthropometrics, 2) growth, 3)

chronicity, 4) etiology, and 5) developmental / functional outcomes[13]. These domains form the components of a more in-depth definition for pediatric malnutrition:

> "Pediatric malnutrition (undernutrition) is defined as an imbalance between nutrient requirements and intakes that results in cumulative deficits of energy, protein, or micronutrients that may negatively affect growth, development, and other relevant outcomes."[13]

Using this definition, nutrition assessments can be focused on specific nutrition requirements and tailored to each individual child. 1) Anthropometrics, the first domain, includes measures such as weight, height, body mass index (BMI), and mid upper arm circumference (MUAC) are indicators of nutrition status, however they take only a snapshot in time. 2) Growth, the second domain, entails a weight history including weight loss and lack of weight gain add additional information to better identify children who may be missed using a single anthropometric measure. The WHO outlines standard growth parameters including the use of growth charts and growth velocity (grams per day) to compare against[14]. 3) The third domain, chronicity, defines malnutrition as either acute (less than three months) or chronic (greater than three months), and 4) the etiology of malnutrition as either illness related, or non-illness related. The fifth domain, 5) developmental / functional outcomes considers the impact of malnutrition on the functional capacity and development a child. These domains are important to consider when diagnosing malnutrition, as they allow for nutrition interventions that are targeted and specific. The complex nature of malnutrition highlights the importance of identifying it in children admitted to hospital, who are specifically susceptible to malnutrition.

For children to benefit from a thorough nutrition assessment and intervention, they must first be identified as malnourished or at nutrition risk, which is not a simple process. ASPEN recommends using a validated screening tool to identify nutrition risk as the first integral step in the nutrition care process for children admitted to hospital[15]. Nutrition screening is often confused or used interchangeably with nutrition assessment, however the two are distinctly different steps in the nutrition care process[16,17]. A nutrition assessment involves a thorough nutrition history, providing a diagnosis, creating an intervention and monitoring outcomes. Nutrition screening is the process of identifying risk factors for malnutrition in a quick and simple manner. Nutrition screening is defined by the European Society for Parenteral and Enteral Nutrition (ESPEN) as a method to detect malnutrition and/or to predict if malnutrition is likely to occur or worsen in the current situation[18].

The purpose of a nutrition screening tool is summarized in four points by ESPEN: "1) Improvement or at least prevention of deterioration in mental and physical function 2) reduced number or severity of complications of disease or its treatment 3) accelerated recovery from disease and shortened convalescence, and 4) reduced consumption of resources e.g. length of hospital stay and other prescriptions"[18]. The lack of validated screening tools used consistently throughout pediatric hospitals leaves the potential for inconsistent identification and risk of missing children who would benefit from a nutrition intervention.

In Alberta, there is no pediatric nutrition screening tool used in hospitals. One tool available to clinicians in Alberta is the SGNA which has been validated in a Canadian centre[2]. However, the SGNA is as assessment tool, not a screening tool. It takes

approximately half an hour to complete, requires expertise in nutrition, and provides the information needed to define malnutrition and create an intervention. The SGNA evaluates anthropometrics, unintentional changes in weight, dietary intake, gastrointestinal symptoms, functional capacity, metabolic stress, and a nutrition focused physical exam[19]. The SGNA has become the preferred method of identifying true nutrition status in children in Canada but does not fill the need for a screening tool. In the nutrition care process, the SGNA would be performed on children who were identified as at nutrition risk by a nutrition screen.

Due to the lack of a validated screening tool in Alberta, it is up to the dietitian on each inpatient unit to screen for children who are at nutrition risk or rely on consults from other health care professionals. Relying on consults from other health care professionals could be problematic; malnutrition is identified through International Statistical Classification of Diseases and Related Health Problems (ICD) codes in less than 2% of pediatric patients in hospital[20]. ICD codes rely on documentation by a physician, therefore if a physician does not identify or document a malnutrition diagnosis, it would go unnoticed. As the prevalence of malnutrition has been reported as high as 50%[2], almost all malnourished children are at risk of being missed if all nutrition assessments were based on physician consult alone. Nutrition deterioration, such as unintentional weight loss, can occur in as little as 72 hours of hospital admission[21]. This highlights the importance of early identification to enable timely interventions and potentially prevent the onset or progression of malnutrition.

1.2 Screening tool selection criteria

Although there are multiple screening tools which have been validated in different settings across the world, there is not enough information to select one tool over the others for widespread use[22-24]. In 2012, *Elia & Stratton* published guidelines for analysis and selection of an appropriate screening tool[25]. A framework was created, dividing the process into three distinct stages: 1) identifying the tools aims, applications, and processes, 2) evidenced-based assessment of desirable characteristics, and 3) assessment of screening programs.

The first step involves identifying desirable features of a screening tool, such as the purpose of the tool. Potential purposes of a screening tool include identifying nutrition risk, identifying the need for nutrition intervention, predicting outcomes, or predicting work load measurement. Another feature to consider is location of intended use, whether it be acute care, long-term care, community-based, or ambulatory clinics. The demographics of the target population must also be identified. Many tools validated in adult settings are not appropriate for use in pediatrics, and some tools are for use in specific disease states while others are for general use. Finally, the intended user of the tool should be considered. Some nutrition screening tools are intended to be used by physicians or trained dietitians, others are meant for front line staff such as nurses, and others are self-screens completed by the patient.

Once tools are assessed based these variables, ones which have the desired characteristics can progress to evidence-based analysis of reliability, concurrent validity, and prospective validity. Statistical analysis of concurrent reliability most often uses the calculation of sensitivity, specificity, positive predictive value (PPV), and negative

predictive value (NPV)[26]. Sensitivity, or true positive rate, is the measure of a tool's ability to correctly identify a condition when it is indeed present. Specificity, or true negative rate, is the ability of a tool to not identify a condition when it is absent.

In the case of nutrition screening tools, sensitivity is the proportion of children who are identified as malnourished by the screening tool who are indeed truly malnourished, and specificity is the percent of children who are correctly identified as well nourished by the screen. PPV and NPV further validate true positive and negative rates, however they are dependent on the prevalence of the disease state, unlike sensitivity and specificity which measure the tool's ability to identify malnutrition independent of the rate of malnutrition in the population. These factors collectively guide clinicians in the selection of a tool. There are no definitive cut-offs of acceptable sensitivity, specificity, PPV and NPV levels, rather clinical judgement based on intended use is needed[27]. Generally speaking, sensitivity is the most important marker in nutrition screening as it is better to over identify than under identify malnutrition. If a child is falsely identified as being malnourished, a full nutrition assessment will properly categorize the child and have little effect on their clinical course in hospital. However, if a child is falsely identified as being well nourished when they are actually malnourished, they may not receive the proper nutrition intervention needed to prevent further nutrition deterioration. For a screening tool to be accepted in a public health care system, impact on workload must also be considered. A tool with poor specificity may unnecessarily increase the work load of dietitians and other health care workers. Therefore, both sensitivity and specificity must be assessed, and an acceptable balance between sensitivity and specificity must be achieved for a tool to be applicable in clinical settings.

After the validation process, the final step is clinical use of a single tool with continued validation of compliance, validity, follow-up and resource implication should then be assessed for long term feasibility.

Considering the above variables, a list of desirable characteristics for a screening tool in pediatric hospitals in Alberta was created. Ideally the screening tool should be able to identify children at nutrition risk who would benefit from a full nutrition assessment and be able to predict outcomes such as length of hospital stay. The target population is children aged one month to seventeen years admitted to hospital and should be applicable to all patients, regardless of reason for admission or past medical history. The tool will be used by front line staff such as nurses or health care aids during the admission process, therefore a background cl in nutrition must not be required. Based on these criterion, five tools were identified in the literature for further analysis.

1. Pediatric Nutrition Risk Score (PNRS)[28]
2. Screening Tool for the Assessment of Malnutrition in Pediatrics (STAMP)[29]
3. Pediatric Yorkhill Malnutrition Score (PYMS)[30]
4. Screening Tool for Risk on Nutritional Status and Growth (STRONGkids)[31]
5. Pediatric Nutrition Screening Tool (PNST)[32]

These were the only tools specifically designed for inpatient pediatric populations, and not adapted from a pre-existing adult tool. Further analysis of each tool including review of the initial validation study, and other prospective studies was conducted.

1.3 Pediatric nutrition screening tools

1.3.1 PNRS

The Pediatric Nutrition Risk Score (PNRS) was created in 2000 by Sermet-Gaudelus *et al*[28]. Nutrition risk was prospectively assessed in 296 children aged one month to seventeen years admitted to surgery and medicine units at one French hospital. The purpose of the PNRS is to identify children who are at risk for nutrition depletion during their admission, as measured through weight loss of >2% of admission weight. Multiple variables were assessed using univariate analysis and it was determined that intake of <50% of estimated needs, pain, and severity of disease were significant predictors of weight loss during admission. These variables were used to create a 3-point screen that classifies children as either no nutrition risk, moderate nutrition risk, or high nutrition risk (Appendix 1). The PNRS identifies children who are at nutrition risk and would benefit from a nutrition intervention but does not identify current nutrition status. The PNRS does not require a background knowledge in nutrition, however it takes 48 hours to assess intake and therefore a nutrition risk score cannot be determined until two days after admission. This is a major limitation of the tool as nutrition deterioration can occur quickly[21]. The PNRS also lacks any further studies to validate the tool in other populations and has no reported data on concurrent validity.

1.3.2 STAMP

The Screening Tool for the Assessment of Malnutrition in Pediatrics (STAMP) tool was developed in 2012 in the United Kingdom[29] for use in children two to seventeen years of age admitted to medicine and surgery units. It is a five-step nutrition screen

completed by nurses on admission to hospital (Appendix 2). The first two steps are questions about admitting diagnosis and recent oral intake. A supplementary table with a list of definite and potential diseases with nutrition implications is provided. The third step requires plotting the admission weight and height on a growth chart and comparing the percentiles of weight and height measurements. A supplementary table is provided for nursing staff to use in place of plotting on a growth chart. The fourth step is to add up the total score and calculate a final nutrition risk diagnosis of no risk, moderate risk, or high risk. The fifth step is an algorithm of care based on the results of the screen. A high-risk diagnosis warrants a dietitian consult. Children with medium risk have their intake monitored for three days, and the STAMP tool repeated after three days. Low risk patients are given routine care with re-screening weekly.

While STAMP was initially intended for use in children over two years old, it has since been validated in children as young as six months. STAMP is one of the most studied tools with multiple validation studies in different populations, all with acceptable concurrent validity, however reliance on assessment of anthropometric measures may limit the clinical feasibility of the tool. While the STAMP tool attempts to make this process simple and easy to use, any assessment of anthropometrics has the potential to limit use by those who are not comfortable using growth charts and percentiles[24] and is dependant on accurate measurements of weight and height on admission which are often done poorly, if at all[33]. A screening tool should be quick and easy to use by nurses during the admission process, and not dependant on measures which may be inaccurate or missing.

1.3.3 PYMS

The Paediatric Yorkhill Malnutrition Score (PYMS) was initially validated in the United Kingdom in 247 children aged one to sixteen years[30]. The tool was used by registered nurses on admission to medical or surgical units and compared to a full dietitian assessment. The PYMS consists of (Appendix 3), assessment of BMI, unintentional weight loss, intake in the past two weeks, and clinical judgement of the impact of hospital stay on nutritional intake. A supplementary table is provided with the designated BMI cut-offs for each age. The final step is to add up the total score; a score of zero is low risk and the tool suggests rescreening in one week, a score of one should be rescreened in three days, and a score of two or greater warrants a dietitian review and rescreening in one week. The PYMS also has a section for nursing notes and concerns and recommends referring to a dietitian regardless of the screen results if nutrition concerns arise.

The PYMS is the only tool that estimates future intake which is useful in a screening tools ability to predict those who are at risk of becoming malnourished, even if they are well nourished on admission. The PYMS has the ability to detect current nutrition status through BMI percentiles as well as risk of becoming malnourished by predicting intake in hospital. However, the potential downfall of the PYMS is relying on nursing staff calculating and interpreting BMI, raising the same concerns seen in STAMP.

1.3.4 STRONGkids

The Screening Tool for Risk on Nutritional Status and Growth (STRONGkids) is one of the most studied pediatric screening tools available. It was created and validated in the Netherlands in 2010[31]. STRONGkids consists of four questions, with a total score out of five being calculated at the end (Appendix 4). The first question is a subjective assessment by the user of the tool asking if the child looks obviously in poor nutritional status (diminished subcutaneous fat and or muscle mass and/or hollow face). The next questions ask about underlying illnesses, nutritional intake and losses, and weight loss or lack of weight gain. A supplementary table is provided with a list of potential high-risk diseases for the second questions. The tool was initially designed to have a physician complete the first two questions (subjective assessment of nutrition status and underlying disease), and a bedside nurse complete the final two. A score of zero is considered low nutrition risk, one to three moderate risk and four or five high risk. The tool suggests monitoring intake and reassessing nutrition status weekly for low risk patients, twice weekly weight checks and potential dietitian consult for moderate risk, and a doctor and dietitian consult for high risk patients, and to consider starting supplements while waiting for further nutritional assessment.

Despite STRONGkids being designed for use by a physician for the first two questions, the screen has since been validated for use by nurses only[34,35]. Studies recommend moving forward with nurses only completing the screen due to the limitations of physician availability during the admission process and no significant impact on validity when completed by a nurse or a physician[35]. STRONGkids has replaced the need for anthropometric measures with a subjective assessment of nutrition

status, potentially improving the usability of the tool for nurses. A systematic review of concluded that STRONGkids is significantly associated with health outcomes such as length of stay, hospital cost and changes in anthropometrics[36]. However, it overestimates nutrition risk, revealed by low specificity in multiple studies (Table 1). This could be in part due to the high emphasis on disease state, a child with a diagnosis that could impact nutrition is automatically at nutrition risk, regardless of their answers to other questions. Overestimation of nutrition risk may unnecessarily increase workload of care providers resulting in an increase burden on public health care systems.

