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ORIGINAL ARTICLE

Validity and reliability of the new Canadian Nutrition Screening Tool in the 'real-world' hospital setting

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BACKGROUND/OBJECTIVES: Nutrition screening should be initiated on hospital admission by non-dietitians. This research aimed to validate and assess the reliability of the Canadian Nutrition Screening Tool (CNST) in the 'real-world' hospital setting.
SUBJECTS/METHODS: Adult patients were admitted to surgical and medical wards only (no palliative patients). Study 1—Nutrition Care in Canadian Hospitals ($n = 1014$): development of the CNST (3 items: weight loss, decrease food intake, body mass index (BMI)) and exploratory assessment of its criterion and predictive validity. Study 2—Inter-rater reliability and criterion validity assessment of the tool completed by untrained nursing personnel or diet technician (DT) ($n = 150$). Subjective Global Assessment performed by site coordinators was used as a gold standard for comparison.
RESULTS: Study 1: The CNST completed by site coordinators showed good sensitivity (91.7%) and specificity (74.8%). Study 2: In the subsample of untrained personnel (160 nurses; one DT), tool's reliability was excellent (Kappa = 0.88), sensitivity was good (>90%) but specificity was low (47.8%). However, using a two-item ('yes' on both weight change and food intake) version of the tool improved the specificity (85.9%). BMI was thus removed to promote feasibility. The final two-item tool (study 1 sample) has a good predictive validity: length of stay ($P < 0.001$), 30-day readmission ($P = 0.02$; X^2 5.92) and mortality ($P < 0.001$).
CONCLUSIONS: The simple and reliable CNST shows good sensitivity and specificity and significantly predicts adverse outcomes. Completion by several untrained nursing personnel confirms its utility in the nursing admission assessment.

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INTRODUCTION

Malnutrition is common in acute care hospitals throughout the developed world,[1] and Canadian hospitals are not an exception.[2–4] Various organizations have identified nutrition screening as an initial strategy to treat malnutrition, with some visionaries mandating this step in the hospital setting.[5–8] In acute care hospitals, it should be a rapid and simple process conducted by admitting staff,[6] busy nurses or other relevant professionals,[9] whereas nutritional assessment requires professional judgment by a dietitian[10,11] and is hugely more time-consuming. Efficacy of nutrition screening lies in the validity, reliability and feasibility of the tool used.[12]

Over the past two decades, much work has been done in the development and validation of nutrition screening tools for hospital use.[13–19] When looking at the criterion validity of these tools, many showed sensitivity and specificity values over 70%, which is considered as the prerequisite for an adequate tool performance.[20] However, most of these tools present bias in their validation process, leading to inflated validation results (Table 1). Specific flaws include the following: (1) the validity was assessed in the same population in which the tool was developed;[2,14] (2) the same rater completed the tool and performed the criterion nutritional assessment in the same patients;[14,20–26] and (3) the screening was conducted by trained researchers,[14,25–27] dietitians[20,21,23,24] or trained nursing personnel.[18,19–21,24,28–31] Moreover, not many screening tools have been validated with completion by nutrition assistants/diet technicians (DTs),[13,22,28] a viable alternative to nursing for this process. Inter-rater reliability often includes only few trained raters.[13,14,18,19,21,24] As a result, validity and inter-rater reliability of these tools is unknown in the 'real-world' setting where it is completed at hospital admission by any number of busy nursing personnel who have no training in nutrition screening.

To be feasible for use in all patients, a screening tool must be simple (few items; taking < 5 min[32]), preferably including data documented in electronic medical records (EMRs).[33] Weight loss,[13–19] food intake[14–19] and body mass index (BMI)[13,15–17] are items consistently included in the tools. However, interpretation of these items can present limitations. Weight, BMI and weight loss are challenging to collect. The quantitative (amount or percentage) of weight loss is also difficult to obtain. It was reported that patients know whether or not they had lost weight, but recalling weight before the loss or estimating the amount of lost weight is difficult.[21] Moreover, a time frame for weight loss needs to be specified, as well as clarifying whether this is unintentional weight loss,[34] as these are essential components to determine the extent of risk. No tool examines these two components of weight loss, without relying also on the difficulty to collect the estimation of the absolute amount of weight lost in a specific time