1.3.5 PNST

The Pediatric Nutrition Screening Tool (PNST) is the newest nutrition screening tool, created in Australia in 2014[32]. This tool was created as a simpler alternative to other pediatric screening tools and was validated in 295 patients from birth to sixteen years of age admitted to a tertiary pediatric hospital. The PNST consists of four yes or no questions, anyone who answers yes to two or more questions is considered at nutrition risk, and one or no yes answers is no nutrition risk (Appendix 5). The questions are whether the child has unintentionally lost weight lately, poor weight gain over the past few months, eating or feeding less in the last few days, or if the child is obviously underweight (subjective assessment). Initially the tool asked if the child was obviously underweight or significantly overweight, but the overweight was removed due to feedback that it is challenging to assess overweight status from visual observation alone. Like all the other tools, the PNST is only validated to assess undernutrition. Based on the answers to the question, the PNST suggests referring for further nutrition assessment, measuring anthropometrics, and monitoring food and fluid intake for those who are at

risk. Similar to STRONGkids, the PNST does not include assessment of anthropometrics, rather it relies on a subjective assessment. The PNST differs from other tools in that it does not ask about medical diagnosis. This was a deliberate omission by the creators to increase ease of use by eliminating the need to refer to a supplementary table. They also found that majority of diagnoses fall under the "other" category when compiling data, therefore it is challenging to classify most diagnosis based on nutritional impact. The PNST does not have any further validation studies beyond the initial study, therefore it is unknown if it can be used in other populations. Its simple design makes it intriguing for use, however without further validation it is unknown if the simple nature will hinder its ability to accurately identify children who are at nutrition risk.

1.4 Comparison

Table 1 summarizes the validation studies for each of the tools except PNRS as it had no validation studies which reported concurrent validity. Studies are included only if they report sensitivity and specificity as concurrent validity. Agreement and interrater reliability are also reported when applicable. As seen in Table 1, there is large variability within each tool, even when compared to the same standards. This concern in raised in many reviews of pediatric nutrition screening tools[22,27,37,38]. There is insufficient evidence to suggest one tool for use based on previous validation. Assessment of a tools ability to perform in a specific population must be assessed.

Table 1.1. |Concurrent validity of the nutrition screening tools

Nutrition screening tool	Author (year)	Standard reference	Sens (%)	Spec (%)	PPV (%)	NPV (%)	Agreement (Kappa)	Interrater reliability[a]
STAMP	McCarthy (2012)[29]	RD	70	91	55	95	0.541	-
	Lama (2012)[39]	RD	75	61	39	88	-	0.85
	Wong (2014)[40]	RD	83	67	78	74	0.507	0.752
	Wonoputri (2014)[41]	SGNA	100	12	58	100	-	-
PYMS	Gerasimidis (2010)[30]	RD	85	87	44	98	0.46	0.53
	Wonoputri (2014)[41]	SGNA	95	77	84	93	-	-
STRONGkids	Huysentruyt (2013)[34]	WHO	72	49	12	95	-	0.61
	Spagnuolo (2013)[42]	WHO	71	53	21	85	-	-
	Wonoputri (2014)[41]	SGNA	100	8	57	100	-	-
	Ortiz-Gutierrez (2018)[43]	WHO	86	72	66	89	0.56	0.67
PNST	White (2014)[32]	SGNA	78	82	69	88	-	-

STAMP, Screening Tool for the Assessment of Malnutrition in Pediatrics. PYMS, Pediatric Yorkhill Malnutrition score. STRONGkids, Screening Tool for Risk on Nutritional Status and Growth. PNST, Pediatric Nutrition Screening Tool.
Sens, Sensitivity. Spec, Specificity. PPV, Positive Predictive Value. NPV, Negative Predictive Value.
RD, Registered dietitian nutrition assessment
WHO, anthropometrics based on World Health Organization definition of malnutrition as a z-score of -2 or less
SGNA, Subjective Global Nutritional Assessment
[a] Cohen's Kappa (k).

For a screening tool to be capable of achieving the goal of identifying malnutrition and/or predicting risk of nutrition deterioration, ESPEN suggests the tool must be able to answer the following four questions: "1) What is the condition now? 2) Is the condition stable? 3) Will the condition get worse? 4) Will the disease process accelerate nutritional deterioration?"[18]. The first question can be answered by assessing current nutrition status through anthropometric measures, a nutrition focused physical exam, or a subjective assessment of physical signs of malnutrition. The second question requires comparison of current nutrition status to previous measures or norms, for example recent weight loss or lack of weight gain. The fourth question requires assessment of recent and current intake or gastrointestinal losses impacting nutrient delivery (vomiting and diarrhea). The final question takes into consideration the disease process and the impact of disease and inflammation on metabolism. Table 2 summarizes how each of the tools fit within the ESPEN guidelines.

Table 1.2. Comparison of the nutrition screening tools to ESPEN core components

	Current status	Weight loss	Change in intake	Effect of disease
PNRS	✗	✗	✓	✓
STAMP	✓	✗	✓	✓
PYMS	✓	✓	✓	✓
STRONGkids	✓	✓	✓	✓
PNST	✓	✓	✓	✗

ESPEN, European Society for Parenteral and Enteral Nutrition[18]. PNRS, Pediatric Nutrition Risk Score. STAMP, Screening Tool for the Assessment of Malnutrition in Pediatrics. PYMS, Pediatric Yorkhill Malnutrition score. STRONGkids, Screening Tool for Risk on Nutritional Status and Growth. PNST, Pediatric Nutrition Screening Tool.

PYMS and STRONGkids are the only two that meet all the criteria laid out by ESPEN. Based on assessment of these core components as well as the framework laid out by Elia *et al*[25] it was determined that the PNRS was inappropriate due to its 48-hour

timeframe for completion, lack of validation studies, and only meeting half of the core components. STAMP and PYMS both demonstrate concurrent validity, and meet at least 75% of the core components, however their limitation is the reliance on anthropometrics measures. Not only does this require accurate weight and height measurements on admission for the tool to be useful, it also may increases the workload for nurses on admission. Due to these limitations, STAMP and PYMS were deemed not appropriate for the current clinical setting. Both STRONGkids and PNST have four simple yes and no questions that could easily be integrated into admission paperwork in Alberta hospitals, and met at least 75% of the core components. Since PNST has only one validation study, and STRONGkids has variable results including documented poor specificity, both tools require further validation in an Alberta centre to determine which is most appropriate for clinical use.

1.5 Conclusion

Review of available pediatric nutrition screening tools has yielded inconclusive results, with insufficient data to recommend one over the other for widespread use[37]. When multiple tools have been used on the same population, there has been a large variation in identification of nutrition risk between tools, suggesting each tool may be too specific to the original population[23]. With this in mind, assessment of the PNST and STRONGkids in an Alberta population should look at the original nutrition risk cut-offs as recommended by tools, but also investigate adjusted nutrition risk cut-offs that may be more appropriate for this population.

Chapter 2: Study rationale

2.1 Rationale

Currently in Alberta, there is no standardized method of screening for malnutrition in children when admitted to hospital. Despite recommendations from both the American Society for Parenteral and Enteral Nutrition (ASPEN) and the European Society for Parenteral and Enteral Nutrition (ESPEN)[15,18] to screen all patients admitted to hospital, an appropriate tool has yet to be implemented into clinical care. The importance of nutrition screening cannot be understated, children are at risk of nutrition deterioration within a few days of admission[21,44] and the impact on malnutrition in childhood can last a lifetime[11,12,45]. Of health care professionals, dietitians are the most aware of the importance of nutrition assessment[46], however they are often left to screen for malnutrition without a standardized approach or rely on consults from other health care professionals. Even with electronic systems, mistakes or missing nutritional data in patient files can occur[46], hindering the ability of a dietitian to properly assess nutrition status when lacking a validated tool.

Nutrition interventions can improve the nutrition status of children while admitted to hospital[46], but children who are malnourished may not always receive the nutrition support they require[47]. In centres that have implemented nutrition screening, there has been an increase in dietitian referrals, and feedback from dietitians was positive, stating they were identified of malnourished children who they would have otherwise missed[48]. Pediatric nutrition care algorithms are becoming common practice to help guide all clinicians through the nutrition care process from admission to discharge, ensuring all children are receiving appropriate nutrition care throughout their hospital stay[15,49]. All the

nutrition care algorithms suggest the use of a screening tool as the integral first step. Before a nutrition care algorithm can be implemented into the Alberta health care system, a validated nutrition screening tool must be identified. Based on the literature review in chapter one, two pediatric nutrition screening tools have been identified as potentially appropriate for use in Alberta.

2.2 Research question

Which tool, Pediatric Nutrition Screening Tool (PNST) or Screening Tool for Risk on Nutritional Status and Growth (STRONGkids), is able to identify children at risk for malnutrition on admission to hospital with clinically acceptable concurrent validity, prospective validity, and interrater reliability when compared to the Subjective Global Nutritional Assessment (SGNA)?

2.3 Research objectives

2.3.1 Primary objective

Determine the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and interrater reliability of the PNST and STRONGkids with the SGNA, based on original and adjusted nutrition risk cut-offs.

2.3.2 Secondary objective

Determine the prevalence of malnutrition in pediatric patients on admission to hospital, and the effects of nutrition status on hospital length of stay.

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Chapter 3: Screening for pediatric malnutrition at hospital admission: Which screening tool is best?

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3.1 Introduction

It is well known that children have high protein and energy requirements for growth and development, and malnutrition during childhood can have life-long effects on health[1]. Malnutrition on admission to Canadian pediatric hospitals has been reported in 8-51% of children[2,3]. Malnutrition is associated with increased length of hospital stay (LOS), morbidity and mortality, infection risk, and increased hospital costs when compared to well-nourished children[2,4-7]. Long term consequences include delayed development, functional impairment, and decreased academic performance[8,9]. The American Society for Parenteral and Enteral Nutrition (ASPEN) recommends using a validated screening tool to identify nutrition risk on all patients admitted to hospital[10], however validated screening tools are not used in many pediatric facilities, leaving a large gap between current and best practice. When selecting a screening tool, the intended purpose, prospective validity, concurrent validity, reproducibility, and practicality must all be considered[11,12].

Multiple tools have been developed to screen for malnutrition in pediatric inpatient settings, but currently there is insufficient data to select one over the other[13-15]. Despite validation of pediatric nutrition screening tools in multiple centers, there is a large variation in the reported concurrent validity, even within the same populations. This suggests the screening tools may be too specific to the original population, and not appropriate for widespread use[14]. Using the framework provided by *Elia and Stratton* in

2011[11] as a guide, five previously validated pediatric screening tools were reviewed; Pediatric Nutrition Risk Score (PNRS)[16], Screening Tool for the Assessment of Malnutrition in Pediatrics (STAMP)[17], Pediatric Yorkhill Malnutrition Score (PYMS)[18], Screening Tool for Risk on Nutritional Status and Growth (STRONGkids)[19], and Pediatric Nutrition Screening Tool (PNST)[20]. To first narrow down the screening tools, all five were assessed for practical use in a clinical setting where a nurse would perform each tool during the admission process. For a tool to be used by nurses on admission, it should be completed quickly and not require expert knowledge in nutrition assessment. The PNRS takes 48 hours to complete, and both STAMP and PYMS require analysis of anthropometrics with a growth curve or percentile chart. Both STRONGkids and PNST consist of four yes or no questions which can be completed in under 5 minutes and do not use any anthropometric measures. Based on the criteria used, PNST and STRONGkids are the only two tools with practical applicability, and therefore were selected for further validation. Despite both tools being validated in pediatric populations, there is insufficient evidence to chose one over the other, and concern that the nutrition risk cut-offs proposed are too specific to the initial study population[14]. Therefore adjusted nutrition risk cut-offs must be assessed to better fit the intended population.

In order to assess the tools' ability to identify children who are malnourished, a reliable method of identifying true nutrition status is required. The Subjective Global Nutritional Assessment (SGNA) is a validated tool which has been shown to accurately identify children who are malnourished[2]. While anthropometric measures such as weight, height, and body mass index (BMI) are often used to identify and classify the extent of malnutrition in children, the more complex etiology of pediatric malnutrition recently

described by Mehta *et al* (2013) acknowledges that anthropometrics only identify a subset of malnourished patients[21]. The SGNA is a more robust assessment than anthropometrics alone as it includes weight gain, weight loss, intake, gastrointestinal patterns, functional status, and a nutrition-focused physical exam. While the SGNA is a validated tool, it takes approximately twenty minutes to complete and can only be used by a trained clinician, therefore it is not a suitable screening tool for nurses to administer during admission. The SGNA was chosen as a measure of malnutrition status, one which the screening tools can be compared to during the validation process.

The primary aim of this study was to determine which tool, STRONGkids or PNST, is able to identify children with malnutrition on admission to hospital as compared to the SGNA with clinically acceptable concurrent validity based on original and adjusted nutrition risk cut-offs. The secondary aim was to determine the prevalence of malnutrition upon admission and impact of malnutrition on LOS.

3.2 Methods

3.2.1 Study Design

This prospective single center study was conducted on surgery and medicine units at the Stollery Children's Hospital in Edmonton, Alberta, Canada from October to December 2017. Patients aged 1 month to 17 years were approached to participate within 24 hours of admission (72 hours for weekend admission) and were only excluded if the expected length of stay was less than 24 hours. This study was approved by the Human Research Ethics Board at the University of Alberta (REB # Pro00071081).

A research nurse approached parents or guardians to participate, and after receiving consent and assent (when applicable) performed both screening tools consecutively in random order by asking parents a series of questions. The PNST asked questions around unintentional weight loss, poor weight gain, and recent feeding habits. STRONGkids asks about poor weight gain or weight loss, nutrition intake and losses, and high nutrition risk diseases for which a supplementary table is provided. Both tools include a question requiring the nurse to subjectively assess the nutrition status of the patient, by determining if he/she looks obviously underweight. STRONGkids was initially designed to have a pediatrician complete two questions (the subjective assessment and disease state), however for feasibility in a clinical setting having nurses complete the entire screen has become standard for its use[22]. Each tool took less than five minutes to complete by nurses with the child and their parent or guardian. Once the screening tools were completed, a dietitian blinded to the results of the screen conducted the SGNA on each patient to assess presence and extent of malnutrition. This took between fifteen to thirty minutes per patient. Age, weight, height, LOS, unit and reason for admission were then collected from the patient chart. A second research nurse repeated both screening tools in a subset of 20 patients, blinded to the results of the initial screens, to assess interrater reliability. Height for age and weight for height (less than 2 years of age) or BMI Z-scores were calculated using World Health Organization anthro software (version 3.2.2, January 2011, Geneva, Switzerland).

SGNA results were categorized as well-nourished, moderately malnourished or severely malnourished, with the moderate and severe categories combined into 'malnourished' for statistical analysis. Anthropometric measures were also collected to

assess their ability to identify malnutrition. Malnutrition was classified as a z-score of less than or equal to -2 in either length/height for age, weight for height or BMI[23,24]. The STRONGkids and PNST tools were first evaluated based on the recommended cut-offs from their original studies[19,20]. Adjusted cut-offs (Table 3.1) were derived from a Receiver Operator Characteristic (ROC) curve and analyzed to determine the impact changing the cut-offs would have on the agreement of the tools with the SGNA[25].

Table 3.1. Screening tools original and adjusted nutrition risk cut-offs

	Original cut-offs		Adjusted cut-offs	
	Score	Nutrition risk	Score	Nutrition risk
STRONGkids	0 points	no risk	0-1 points	no risk
	1-3 points	moderate risk*	2-3 points	moderate risk*
	4-5 points	severe risk*	4-5 points	severe risk*
PNST	0-1 yes answers	no risk	0 yes answers	no risk
	2-4 yes answers	at risk	1-4 yes answers	at risk

Original cut-offs are based on original validation studies[19,20]
adjusted cut-offs based on Receiver Operator Characteristic (ROC) curve analysis. STRONGkids, Screening Tool for Risk on Nutritional Status and Growth. PNST, Pediatric Nutrition Screening Tool. *Grouped into "at nutrition risk" for statistical analysis

3.2.2 Statistical Analysis

Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and Cohen's Kappa were derived from 2x2 crosstab tables and used to compare the screening tools' original and alternate cut-off points to the SGNA for concurrent validity. Prospective validity was assessed by determining the difference in LOS between the nutrition risk categories for each screening tool using the Mann Whitney U-test and the independent sample Kruskal-Wallis test. Demographics were compared to the SGNA and screening tools using Chi squared analysis and the Mann-Whitney U test. ROC curve analysis was used for creation of adjusted nutrition risk cut-offs and to assess both tools

ability to identify nutrition risk. All statistics were done on SPSS for Windows version 24 (IBM Corp, 2016, Armonk, NY: IBM Corp). A value of $P<.05$ was considered statistically significant.

3.3 Results

177 patients consented to participate, representing 51% of those eligible. Twelve were discharged prior to any data collection and were therefore excluded, a further eleven were discharged after the screening tools were completed but before the SGNA was able to be performed. These patients were included for length of stay and demographic analysis to avoid bias. In total, 154 patients were included for the full analysis, and 165 were included for LOS and demographic analysis.

The median age was 5.7 years (1 month -16.9 years), and median length of stay 3 days (1-47 days) (Table 3.2). The SGNA classified 71% of the patients as well nourished, 25% as moderately malnourished and 4% as severely malnourished for an overall malnutrition rate of 29% (Table 3.3). There was no difference in malnutrition rates for age or gender ($p =0.128$, 0.767 respectively), but those admitted to medicine units were three times more likely to be malnourished (moderate or severe) than those admitted to the surgery unit (OR = 3.03, CI 1.452-6.335, $p = 0.003$). Anthropometric measures classified 33 (20%) of patients as being malnourished.

Table 3.2. Patient Demographics

	n (%)[a]
Patients	165 (100)
Gender	
Male	90 (55)
Female	75 (45)
Age, median (range), years	5.7 (0.1-16.9)
Unit of admission	
Surgery	84 (51)
Medicine	81 (49)
Reason for Admission	
General medicine	45 (27)
Neurology	15 (9)
Other medicine	21 (13)
General Surgery	25 (15)
Neurosurgery	14 (9)
Orthopedic surgery	17 (10)
ENT surgery	21 (13)
Other Surgery	7 (4)
LOS, median (range), days	3 (1-47)

a. Unless otherwise indicated
LOS, Length of Stay

Based on original cut-offs, PNST identified 25% of the population as being at nutrition risk, while STRONGkids identified 72% as at nutrition risk (56% at moderate risk and 16% at high risk). There was no difference in rates of nutrition risk for either tool based on which screening tool was performed first ($p = 0.094$, 0.468 for PNST and STRONGkids respectively).

Table 3.3. Prevalence of malnutrition based on the SGNA

	Total	Well Nourished n (%)	Moderate malnutrition n (%)	Severe malnutrition n (%)
Total	154	109 (71)	38 (25)	7 (4)
Gender				
Male	86	62 (72)	21 (24)	3 (4)
Female	68	47 (69)	17 (25)	4 (6)
Unit				
Surgery	77	63 (82)	12 (16)	2 (2)
Medicine	77	46 (60)	26 (34)	5 (6)
Reason for admission				
General medicine	42	28 (67)	11 (26)	3 (7)
Neurology	14	10 (71)	4 (29)	0 (0)
Other medicine	21	8 (38)	11 (52)	2 (10)
General Surgery	22	17 (77)	5 (23)	0 (0)
Neurosurgery	13	11 (84)	1 (8)	1 (8)
Orthopedic surgery	15	12 (80)	2 (13)	1 (7)
ENT surgery	20	17 (85)	3 (15)	0 (0)
Other Surgery	7	6 (86)	1 (14)	0 (0)

Based on the 154 patients who had the SGNA performed
SGNA, Subjective Global Nutritional Assessment

3.3.1 Concurrent validity

ROC curve analysis of under the curve area (Figure 1) showed significant agreement between the SGNA and both STRONGkids and PNST. Based on the results of the ROC curve analysis, adjusted cut-off points were analyzed for both screening tools. These changes improved the sensitivity of PNST and the sensitivity of STRONGkids, and for both tools showed better overall agreement with the SGNA (Table 4). With original and adjusted cut-offs, both screening tools were able to identify all patients classified as severely malnourished by the SGNA. There was slightly lower agreement, although still significant, in the surgery population as compared to the medicine population (Table 5).

Patients admitted under specialty medicine programs (neurology, cardiology, gastrointestinal, metabolics, oncology, and nephrology) showed a high prevalence of malnutrition therefore results from both screening tools were assessed in this population alone. Using the adjusted cut-offs, PNST had a sensitivity of 88%, specificity of 78%, PPV 79%, NPV 88%, Cohen's Kappa 0.658 ($p < 0.001$). STRONGkids had a sensitivity of 94%, specificity of 44%, PPV of 62%, NPV of 89%, Cohen's Kappa 0.38 ($p = 0.009$).

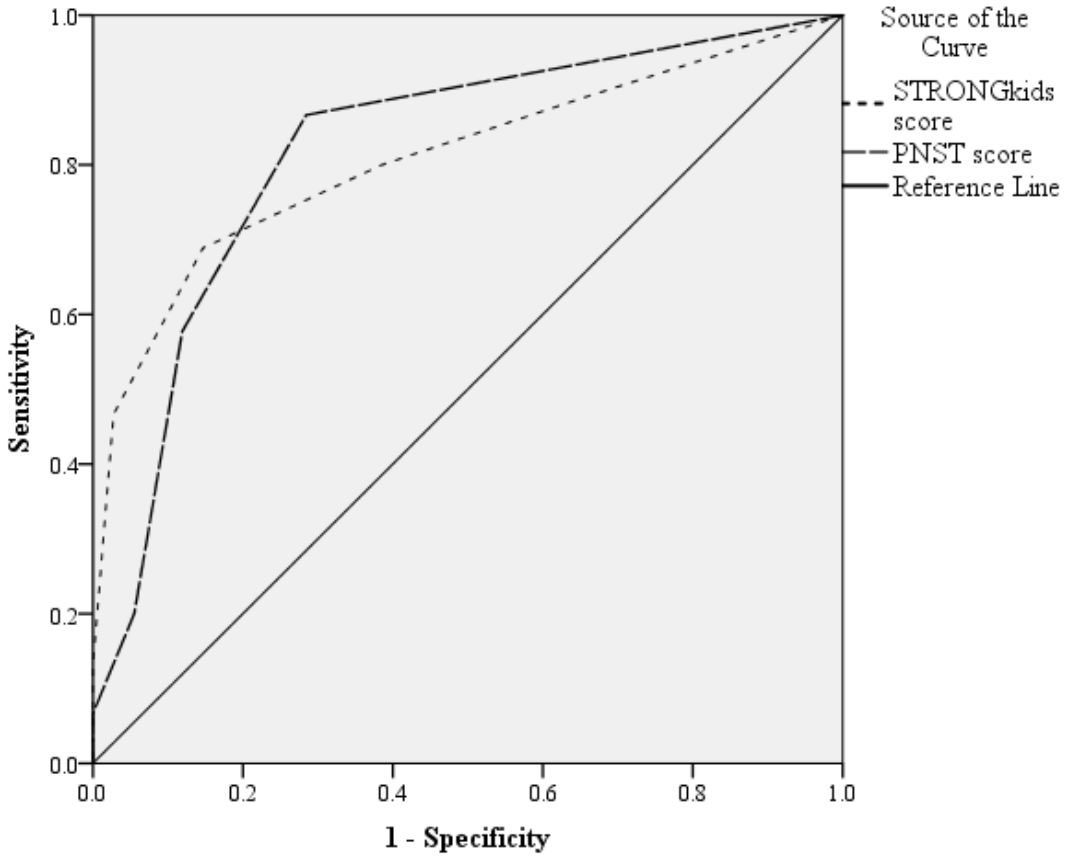

Figure 3.1. ROC curve analysis of STRONGkids and PNST as compared to the SGNA for the whole population**.**
The closer the AUC is to 1, the stronger the agreement between the screening tool and the SGNA. AUC for PNST: 0.819 (0.745 - 0.894), $p < 0.001$. AUC for STRONGkids: 0.809 (0.723 - 0.894), $p < 0.001$. ROC, receiver's operator characteristic. AUC, area under the curve. STRONGkids, Screening Tool for Risk on Nutritional Status and Growth. PNST, Pediatric Nutrition Screening Tool. SGNA, Subjective Global Nutritional Assessment.

Table 3.4. Concurrent validity of STRONGkids and PNST as compared to the SGNA

	Nutrition risk, n (%)	Sensitivity %[#]	Specificity %[#]	PPV %[#]	NPV %[#]	k	P value
Original cut-offs							
STRONGkids	119 (72)	89 (75-96)	35 (26-45)	36 (27-46)	88 (74-96)	0.166	0.003*
PNST	42 (25)	58 (42-72)	88 (80-93)	67(50-80)	83 (75-90)	0.477	<0.005*
Adjusted cut-offs							
STRONGkids	85 (51)	80 (65-90)	61 (52-70)	46(35-58)	88 (78-94)	0.341	<0.005*
PNST	74 (45)	87 (73-94)	71 (62-80)	56(43-67)	93 (85-97)	0.501	<0.005*

Percent (95% confidence interval). * Statistically significant (p= < 0.05).
Original cut-offs are based on the original validation study of each tool.
PPV, Positive Predictive Value. NPV, Negative Predictive Value. k, Kappa. STRONGkids, Screening Tool for Risk on Nutritional Status and Growth. PNST, Pediatric Nutrition Screening Tools. SGNA, Subjective Global Nutritional Assessment.

Table 3.5. ROC curve analysis

	n	Area under the curve (95% CI)	P
Whole population	154		
STRONGkids		0.809 (0.723 - 0.894)	<0.001
PNST		0.819 (0.745 - 0.894)	<0.001
Medicine	77		
STRONGkids		0.826 (0.722 - 0.929)	<0.001
PNST		0.816 (0.718 - 0.914)	<0.001
Surgery	77		
STRONGkids		0.735 (0.595 - 0.912)	0.003
PNST		0.786 (0.647 - 0.926)	0.001

The closer the area under the curve is to 1, the stronger the agreement between the screening tool and the SGNA. ROC, receiver's operator characteristic.CI = confidence interval. STRONGkids, Screening Tool for Risk on Nutritional Status and Growth. PNST, Pediatric Nutrition Screening Tools.

3.3.2 Interrater reliability

In the subset of 20 patients who had both screening tools completed twice by different nurses, Cohen's Kappa analysis showed moderate agreement for STRONGkids ($k = 0.483$, $p = 0.028$) and substantial agreement for PNST ($k = 0.601$, $p= 0.002$)[26]. With the adjusted cut-offs there was minimal improvement in the agreement of both tools with STRONGkids increasing to $k=0.5$ ($p=0.01$), and PNST increasing to $k=0.681$ ($p = 0.002$).

3.3.3 Prospective validity

The median LOS for those well-nourished (SGNA) was two days, and five days for those malnourished ($p < 0.005$). Both screening tools showed an association between higher points or more yes answers on the screen and increased LOS (figure 2). Removal of one outlier (LOS = 47) days made no impact on the significance of the results. When classified based on original and adjusted cut-offs, both screening tools showed a significant difference in median length of stay between those at 'no nutrition risk' and those 'at nutrition risk' (Figure 3).

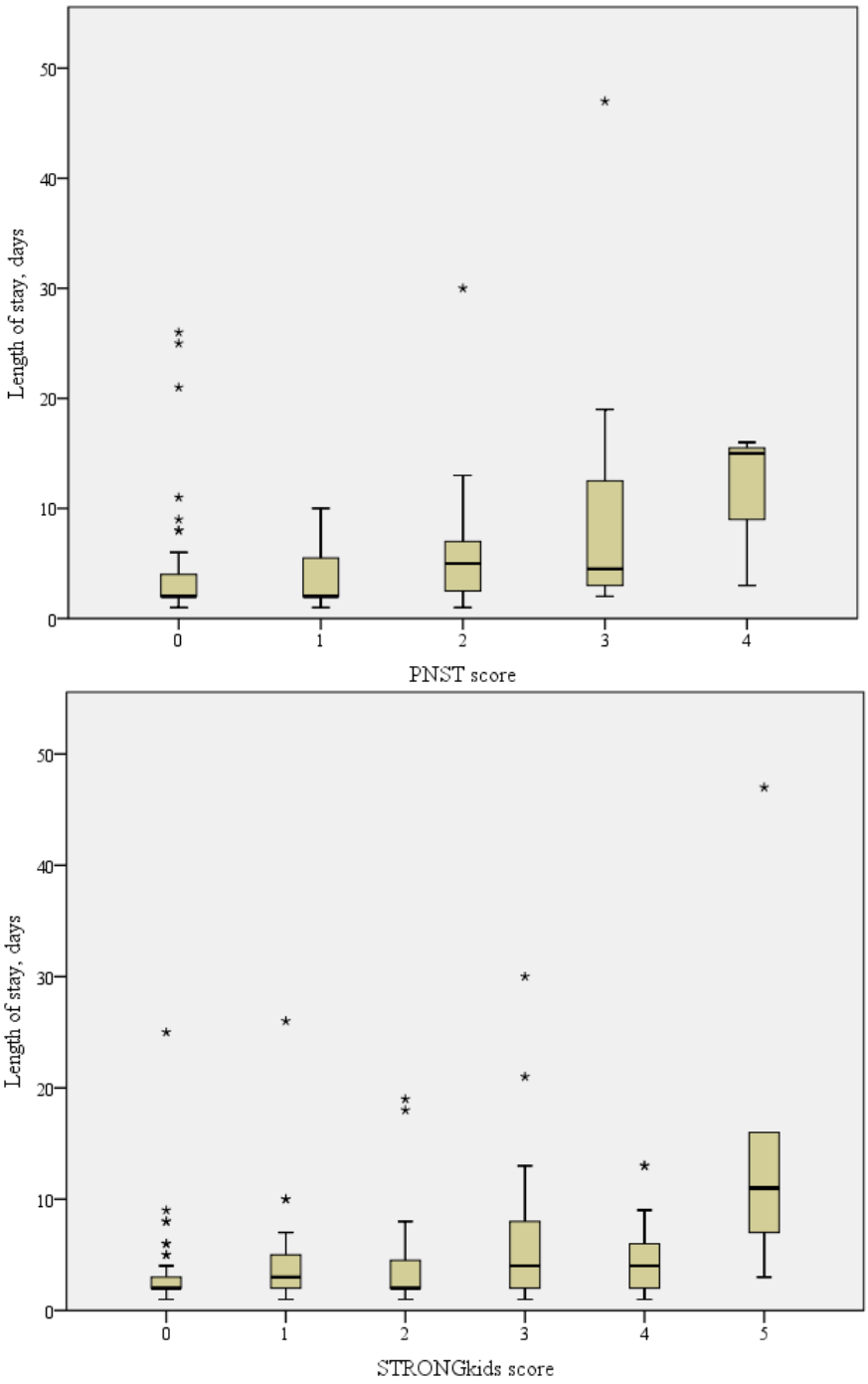

Figure 3.2. Length of hospital stay for patients based on score from the PNST and STRONGkids.
The median length of stay was longer for those who scored higher on the screening tools with adjusted cut-offs. Both tools showed a significant association with length of stay based on an independent sample Kruskal-Wallis test, p = 0.001, and 0.004 for PNST and STRONGkids respectively. STRONGkids, Screening Tool for Risk on Nutritional Status and Growth. PNST, Pediatric Nutrition Screening Tool.

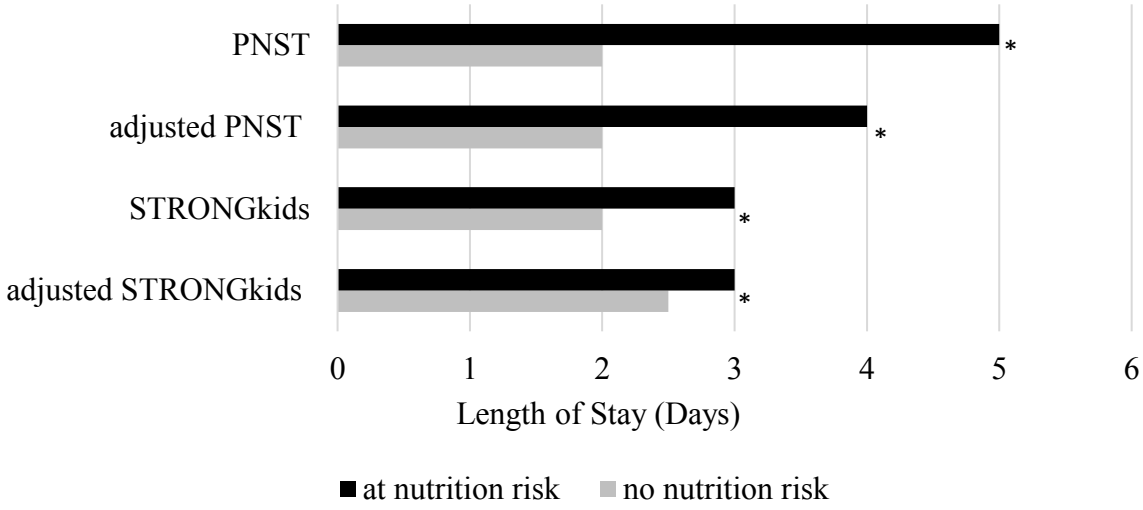

Figure 3.3. Median length of hospital stay for children at nutrition risk versus not at nutrition risk based on STRONGkids and PNST with original and adjusted cut-offs. *Statistically significant ($p < 0.05$) based on Mann-Whitney U test. Children identified as being at nutrition risk by both screening tools with original and adjusted cut-offs had significantly longer length of hospital stay. PNST, Pediatric Nutrition Screening Tool. STRONGkids, Screening Tool for Risk on Nutritional Status and Growth.

3.4 Discussion

The consequences of malnutrition on hospitalized children are becoming increasingly recognized, however nutrition risk screening in pediatrics hospitals has yet to receive widespread use. This is partly due to the lack of validated tools that meet all the requirements of a practical screening tool[27]. Evidence suggests that over half of pediatric patients lose weight while in hospital and those who were malnourished on admission are being discharged with no improvement in nutritional status[28,29]. These concerning findings highlight the importance of early identification of malnutrition to allow for timely interventions and nutrition management. This study is the first, to our knowledge, to compare two previously validated screening tools to the SGNA in a Canadian pediatric population. Neither screening tool, when used as recommended, was able to identify children at risk for malnutrition with acceptable concurrent validity. The

PNST had a low sensitivity, it correctly identified malnourished children only 58% of the time. STRONGkids had a poor specificity at 35%, suggesting it falsely identified (false positive) children as at nutrition risk when they were truly well nourished 65% of the time. During the initial development of both screening tools, their nutrition risk cut-offs were derived from different methods. STRONGkids based their nutrition risk cut-offs on groupings that had similar mean weight for height (WFH) z-scores[19], while the PNST looked at the cumulative percentage of affirmative responses that most closely matched the SGNA[20]. As suggested by Huysentruyt *et al,* the choice of cut-off points can have a great impact on the tools' performance and need to be evaluated closely[30]. By adjusting the risk classifications based on ROC curve analysis, both tools saw an improvement in overall agreement with the SGNA without significantly impacting the prospective validity or interrater reliability. Both tools have the ability to identify children who are malnourished on admission, however further validation of adjusted cut-offs may be warranted.

STRONGkids is the most thoroughly investigated of the two screening tools. It has been found to have the best correlation with anthropometric measures[31] and chosen over other screening tools when compared[32]. However, similar to the findings of this study, STRONGkids has been shown to have poor specificity, ranging from 7.7-53%[22,33,34]. Teixeira *et al* argues sensitivity is more important than specificity when it comes to nutrition risk screening, as the only downside to over identification is exposing children to an in-depth nutrition assessment, which is better than the adjusted of missing a child who is malnourished[35]. However, excessive unnecessary referrals to a dietitian

could put stress on an already overburdened health care system, therefore both sensitivity and specificity must be considered when selecting a nutrition risk screening tool.

PNST is a more recent tool and has not, to our knowledge, been further validated beyond the original population. This study found it had poor sensitivity at only 58%, however this improved to 87% by adjusting the cut-offs. There was an associated decrease in specificity, but the number remained higher than STRONGkids. One major difference between PNST and STRONGkids is its omission of disease state, a category of nutrition screening recommended by the European Society for Enteral and Parenteral Nutrition (ESPEN)[36]. Despite this, the PNST performed better in the specialty medicine population, which include children admitted with underlying medical diagnoses such as cardiac, gastrointestinal, nephrotic, metabolic, and oncologic. In this population with the highest prevalence of malnutrition, both tools performed just as well, if not better, than they did in the population as a whole. Additionally, neither tool missed any child who was severely malnourished based on the SGNA. Despite its omission of disease state, PNST was able to identify malnutrition in high risk children who were admitted for chronic disease concerns. Overall the PNST with adjusted cut-offs has the strongest agreement with the SGNA for this population and should be considered for clinical use and further validation studies.

Another important finding is the association between not only malnutrition, but also nutrition risk and LOS. Similar to other studies[2,4,22,31] there was a significantly longer median LOS for those who were malnourished versus well nourished, and those who scored higher on the screens. Not only does malnutrition on admission impact LOS, but the inverse is true also. Days of hospital admission is an independent risk factor for

nutrition deterioration in children[37,38]. This presents a concerning cycle of worsening nutrition status and longer hospital stay. Further investigation into the nutrition status of children during their hospital stay including of weight changes, morbidity, mortality, readmission rates and effects of dietitian interventions is warranted.

This study compared two previously validated nutrition screening tools in a tertiary Canadian pediatric hospital and was able to validate alternate cut-off points for nutrition risk classification in this population. While further research is needed to validate these findings in a larger population, these results can be used to guide future research and clinical implementation. A limitation of this study is the use of a convenience sample, although limited exclusion criteria allowed for a sample that appears representative of the population studied. Only recruiting 51% of those eligible creates a potential recruitment bias as only those present in their room with a parent or guardian were approached to participate. Additional prospective validation including weight loss and clinical course in hospital were not assessed, but should be included in future studies in this population.

3.5 Conclusion

Nutrition risk screening has the potential to identify children who are malnourished on admission to hospital. Both STRONGkids and PNST were adapted to better fit this population by adjusting the cut-off values for nutrition risk. With adjusted cut-offs the PNST with had the strongest concurrent validity and interrater reliability, and is the most appropriate tool for clinical use in this population.

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Chapter 4: Conclusion and future direction

4.1 Summary of findings

4.1.1 Primary objectives

The primary aim of this thesis was to identify, assess and validate a pediatric nutrition screening tool appropriate for use in Alberta hospitals. Globally, five tools have been created specifically for a pediatric population, but there is a lack of evidence to support widespread use of one tool over the others[1-4]. Evaluation of the tools identified two appropriate for clinical use in Alberta; Pediatric Nutrition Screening Tool (PNST) and the Screening Tool for Risk on Nutrition Status and Growth (STRONGkids). The other tools were deemed too complex or took too long to be completed during the admission process. Comparing nutrition risk classification of both tools to the SGNA showed that neither STRONGkids nor PNST were able to identify children who were malnourished on admission with acceptable concurrent validity. To better meet the needs of the target population, the suggested cut-offs for nutrition risk were re-assessed and new adjusted cut-offs proposed for the screening tools. This adjustment increased the agreement of both tools to the Subjective Global Nutritional Assessment (SGNA) without affecting interrater reliability or association with length of stay (LOS). PNST had the most acceptable combination sensitivity and specificity, and the best overall agreement with the SGNA, suggesting it is the most appropriate tool for use in Alberta hospitals.

4.1.2 Secondary objectives

4.1.2.1 Prevalence of malnutrition

On medicine and surgery units at the Stollery Children's hospital, 29% of children were malnourished on admission based on the SGNA. Those admitted under specialty medicine programs (cardiac, oncologic, nephrology, metabolic, gastrointestinal) were three times more likely to be malnourished than those admitted to general medicine or surgery programs. The impact of disease on malnutrition is well documented[5], and treatment for disease versus non-disease related malnutrition is very different[6,7]. Early identification of malnutrition can allow for timely interventions to prevent further nutrition deterioration. An understanding of the prevalence and risk factors for malnutrition, specifically chronic diseases, will aid in the identification and management of children who are not only malnourished on admission, but those who may become malnourished during their hospital stay.

4.1.2.2 Length of stay

To assess prospective validity, LOS was used as an outcome measure. There was a significant association between higher scores on both screening tools and longer LOS. When using both the adapted and adjusted cut-offs, those identified as being malnourished had a significantly longer median LOS. Shorter hospital admissions benefit not only the patient, but the health care system. In adult populations, disease related malnutrition is associated with increased hospital costs when compared to patients who are well nourished[8]. Identifying malnutrition in children through a nutrition screening tool could have a positive impact on health care costs and provides support to advocate

for better nutrition care through multidisciplinary care including nutrition screening, assessment, and intervention.

4.2 Strengths and limitations

Almost one-third of children admitted to hospital are malnourished. The PNST with adjusted nutrition risk cut-offs was able to identify malnourished children on admission and identify those most likely to have longer hospital stays. Strengths of this study include being the first to compare to previously validated pediatric nutrition screening tools in a Canadian population and use of the SGNA as a more robust assessment of nutrition status than anthropometrics alone. This study is also not without its limitations. The rates of malnutrition in this population were previously unknown, and reported data is inconsistent, making sample size calculations challenging. Previous studies comparing two or more nutrition screening tools have sample sizes ranging from 42 to 2567 patients[2,9,10]. This study utilized a convenience sample, and only patients with guardians present were able to participate, creating a potential recruitment bias that could affect the reported prevalence of malnutrition. Future studies should focus on a single screening tool, the adjusted PNST, implemented into standard care to allow for a larger sample size and consecutive sampling.

4.3 Future direction: Creation of a nutrition care algorithm

4.3.1 Nutrition care algorithm

Identification of nutrition risk using a screening tool is the first step of nutritional management for children in hospital. A validated screening tool appropriate for use in Alberta has been identified, however management of patients after they have been identified must also be assessed for best practice. Standardization of care through

algorithms or care pathways have been shown to improve patient outcomes in adult populations[11]. The goal of nutrition care algorithms is to "support the detection, prevention and treatment of malnutrition" through a standardized approach to each step in the nutrition care pathway[12].

In pediatrics, there are few nutrition care algorithm's available[13]. ASPEN released a pediatric nutrition care pathway as part of its 2015 publication "Improve Patient Outcomes: ASPEN's step-by-step guide to addressing malnutrition"[14]. The pathway outlines the flow of care from screening to assessment, intervention, monitoring, evaluation and discharge. Continual re-assessment of nutrition status allows patients to move to different arms of the nutrition care algorithm, ensuring best care for patients at all times during their hospital admission.

The ASPEN care pathway provides a strong framework for creation of a more specific nutrition care algorithm for children admitted to Alberta hospitals, including use of the adjusted PNST as the first step in the care process followed by the SGNA for any child who is screened as being at nutrition risk. Figure 4.1 outlines a proposed pediatric nutrition care algorithm. The shaded box in the algorithm identify areas for future research, specifically how to manage children who are screened as at 'no nutrition risk' on admission, or those screened as 'at nutrition risk' who are then identified as well nourished by an SGNA. These children should not be left unmonitored as nutrition deterioration can occur quickly in hospital[15], however the best method of identifying changes in nutrition status is unknown. Monitoring oral intake, weight changes, and re-screening are potential methods of identifying changes in nutrition status during hospital admission.

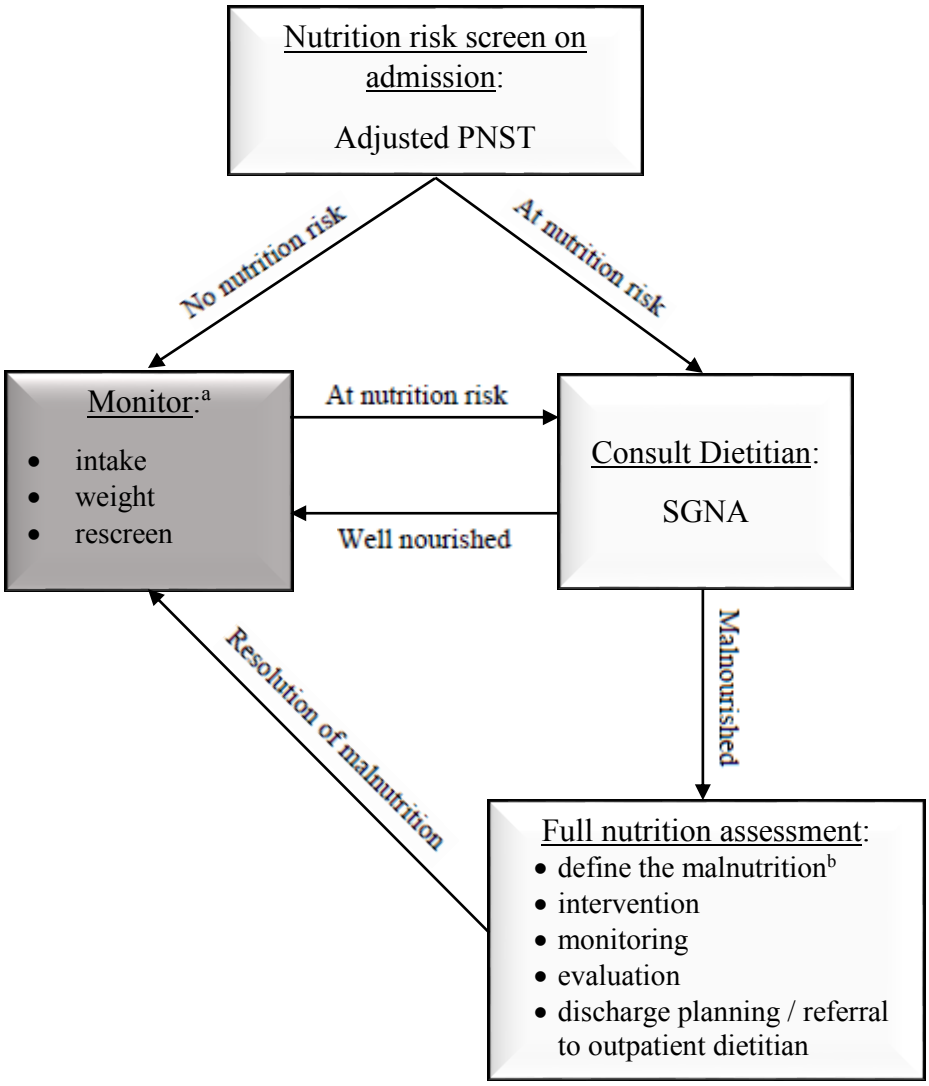

Figure 4.1. Proposed nutrition care algorithm for pediatric hospitals in Alberta
PNST, Pediatric Nutrition Screening Tool.
a, Future research is needed to determine frequency of nutrition monitoring and to create specific criteria for oral intake, weight loss, and rescreening to warrant reassessment of nutrition status.
b, Define malnutrition based on the five domains of anthropometrics, growth, chronicity, etiology, and functional outcomes[16].

4.3.2 Addressing barriers to oral intake

In children, oral food intake of less than 50% of estimated requirements is associated with moderate malnutrition and less than 25%, severe malnutrition[17]. If there is no routine monitoring of oral intake, a child on a regular diet who is not eating well may not be identified for further investigation despite being at nutrition risk. Once poor intake is identified, health care professionals must determine the cause before an intervention to improve intake can be created. In Canadian adult centres, research has been conducted to determine the barriers to oral intake in hospital, but there is limited data for children. Children have unique feeding issues not present in adults such as food neophobia, or fear of new and novel foods[18]. A recent study at the Stollery Children's Hospital (Appendix 6) reported children were often hungry between meals, had family members bring in food from home, and did not always want the food they ordered once it arrived. These findings highlight barriers to oral food intake not yet described in adult literature[19]. An understanding of the barriers affecting oral intake in children is needed to inform decisions around food service delivery and menu selections. Identification of children with barriers to oral intake and food intake monitoring throughout admission will allow for patients to be reclassified into the appropriate nutrition risk category and receive the proper care throughout their stay.

4.3.3 Weight monitoring

Weight monitoring is necessary to identify malnutrition as children are in a constant state of growth and development, therefore any period of weight loss is a potential indicator of malnutrition[17]. However studies have found that measurement of weight and height in children admitted to hospital are often done incorrectly, if at all[20].

Alberta Health Services created the *Childhood Growth Measurement Protocol* in 2015 to standardize growth measurement practices across all Alberta pediatric centres. The protocol includes how to measure weight, height, and head circumferences, the proper equipment needed, and how often measurements should be done[21]. Integration of this protocol into the nutrition care algorithm will provide guidance for clinicians monitoring children who were well nourished on admission. Future research is needed to determine how and when a child should be referred to a dietitian for assessment using the SGNA based on changes in weight.

4.3.4 Re-screening

Nutrition care algorithms attempt to identify children with nutrition deterioration through not only monitoring of intake and weight, but also re-screening for nutrition risk at set intervals throughout a patient's hospital stay. Unfortunately, most pediatric nutrition screening tools were created and validated only for use on admission to hospital, not specifically for use throughout hospital admission[22-26]. A validation study using a pediatric nutrition screening tools throughout admission to determine if the questions are applicable, and the appropriate time frame for re-screening, is warranted. For example, the PNST asks about poor weight gain in the past few months, and changes in intake in the past few weeks. The timeframes provided raise the question of whether this tool will be able to detect changes in weight and intake more acutely in hospital.

4.4 Conclusion

The aim of this thesis was to identify a nutrition screening tool appropriate for use in Alberta pediatric hospitals. Through a literature review and prospective single centre

study, the PNST with adjusted cut-offs was identified as the most appropriate tool for clinical use. It had the strongest association with true nutrition status (as measured through the SGNA), had acceptable interrater reliability, and was associated with LOS. Future research is needed to validate these findings in a larger population, to assess the tools ability to be used for re-screening, and determine correlations with other outcomes measures such as weight loss and overall clinical outcomes. The first step in a nutrition care algorithm for Alberta has been identified, future work should focus on determining best practice for the remaining steps in the algorithm after nutrition screening using the adjusted PNST.

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Appendix 1: PNRS

	Score
Pathology	
Mild (Grade 1)	0
Moderate (Grade 2)	1
Severe (Grade 3)	3
Pain	
No	0
Yes	1
Intake <50%	
No	0
Yes	1
Total score	

Score	Nutrition risk	Nutrition intervention
0	Low	• None
1-2	Moderate	• Assess food intake • Daily weights • Refer to a dietitian • Start oral nutritional support
3-5	High	• Measure ingested food precisely • Refer to a nutrition team • Consider enteral or parenteral nutrition support

Adapted from: Sermet-Gaudelus I, Poisson-Salomon A, Colomb V, Brusset M, Mosser F, Berrier F, *et al*. (2000). Simple pediatric nutritional risk score to identify children at risk of malnutrition. *Am J Clin Nutr.* 2000;72(1):64-70.

Appendix 2: STAMP

STAMP screening form

This form can be used to screen a child up to three times – please date, sign and initial the space at the bottom of this sheet every time you do so.

Step 1 – Diagnosis				
Does the child have a diagnosis that has any nutritional implications?	Score	1st screening	2nd screening	3rd screening
Definite nutritional implications	3			
Possible nutritional implications	2			
No nutritional implications	0			
Step 2 – Nutritional intake				
What is the child's nutritional intake?	Score	1st screening	2nd screening	3rd screening
No nutritional intake	3			
Recently decreased or poor nutritional intake	2			
No change in eating patterns and good nutritional intake	0			
Step 3 – Weight and height				
Use a growth chart or the centile quick reference tables to determine the child's measurements	Score	1st screening wt: ht:	2nd screening wt: ht:	3rd screening wt: ht:
> 3 centile spaces/≥ 3 columns apart (or weight < 2nd centile)	3			
> 2 centile spaces/= 2 columns apart	1			
0 to 1 centile spaces/columns apart	0			
Step 4 – Overall risk of malnutrition				
Add up the scores from the boxes in steps 1–3 to calculate the overall risk of malnutrition	Score	1st screening	2nd screening	3rd screening
High risk	≥4			
Medium risk	2–3			
Low risk	0–1			
Step 5 – Care plan				
What is the child's overall risk of malnutrition, as calculated in step 4?	Use management guidelines and/or local nutrition policies to develop a care plan for the child			
High risk	• Take action • Refer the child to a Dietitian, nutritional support team, or consultant • Monitor as per care plan			
Medium risk	• Monitor the child's nutritional intake for 3 days • Repeat the STAMP screening after 3 days • Amend care plan as required			
Low risk	• Continue routine clinical care • Repeat the STAMP screening weekly while the child is an in-patient • Amend care plan as required			

Please complete after each screening	Date	Signature	Initials
1st screening			
2nd screening			
3rd screening			

Child's name: _____

DOB: _____

Hospital no.: _____

Supported by an educational grant from Abbott Nutrition

Central Manchester University Hospitals NHS Foundation Trust

Screening tool for the assessment of malnutrition in paediatrics. http://www.stampscreeningtool.org/stamp.html. 2008. Retrieved May 2017.

Diagnosis table

To be used to assign a score for step 1 of STAMP

Screening Tool for the Assessment of Malnutrition in Paediatrics
STAMP

Definite nutritional implications	Possible nutritional implications	No nutritional implications
▪ Bowel failure, intractable diarrhoea ▪ Burns and major trauma ▪ Crohn's disease ▪ Cystic fibrosis ▪ Dysphagia ▪ Liver disease ▪ Major surgery ▪ Multiple food allergies/intolerances ▪ Oncology on active treatment ▪ Renal disease/failure ▪ Inborn errors of metabolism	▪ Behavioural eating problems ▪ Cardiology ▪ Cerebral palsy ▪ Cleft lip and palate ▪ Coeliac disease ▪ Diabetes ▪ Gastro-oesophageal reflux ▪ Minor surgery ▪ Neuromuscular conditions ▪ Psychiatric disorders ▪ Respiratory syncytial virus (RSV) ▪ Single food allergy/intolerance	▪ Day case surgery ▪ Investigations

- While every effort has been made to include diagnoses that have nutritional implications, this list is not exhaustive
- If you have any queries, please discuss them with a Dietitian

STAMP should be used in association with Trust referral guidelines and policies

Supported by an educational grant from Abbott Nutrition

Central Manchester University Hospitals NHS
NHS Foundation Trust

Screening tool for the assessment of malnutrition in paediatrics. http://www.stampscreeningtool.org/stamp.html. 2008. Retrieved May 2017.

Infant weight and height centile tables – boys

Weight centiles (kg)									
Age	0.4th	2nd	9th	25th	50th	75th	91st	98th	99.6th
Birth	2.17	2.5	2.83	3.16	3.5	3.84	4.17	4.5	4.84
2 months	3.95	4.3	4.7	5.12	5.56	6.05	6.55	7.2	7.65
4 months	5.15	5.5	6	6.5	7	7.55	8.15	8.75	9.4
6 months	5.9	6.35	6.85	7.4	7.94	8.55	9.2	9.85	10.6
8 months	6.45	6.9	7.45	8	8.6	9.26	9.95	10.65	11.45
10 months	6.85	7.3	7.9	8.5	9.2	9.8	10.6	11.45	12.2
12 months	7.2	7.7	8.3	8.95	9.65	10.4	11.2	11.95	12.9
14 months	7.5	8.1	8.7	9.37	10.1	10.9	11.7	12.6	13.5
16 months	7.85	8.4	9.1	9.75	10.5	11.4	12.2	13.2	14.05
18 months	8.1	8.7	9.4	10.1	10.95	11.8	12.7	13.7	14.7
20 months	8.4	9	9.75	10.5	11.35	12.3	13.2	14.15	15.25
22 months	8.7	9.4	10.1	10.9	11.75	12.7	13.7	14.7	15.9
24 months	9	9.7	10.4	11.3	12.1	13.1	14.2	15.3	16.4
Height centiles (cm)									
Age	0.4th	2nd	9th	25th	50th	75th	91st	98th	99.6th
Birth	44.8	46.1	47.9	49.5	51	52.5	54.1	55.9	57.1
2 months	53.1	54.5	55.8	57.1	58.4	59.8	61.1	62.5	63.7
4 months	58.3	59.5	61.1	62.5	63.9	65.3	66.7	68	69.4
6 months	62	63	64.8	66.2	67.6	69.1	70.5	72	73.3
8 months	64.7	66	67.6	69.1	70.6	72.1	73.5	75	76.5
10 months	67.2	68.5	70.2	71.7	73.3	74.8	76.4	77.8	79.3
12 months	69.5	70.8	72.5	74.1	75.8	77.3	78.9	80.5	82
14 months	71.5	73	74.8	76.4	78.1	79.7	81.4	83	84.6
16 months	73.4	75	76.8	78.5	80.2	82	83.6	85.5	87
18 months	75	76.8	78.6	80.4	82.2	84.1	85.8	87.8	89.5
20 months	76.8	78.5	80.5	82.3	84.2	86.1	87.9	89.8	91.6
22 months	78.3	80	82.1	84.1	86	88	89.9	92	93.8
24 months	79	81	83	85.1	87.1	89.2	91	93.5	95.3

Supported by an educational grant from Abbott Nutrition

Central Manchester University Hospitals NHS
NHS Foundation Trust

Screening tool for the assessment of malnutrition in paediatrics. http://www.stampscreeningtool.org/stamp.html. 2008. Retrieved May 2017.

Infant weight and height centile tables – girls

Screening Tool for the Assessment of Malnutrition in Paediatrics
STAMP

Weight centiles (kg)									
Age	0.4th	2nd	9th	25th	50th	75th	91st	98th	99.6th
Birth	2.1	2.4	2.7	3.04	3.36	3.68	4	4.3	4.6
2 months	3.6	3.9	4.3	4.7	5.12	5.6	6.1	6.6	7.2
4 months	4.6	5	5.45	5.9	6.45	6.98	7.6	8.2	8.9
6 months	5.3	5.7	6.2	6.73	7.3	7.94	8.6	9.3	10.1
8 months	5.8	6.2	6.75	7.32	7.95	8.64	9.4	10.2	11
10 months	6.2	6.6	7.2	7.8	8.47	9.2	10	11	11.8
12 months	6.5	7	7.6	8.25	8.95	9.72	10.6	11.5	12.5
14 months	6.85	7.3	8	8.65	9.4	10.2	11.1	12.1	13.2
16 months	7.2	7.9	8.35	9	9.8	10.7	11.6	12.7	13.8
18 months	7.5	8	8.7	9.4	10.2	11.1	12.1	13.2	14.4
20 months	7.8	8.3	9	9.8	10.65	11.6	12.6	13.8	15
22 months	8.1	8.7	9.4	10.2	11.1	12	13.1	14.3	15.6
24 months	8.35	9	9.75	10.6	11.5	12.5	13.6	14.9	16.2
Height centiles (cm)									
Age	0.4th	2nd	9th	25th	50th	75th	91st	98th	99.6th
Birth	44.7	46	47.3	48.6	50	51.3	72.7	54	55.3
2 months	51.6	53	54.3	55.7	57	58.5	59.8	61.1	62.5
4 months	56.3	57.5	59.2	60.6	62.1	63.5	65	66.5	67.9
6 months	59.7	61	62.7	64.2	65.7	67.3	68.8	70.3	71.7
8 months	62.5	64	65.6	67.1	68.8	70.3	71.9	73.5	75
10 months	65	66.5	68.2	69.8	71.5	73.2	74.8	76.4	78
12 months	67.1	69.5	70.5	72.3	74	75.7	77.4	79.2	80.8
14 months	69.3	71	72.8	74.6	76.4	78.2	80	81.7	83.5
16 months	71.3	73	74.8	76.7	78.6	80.5	82.4	84.2	86
18 months	73	75	76.8	78.7	80.7	82.7	84.6	87	88.5
20 months	74.8	76.5	78.6	80.7	82.7	84.7	86.7	88.7	90.6
22 months	76.3	78.3	80.5	82.5	84.6	86.7	88.8	91	92.8
24 months	77.2	78.9	81.3	83.5	85.7	87.9	90	92.5	94.3

Supported by an educational grant from Abbott Nutrition

Central Manchester University Hospitals NHS
NHS Foundation Trust

Screening tool for the assessment of malnutrition in paediatrics. http://www.stampscreeningtool.org/stamp.html. 2008. Retrieved May 2017.

Child weight and height centile tables – boys

Weight centiles (kg)									
Age	0.4th	2nd	9th	25th	50th	75th	91st	98th	99.6th
2 years	9	9.7	10.4	11.25	12.2	13.14	14.2	15.3	16.4
2.5 years	9.75	10.5	11.4	12.3	13.3	14.4	15.6	16.9	18.1
3 years	10.4	11.2	12.2	13.2	14.3	15.5	16.9	18.3	19.9
3.5 years	11.1	12	13	14.1	15.3	16.7	18.1	19.9	21.4
4 years	12.4	13.3	14.2	5.3	16.5	17.9	19.4	21.1	23
4.5 years	13.1	14	15.1	16.2	17.6	19	20.7	23	24.6
5 years	13.9	14.9	16	17.2	18.6	20.2	22	24.1	26.5
5.5 years	14.6	15.5	16.8	18.1	19.7	21.5	23.5	26	29
6 years	15.4	16.5	17.7	19.1	20.8	22.7	25	27.8	30.7
6.5 years	16.1	17	18.5	20.1	21.9	24	26.5	29.5	33
7 years	17	18	19.5	21.1	23.1	25.4	28	31.9	35.5
7.5 years	17.6	19	20.5	22.2	24.3	27	30	34	38.7
8 years	18.5	19.5	21.5	23.3	25.6	28.4	32	36.5	42
8.5 years	19.4	20.5	22.5	24.5	27.0	30	34	39	45.8
9 years	20.2	21.8	23.5	25.7	28.4	31.8	36	42	49.5
9.5 years	21	22.5	24.6	27	29.8	33.5	38.3	44.5	53
10 years	22	23.5	25.8	28.3	31.4	35.3	40.5	47	57
10.5 years	23	24.8	27	29.7	33.0	37.2	42.8	50	60.5
11 years	24	26	28.2	31	34.6	39	45	53	64
11.5 years	24.8	27	29.4	32.5	36.3	41	47.5	55.5	67
12 years	25.8	28	30.8	34	38.1	43.2	50	58	70
12.5 years	27	29.5	32.5	36	40.4	46	53	61.5	73
13 years	28	31	34.3	38.1	43.0	49	56	65	76
13.5 years	29.8	33	36.5	40.8	46.0	52.3	60	69	80
14 years	31.5	35	39	43.6	49.2	56	63.5	73	84.5
14.5 years	33.5	37	41.5	46.5	52.3	59.5	67.5	77	88.5
15 years	35.5	39.5	44	49.1	55.4	62.7	71	81	92.5
15.5 years	38	42	46.7	52	58.1	65.5	74	84	95.5
16 years	40.5	44.7	49	54.5	60.6	68	76	86	97
16.5 years	43	47	51.5	56.5	62.6	69.5	77.7	87	98
17 years	45	49	53.2	58.3	64.3	71	79	88.1	99
17.5 years	46.5	50	54.7	60	65.7	72.5	80	89	100
18 years	48	52	56	61	66.7	73.5	81	90	101
Height centiles (cm)									
Age	0.4th	2nd	9th	25th	50th	75th	91st	98th	99.6th
2 years	79	81	83	85.1	87.1	89.2	91.2	93.5	95.3
2.5 years	83	85	87.4	89.6	91.9	94.2	96.5	99	101
3 years	86.1	88.5	91	93.6	96.1	98.6	101	103.5	106
3.5 years	89.2	92	94.5	97.2	99.9	102.5	105.1	108	110.5
4 years	91.5	95.5	97	99.7	102.5	105.2	108	111	113.5
4.5 years	94.5	97.5	100.3	103.1	106.0	108.9	111.8	115	117.5
5 years	97.5	100.5	103.5	106.5	109.6	112.5	115.7	119	121.8
5.5 years	100	103	106	109.2	112.4	115.5	118.5	122	124.8
6 years	103	106	109.5	112.6	115.9	119.2	122.5	126	129
6.5 years	105.5	109	112	115.5	118.9	122.3	125.5	129.3	132.2
7 years	108	113	115	118.5	121.9	125.4	129	132.5	135.8
7.5 years	111	114	118	121.3	124.9	128.5	132	136	139.5
8 years	113.5	117	120.5	124	127.9	131.5	135	139	142.5
8.5 years	116	119	123	127	130.6	134.5	138.2	142	145.5
9 years	118	122	125.5	129.4	133.3	137.2	141	145	149
9.5 years	120	124	128	131.8	135.8	140	144	148	152
10 years	122	126	130	134.3	138.4	142.5	146.8	151	155
10.5 years	124	128	132.5	136.7	141.0	145.3	149.5	154	158
11 years	126	130	134.5	139	143.4	148	152.5	157	161
11.5 years	127.5	132	136.5	141	145.8	150.5	155	160	164
12 years	129.5	134	139	143.5	148.4	153	158	163	167.5
12.5 years	131.5	136.5	141.5	146.5	151.4	156.5	161.5	166.5	171.5
13 years	134	139	144.5	149.5	154.8	160	165	170.5	175.5
13.5 years	137	142.5	147.5	153	158.6	164	169.5	175	180
14 years	140	146	151	156.7	162.4	168	173.5	179	184.5
14.5 years	144	149.5	155	160.2	165.9	171.5	177	182.5	188
15 years	147.5	153	158	163.5	168.9	174.5	180	185.5	190.5
15.5 years	150.1	156	161	166	171.4	176.7	182	187.5	192.5
16 years	153	158	163	168.3	173.4	178.5	183.5	189	194
16.5 years	155	159	165	169.8	174.8	179.7	184.6	189.3	194.2
17 years	156.7	161	166.3	171	175.9	180.7	185.5	190.2	195
17.5 years	157.5	162	167	171.8	176.6	181.5	186	190.6	195.2
18 years	158.5	163	167.5	172.4	177	181.8	186.5	191	195.5

Supported by an educational grant from Abbott Nutrition

Central Manchester University Hospitals NHS
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Screening tool for the assessment of malnutrition in paediatrics. http://www.stampscreeningtool.org/stamp.html. 2008. Retrieved May 2017.

Child weight and height centile tables – girls

Weight centiles (kg)									
Age	0.4th	2nd	9th	25th	50th	75th	91st	98th	99.6th
2 years	8.3	9	9.8	10.6	11.5	12.5	13.5	14.9	16.1
2.5 years	9.1	10	10.8	11.7	12.8	13.9	15	16.4	18
3 years	10	10.8	11.75	12.7	13.9	15	16.5	18	20
3.5 years	10.7	11.6	12.6	13.8	15.0	16.2	18	19.8	21.9
4 years	11.2	12.2	13.3	14.5	16.0	17.6	19.4	21.5	23.9
4.5 years	12.7	13.7	14.7	15.8	17.2	18.9	20.8	22.9	25.3
5 years	13.2	14.2	15.5	16.9	18.3	20	22	24.5	27.2
5.5 years	14	15	16.2	17.7	19.4	21.3	23.5	26	29.5
6 years	14.5	15.8	17	18.7	20.5	22.5	25	28	32
6.5 years	15.4	16.5	18	19.7	21.7	24	26.8	30	34
7 years	15.8	17.5	19	20.8	23.0	25.5	28.5	32.5	37
7.5 years	17	18.5	20	22	24.4	27.3	30.5	35	40.5
8 years	18	19	21	23.3	25.9	29	33	37.7	44
8.5 years	18.5	20	22.2	24.5	27.4	30.8	35	40	47.5
9 years	19.5	21.5	23.5	26	28.9	32.5	37	43	51
9.5 years	20.5	22.5	24.5	27.2	30.6	34.5	39.5	46	55
10 years	21.5	23.5	26	28.8	32.3	36.8	42	49	59
10.5 years	22.2	24.5	27	30.2	34.1	39	45	52	62
11 years	23	25.5	28.5	32	36.0	41	47.2	55	66
11.5 years	24.2	27	30	33.5	38.1	43.5	50	58	69
12 years	25.5	28.5	31.8	35.7	40.3	46	52.5	61	71
12.5 years	27.2	30	34	38	42.8	48.4	55	63	73
13 years	29.2	32.5	36	40.3	45.4	51	58	65.5	75
13.5 years	31.2	34	38.5	43	47.9	53.5	60	68	77
14 years	33.3	36.5	40.5	45	50.1	56	62.5	70	79
14.5 years	35	38.5	42.5	47	51.9	57.5	64	72	81
15 years	37	40	44	48.4	53.4	59	66	73.5	82
15.5 years	38	41.5	45	49.5	54.6	60.3	67	74.5	84
16 years	39	42.5	46	50.5	55.5	61.5	68	76	85
16.5 years	39.8	43	47	51.3	56.2	62	68.8	76.5	86
17 years	40.4	43.6	47.3	51.8	56.9	62.6	69.3	77	87
17.5 years	40.5	44	47.9	52.2	57.2	63	70	78	87
18 years	40.9	44	48	52.3	57.5	63.5	70.5	78	88
Height centiles (cm)									
Age	0.4th	2nd	9th	25th	50th	75th	91st	98th	99.6th
2 years	77.2	79	81.4	83.5	85.7	87.9	90	92.5	94.4
2.5 years	81.4	83.7	86	88.3	90.7	93.1	95.5	98	100
3 years	85	87.5	90	92.5	95.0	97.6	100.2	103	105
3.5 years	88.3	91	93.5	96.3	99.0	101.8	104.5	107.5	110
4 years	91	93	96.1	98.8	101.5	104.3	107	110	112.4
4.5 years	93.7	96.5	99.5	102.3	105.2	108	110.8	113.5	116.5
5 years	97	100	103	106	108.9	112	115	118	120.5
5.5 years	100	103	106	109	112.2	115.4	118.5	122	124.8
6 years	102.5	105	109	112	115.3	118.6	122	125	128
6.5 years	105	108	111.7	115	118.3	121.7	125	128.5	131.8
7 years	107.5	111	114.2	117.8	121.3	124.8	128	131.5	135
7.5 years	110	113	117.3	120.7	124.3	128	131.5	135	138.5
8 years	113	116.5	120	123.7	127.3	131	134.8	138	142
8.5 years	115	119	122.7	126.5	130.1	134	137.7	141.5	145
9 years	117	121	125	129	132.8	136.7	140.5	144.5	148.5
9.5 years	119.5	122.5	127.5	131.5	135.6	139.7	144	148	152
10 years	121.5	126	130	134	138.4	142.7	147	151	155.5
10.5 years	123.5	128	132.5	137	141.3	145.8	150	154.5	159
11 years	125.5	130	135	139.5	144.1	148.8	153.2	158	162.2
11.5 years	128	133	137.5	142	146.9	151.8	156.2	161	166
12 years	131	135	140	145	149.8	154.5	159	164	169
12.5 years	133.5	138.5	143	147.9	152.6	157.5	162	167	171.5
13 years	137	141.5	146	150.7	155.3	160	164.5	169	174
13.5 years	140	144	148.7	153	157.7	162	167	171	175.8
14 years	142	146.5	151	155	159.6	164	168.5	173	177
14.5 years	144	148.5	152.7	157	161.1	165.5	169.8	174	178
15 years	146	149	154	158	162.2	166.5	170.5	175	179
15.5 years	146.5	150.5	154.7	158.7	162.9	167	171	175	179.5
16 years	147	151	155	159	163.2	167.2	171.5	175.5	180
16.5 years	147.5	151	155.3	159.3	163.5	167.5	171.5	175.5	179.5
17 years	147.5	151	155.3	159.4	163.5	167.5	171.5	175.5	179.5
17.5 years	147.5	151	155.3	159.4	163.5	167.5	171.5	175.5	179.5
18 years	147.5	151	155.3	159.4	163.5	167.6	171.5	175.5	179.5

Supported by an educational grant from Abbott Nutrition

Central Manchester University Hospitals NHS Foundation Trust

Screening tool for the assessment of malnutrition in paediatrics. http://www.stampscreeningtool.org/stamp.html. 2008. Retrieved May 2017.

Appendix 3: PYMS

Paediatric Yorkhill Malnutrition Score (PYMS)

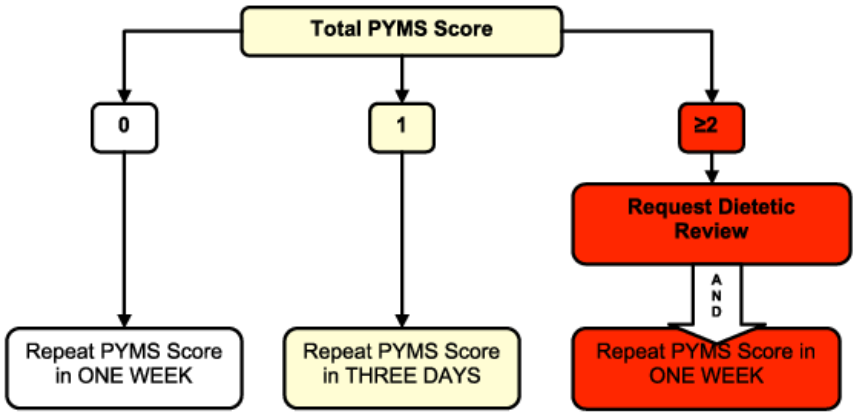
NHS Greater Glasgow and Clyde

Name:		**Hospital No:**	**Date**			
Surname:		**CHI:**	**Nurse Signature**			
DoB:			**Weight**			
Age:		**Sex: F / M**	**Height**			
Ward:		**Consultant:**	**BMI**			
Step 1	**Is the BMI below the cut-off value in the table overleaf?**	NO	**0**			
		YES	**2**			
Step 2	**Has the child lost weight recently?**	NO	**0**			
		YES • Unintentional weight loss • Clothes looser • Poor weight gain (if <2yrs)	**1**			
Step 3	**Has the child had a reduced intake (including feeds) for at least the past week?**	NO Usual intake	**0**			
		YES Decrease of usual intake for at least the past week	**1**			
		YES No intake (or a few sips of feed only) for at least the past week	**2**			
Step 4	**Will the child's nutrition be affected by the recent admission/condition for at least the next week?**	NO	**0**			
		YES For at least the next week • Decreased intake and/or • Increased requirements and/or • Increased losses	**1**			
		YES No intake (or a few sips of feed only) for at least the next week	**2**			
Step 5	**Calculate total score** (total of steps 1-4)	**Total PYMS Score**				

PYMS must be completed by a registered nurse

Paediatric Yorkill Malnutrition Score: Information and user's guide. http://www.knowledge.scot.nhs.uk/media/2592959/pyms%20user%20and%20info%20guide.pdf. 2009. Retrieved May 2017.

PYMS Dietetic Management Pathway



****NB: Regardless of PYMS score if you have any nutritional concerns about this patient please refer to dietitians following initial screening.****

Body Mass Index (BMI) Scoring Guide

(If the BMI calculated is less than that shown for age and gender, answer Yes for Step 1)

Age (years)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Boys	15.0	14.5	14.0	13.5	13.5	13.5	13.5	13.5	13.5	14.0	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.0
Girls	15.0	14.0	13.5	13.5	13.0	13.0	13.0	13.0	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.0

Notes – Comments

	Date: ___/___/_____	Date: ___/___/___	Date: ___/___/___
Nursing Comments (including reason unable to complete PYMS step)			
Health Professional Request made to:	Dietitian □ Dentist □ SALT □ Other □ Specify……	Dietitian □ Dentist □ SALT □ Other □ Specify……	Dietitian □ Dentist □ SALT □ Other □ Specify……
Health Professional Comments			

Paediatric Yorkill Malnutrition Score: Information and user's guide. http://www.knowledge.scot.nhs.uk/media/2592959/pyms%20user%20and%20info%20guide.pdf. 2009. Retrieved May 2017.

Appendix 4: STRONGkids

Subjective Clinical Assessment (1 point)

Is the patient in a poor nutritional status judged by subjective clinical assessment (diminished subcutaneous fat and/or muscle mass and/or hollow face)?

High risk disease (2 points)

Is there an underlying illness with a risk of malnutrition or expected major surgery?

Nutrition intake and losses (1 point)

Are one of the following items present?
Excessive diarrhea (5x/day) and/or vomiting (3x/ day) the last few days?
Reduced food intake during the last few days before admission (not including fasting for an elective procedure or surgery)?
Pre-existing dietetically advised nutritional intervention?
Inability to consume adequate intake because of pain?

Weight loss or no weight gain (1 point)

Is there weight loss or no weight gain (infants < 1 year) during the last few weeks/months?

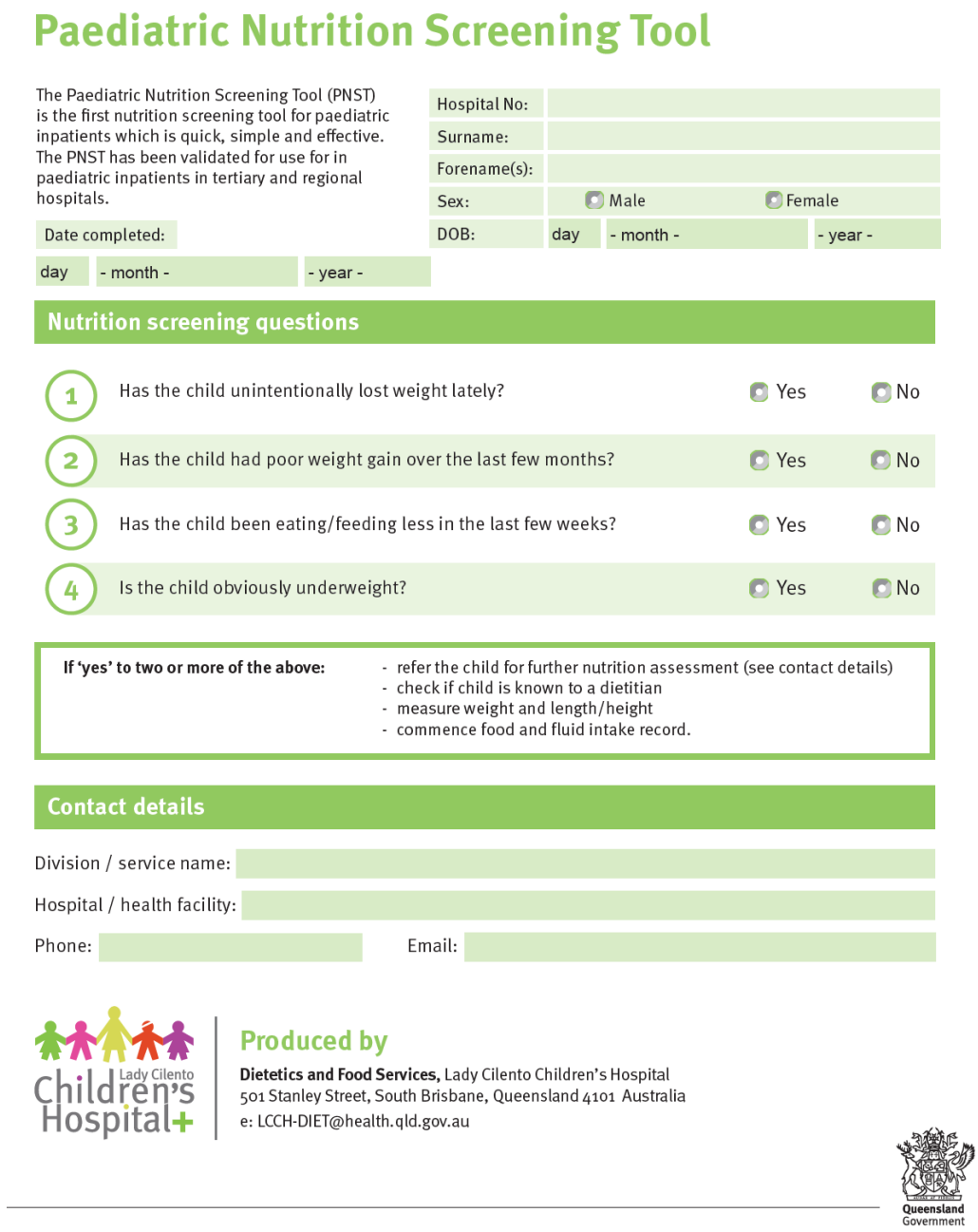
High risk disease

- Anorexia nervosa
- Burns
- Bronchopulmonary dysplasia (maximum age 2 years)
- Celiac disease
- Cystic fibrosis
- Dysmaturity/prematurity (corrected age 6 months)
- Cardiac disease
- Chronic Infectious disease
- Inflammatory bowel disease
- Cancer
- Liver disease
- Chronic Kidney disease
- Chronic Pancreatitis
- Short bowel syndrome
- Muscle disease
- Metabolic disease
- Trauma
- Mental handicap/retardation
- Expected major surgery
- Not specified (classified by doctor)

Points	Risk	Intervention and folloq-up
4-5	High	Consult doctor and dietician for full diagnosis and individual nutritional advice and follow-up. Start prescribing sip feeds until further diagnosis
1-3	Medium	Consult doctor for full diagnosis; consider nutritional intervention with dietician. Check weight twice a week and evaluate the nutritional risk after one week
0	Low	No intervention necessary. Check weight regularly conform hospital policy and evaluate the nutritional risk after one week

Adapted from: Hulst JM, Zwart H, Hop WC, Joosten KM. Dutch national survey to test the STRONGkids nutritional risk screening tool in hospitalized children. *Clin Nutr.* 2010;29(1):106-111.

Appendix 5: PNST



Paediatric Nutrition Screening Tool

The Paediatric Nutrition Screening Tool (PNST) is the first nutrition screening tool for paediatric inpatients which is quick, simple and effective. The PNST has been validated for use for in paediatric inpatients in tertiary and regional hospitals.

Date completed: day - month - - year -

Hospital No:
Surname:
Forename(s):
Sex: Male Female
DOB: day - month - - year -

Nutrition screening questions

1	Has the child unintentionally lost weight lately?	Yes	No
2	Has the child had poor weight gain over the last few months?	Yes	No
3	Has the child been eating/feeding less in the last few weeks?	Yes	No
4	Is the child obviously underweight?	Yes	No

If 'yes' to two or more of the above:
- refer the child for further nutrition assessment (see contact details)
- check if child is known to a dietitian
- measure weight and length/height
- commence food and fluid intake record.

Contact details

Division / service name:
Hospital / health facility:
Phone: Email:

Lady Cilento Children's Hospital

Produced by

Dietetics and Food Services, Lady Cilento Children's Hospital
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e: LCCH-DIET@health.qld.gov.au

Queensland Government

Pediatric Nutrition Screening Tool. Queensland Government. Children's Health Queensland Hospital and Health Service. https://www.childrens.health.qld.gov.au/chq/health-professionals/paediatric-health-resources/nutrition-screening-tool/. 2017. Retrieved May 2017.

Appendix 6: Barriers to oral food intake for children admitted to hospital

Barriers to oral food intake for children admitted to hospital

Laura E Carter, Natalie Klatchuk, Kyla Sherman, Paige Thomsen, Vera C. Mazurak, M. Kim BrunetWood

Abstract

Children are at risk for malnutrition in hospital, and a contributing factor may be poor oral intake. Barriers to intake have been studied in adults, but there is a lack of research in children. The purpose of this study was to identify the potential barriers to oral intake for children in hospital. Patients and families (n=58) admitted to surgery and medicine units at The Stollery Children's Hospital completed a survey on barriers to oral food intake. Barriers were classified into six domains and major barriers were those identified by at least 30% of the population. On average each patient was affected by 22% of the barriers. Within each domain, the proportion of patients identifying at least one barrier were as follows; organization (74%), hunger (67%), quality (60%), effects of illness (53%), choice (38%) and physical limitations (29%). Having food brought in from home due to hunger, not wanting what was ordered once it arrives, food quality, decreased appetite, sickness, and pain were identified as major barriers. Children have unique barriers to oral food intake in hospital which have not been previously identified. Food service models should consider these barriers to better meet the needs of this population.

Introduction

The prevalence of malnutrition in children admitted to hospital is reported to range from 20-50% [1-4]. Weight loss can occur in over half of the children during their stay [5]. The presence of malnutrition is associated with increased morbidity, mortality, and increased length of hospital stay, therefore this is an important health and economic issue [1, 6-9]. Many factors contribute to the development of malnutrition such as increased requirements, nutrient malabsorption, metabolic dysregulation, and decreased energy intake [10]. Food intake less than 50% of estimated needs has been linked to increased risk of malnutrition in hospitalized children [6, 7].

Barriers to intake for hospitalized adults have been identified [11], however it is unknown if the same barriers apply in children. Naithani *et al* [12] validated a survey to assess barriers to oral intake in hospitalized adults. The survey was able measure barriers to food access with satisfactory psychometric properties including construct and criterion validity. The survey has since been adapted to a Canadian setting [11]. The survey categorizes barriers to oral food intake into six domains; food quality, hunger, choice, organization, physical limitations, and effects of illness. To our knowledge, there is no validated survey for a pediatric setting. Identifying barriers to adequate oral intake in pediatric populations is an important step in managing pediatric malnutrition. The aim of this study was to identify the barriers to oral food intake in hospitalized pediatric patients and determine any relationship between the barriers and patient characteristics.

Methods

This was a prospective, single centre observational study of patients admitted to medicine and surgery units at the Stollery Children's Hospital, Alberta, Canada from January to February 2017. The study was approved by the Human Research Ethics Board at the University of Alberta and legal guardians gave informed consent. For mature minors, assent was provided with a separate form. A previously validated survey was completed by a convenience sample of the patients and their family [12]. The survey had 38 Likert scale style questions with four options, two negative and two positive, to choose from (e.g. strongly agree, agree, disagree, strongly disagree or every meal/day, most meals/days, some meals/days, never).

Patients were included if they were one to sixteen years of age, admitted for a minimum of 72 hours, and receiving a food tray from the hospital kitchen. Exclusion criteria included children that were terminally ill, non-English speaking, or on nutrition support. The patient and their family had the option of completing the survey independently or to have it read to them by the researcher. For patients too young to understand the survey and answer independently, a family member completed the survey on their behalf. Patient age, gender, unit type, reason for admission, length of stay (LOS) prior to survey, total LOS, dietary restrictions, and number of medications were collected from patient charts.

Survey answers were dichotomized as being either "affected by" or "not affected by" upon analysis. If the question was negatively worded (i.e. I did not receive the food I ordered) and the patient answered on the positive side of the scale, they were affected by that barrier. If the question was worded positively (i.e. meals are served at times that suit

me) and the patient answered on the positive side, they were not affected by that barrier. Based on previous research with the same survey [11], if 30% or more of patients were affected by a barrier it was considered to be a major barrier. The percent of patients who identified at least one barrier within each domain was calculated to determine the most prevalent domains affecting the population.

Due to the nonparametric nature of the data, categorical variables were expressed as frequency and percentage. Association between the barrier domains and patient demographics was assessed using Pearson's Chi-squared and Spearman's rank correlation. Total LOS, LOS prior to survey, and number of medications were reported as continuous data. Unit type, gender, and dietary restrictions were dichotomized into two categories for analysis. Age was analyzed as both a continuous and categorical data. Reason for admission was recorded but unable to be analyzed due to large variation in answers and low sample size. A P-value of <0.05 was considered statistically significant. SPSS for Windows version 24 (IBM Corp, 2016, Armonk, NY: IBM Corp) was used for the statistical analysis.

Results

One hundred and forty two patients met inclusion criteria on the days of data collection. Of those, 58 (41%) participated. Thirteen declined and 71 were unavailable or had no guardian present. Patient demographics are found in Table 1. Seven patients completed the survey independently, thirty four completed it with their guardian's assistance, and seventeen had the researcher conduct the survey.

On average, each patient was affected by 8 out of a possible 37 barriers (22%). Only two patients reported no barriers, and one was affected by 27 barriers (71%). The domain with the highest number of negative responses was organization with 74% of all patients identifying at least one barrier in this domain, followed by the domains of hunger (67%), quality (60%), effects of illness (53%), choice (38%) and physical limitations (29%). Details of the survey responses are found in Table 2.

All domains except choice and physical limitations had at least one major barrier. Within the organization domain, not wanting what was ordered (33%) and missing meals because of disliking the food (45%) were the most common. In the domain of hunger, "*my visitors bring in food for me because I am hungry*" was the most prevalent barrier, with 60% of participants identifying it. Taste (43%), appearance (34%), and smell (33%) were major barriers in the quality domain. Within the illness domain, loss of appetite (50%), sickness (34%), pain (31%) and fatigue (36%) all affected the population.

Table 1: Patient demographics

Gender	
Male	30(52)
Female	28 (48)
Ward	
Surgery	29 (50)
Medicine	29 (50)
Reason for admission	
Orthopedic surgery	11 (19)
Respiratory illness	9 (15)
Neurological surgery	8 (14)
General surgery	7 (12)
Neurology	7 (12)
Gastrointestinal	5 (9)
Other	11 (19)
Dietary Restrictions	10 (17)
Age (years)	11 (1-15)
LOS prior to survey (days)	5 (3-40)
Total LOS (days)	6 (3-41)
Number of medications	5.5 (0-13)

LOS, Length of Stay
Values are presented as n (%) or mean (range)

Table 2: Prevalence of meal time barriers within each domain

Choice	n (%)
I understand how to complete the menu selection sheet	2 (3)
I have been able to choose foods that I like or prefer	8 (14)
Choosing the right food is difficult because there isn't enough information on the menu	13 (22)
Meals are served at times that suit me	8 (14)
Organization	
When the food arrives, I always want what I have ordered	19 (33)*
I did not receive the food that I ordered	7 (12)
When I was eating I was disturbed by activities, noises or unpleasant smells	14 (24)
My mealtimes were interrupted by the staff wanting to speak to me or give me treatment	9 (16)
I missed my meals because I did not like the food	26 (45)*
I missed my meals because I was not available when they were served	5 (9)
I missed meals because I had to avoid food for tests	5 (9)
When I missed my meals, I was given hospital food by staff	11 (19)
When I needed help, I got the help I needed to eat my meals	5 (9)
Hunger	
My visitors bring in food for me because I am hungry	35 (60)*
I get hungry because the time between meals is too long	13 (22)
I felt hungry but I could not ask staff for food	6 (10)
I felt hungry and wanted something to eat but no food was available from the hospital	5 (9)
Physical limitations	
Difficulty reaching my food	8 (14)
Difficulty cutting up my food	10 (17)
Difficulty opening packets/ unwrapping food	8 (14)
Difficulty feeding myself	8 (14)
Not enough time to eat all the food that I wanted to eat	1 (2)
I need help to eat my meals	1 (2)
Quality	
Taste	25 (43)*
Appearance	20 (34)*
Smell	19 (33)*
Portion Size	8 (14)
Temperature of food.	7 (12)
Illness	
Loss of appetite/ didn't feel like eating	29 (50)*
Sickness	20 (34)*
Pain	18 (31)*
Fatigue	21 (36)*
Worry	3 (5)
Depressed	4 (7)
Breathing difficulties	4 (7)
Chewing or swallowing or sucking difficulties	6 (10)
Irritability	6 (10)
Nausea/ vomiting	11 (19)

* ≥ 30% considered a major barrier

Patients admitted to the surgery unit were more likely than those admitted to medicine unit to be affected by organization (P = 0.04), physical limitations (p = 0.04), and quality barriers (p = 0.02). Patients over 11 years of age were significantly more affected by the quality of the food than those under 11 years (p = 0.05), and females were more likely to be affected by their illness than male patients (p = 0.03). There were no significant associations between number of medications, LOS prior to survey, total LOS, or dietary restrictions (data not reported).

Discussion

The most common barriers were hunger, necessitating bringing food from home and food quality, specifically taste, smell, and appearance. Multiple factors can affect a patient's perception of food, especially in children. There are feeding problems unique to children that may not be relevant in an adult population, for example food neophobia, or a fear of new or novel foods [13]. Neophobic reactions to food result in new foods being rejected on sight and can significantly decrease intake of nutrient dense foods [14, 15]. Implementing opportunities to choose foods between meals, at the time of hunger, may be a key strategy to improve oral intake. Pantalos and Bishop [16] describe a patient-centered snack delivery system that was implemented at a children's hospital. A cart that stocked nutritious snacks was circulated three times daily through inpatient units, offering a variety of fresh and prepackaged items. After implementation of this system, the patient's consumption of snacks increased from 50% to 84%. Success of this service was attributed to the ability to make a choice at the time of food consumption. In a similar study, White et al [17] found 75% of children/families believed a snack cart with both

savory and sweet items operated around mid-afternoon improved food service satisfaction.

One third of patients reported not wanting the food they ordered when it arrived. The food service model currently used at the study site is a traditional style which requires menu item selection one day in advance of meal tray delivery. Making a meal choice over 24 hours before the meal arrives may contribute to dissatisfaction with food choices. This issue could be heightened in children whose parents are making the choices for them. There is a need for flexible, responsive food service delivery to improve satisfaction with meal choices and improve overall oral intake [18]. Alternative service methods such as room service models, have recently become more common. Multiple studies reported improvement in overall calorie intake and meal time satisfaction using room service delivery as compared to traditional service styles [19-21]. However room service models are not without limitations. Room service models allow for more choices resulting in a diet that may not meet all macronutrient and micronutrient needs [12]. Obadia *et al* [22] found that V*egetable and Fruits* were ordered less than recommended by Canada's Food Guide [23] and *Foods to Limit* (carbonated beverages, juices, desserts, salty snacks, and fried foods) were ordered significantly more frequently than recommended. While offering a variety of foods can help with overall meal satisfaction, nutritional quality of foods offered must be considered for these patients who are at high malnutrition risk while in hospital.

While some significant associations were seen between the domains and patient demographics, the small sample size did not allow for strong conclusions to be drawn from the results. To better identify children who may be at risk of having poor food

intake while in hospital, the relationship between these demographics and the barriers should be explored in future studies with emphasis on gender, age, and hospital unit type as well as others not analyzed in this study such as drug class [24] and disease state.

The findings of this study differ from those found in an adult population using the same survey [11]. Adults were more affected by organizational barriers such as missing meals due to tests, and had more physical limitations such difficulty opening packages and limited assistance during meal times. On the contrary, children were more affected by their hunger and the quality of food than adults. Both children and adults reported a high prevalence of the effects of illness on meal time experience. Loss of appetite, sickness, pain and fatigue were major barriers in both populations. These differences highlight the unique barriers children face while in hospital. Traditional food service methods found in hospitals may not be effective on pediatric units, and could contribute to meal time barriers. Strategies to combat these issues faced by hospitalized children need to be tailored to the specific issues faced by children in hospital.

This study is one of the first, to our knowledge, to look specifically at the barriers to oral intake affecting hospitalized children. Limitations included a small sample size which did not allow in-depth analysis of all variables including medication type and disease state. The study recruited a convenience sample and many families were missed if not available when researchers were present, creating a potential recruitment bias. This study was conducted in one institution over a specified time period, so results may not apply to other institutions or hospital units. The survey used has been validated in adult populations, but not in pediatrics, therefore other barriers specific to pediatrics may not have been captured. Although this study has its limitations, the data collected can be used

to guide future larger scale studies on the topic, and explore the barriers in facilities providing alternate meal service systems.

Relevance to Practice

Children have unique barriers affecting oral food intake in hospital. The traditional hospital food service style did not meet the needs of the pediatric patients studied. Children are at high risk of becoming malnourished during their hospital admission, and identifying the barriers to oral intake is the first step to improve practice and prevent malnutrition. Continued re-evaluation of pediatric hospital menus and food delivery systems is needed to provide acceptable food choices that meet the needs of children in hospital. As we begin to understand the pediatric perspective, we can work towards solutions to improve overall meal time satisfaction and have a positive effect on outcomes.

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