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Table 1. Validation and reliability assessment results of nutrition screening tools for hospital use

Tools	*Inpatient population,* n	*First author and year/Country*
Same rater completed the tool and conducted the nutrition assessment and/or		
Raters: trained researchers or dietitians		
MST		
Se 93% Sp 93%; K 0.84–0.93	Acute hospitalized, $n=408$	Ferguson *et al.* 1999[14]/Australia
Se 78% Sp 96%	Adults and elderly, $n=193$	Neelemaat *et al.* 2011[20]/The Netherlands
Se 74% Sp 76%; K 0.72	Adults in different wards, $n=2211$	Nursal *et al.* 2005[21]/Turkey
Se 90% Sp 85%	Medical wards, aged ⩾65 years, $n=134$	Young *et al.* 2012[23]/Australia
Se 94% Sp 89%; K 0.74	Adults aged ⩾65 years, $n=157$	Wu *et al.* 2012[24]/Australia
SNAQ		
Se 75% Sp 84%	Adults and elderly, $n=198$	Neelemaat *et al.* 2011[20]/The Netherlands
Se 79% Sp 90%	Medical wards, aged ⩾65 years, $n=134$	Young *et al.* 2012[23]/Australia
MUST		
Se 96% Sp 80%	Adults and elderly, $n=168$	Neelemaat *et al.* 2011[20]/The Netherlands
Se 61% Sp 79%	Medical and Surgical, $n=995$	Kyle *et al.* 2006[22]/Switzerland
Se 87% Sp 86%	Medical wards, aged ⩾65 years, $n=134$	Young *et al* 2012[23]/Australia
Se 85% Sp 93%	Surgical, $n=300$	Almeida *et al* 2012[25]/Portugal
Se 72% Sp 90%	Internal Medicine and Surgery, $n=400$	Velasco *et al.* 2011[27]/Spain
NRS 2002		
Se 92% Sp 85%	Adults and elderly, $n=198$	Neelemaat *et al.* 2011[20]/The Netherlands
Se 62% Sp 93%	Medical and Surgical, $n=995$	Kyle *et al.* 2006[22]/Switzerland
Se 90% Sp 83%	Medical wards, aged ⩾65 years, $n=134$	Young *et al.* 2012[23]/Australia
Se 80% Sp 89%	Surgical, $n=300$	Almeida *et al.* 2012[25]/Portugal
Se 70% Sp 85%	Acute geriatric wards, $n=121$	Bauer *et al.* 2005[26]/Germany
Se 74% Sp 87%	Internal Medicine and Surgery, $n=400$	Velasco *et al.* 2011[27]/Spain
MNA-SF		
Se 100% Sp 41%	Adults and elderly, $n=91$	Neelemaat *et al.* 2011[20]/The Netherlands
Raters: Trained nurses		
MST		
Se 67% Sp 86%; K 0.53	Orthogeriatic units/hip fracture, $n=142$	Bell *et al.* 2014[28] [a]/Australia
Se 49% Sp 86%; K 0.33	Three renal wards, $n=145$	Lawson *et al.* 2012[29]/United Kingdom
Se 73% Sp 55%; K 0.28	Elderly with hip fracture, All $n=96$	Bell *et al.* 2013[30]/Australia
Se 73% Sp 70%	No cognitive impairment, $n=36$	
Se 39% Sp 93%; K 0.21	Acute care medical wards, $n=114$	Kam *et al.* 2013[42] [a]/China
SNAQ		
Se 79% Sp 83%; K 0.69 (2 nurses)	Mixed internal surgery/oncology wards, $n=297$	Kruizenga *et al.* 2005[18] [a]/The Netherlands
MUST		
Se 54% Sp 78%; k 0.31	Three renal wards, $n=145$	Lawson *et al.* 2012[29]/United Kingdom
MNA-SF (1 nurse)		
Se 100% Sp 38%	General medical department (aged ⩾70 years)	Ranhoff *et al.* 2003[31]/Norway
3-MinNS: (3 nurses)		
Se 89% Sp 88%; K 0.58	Surgical and oncology wards, $n=121$	Lim *et al.* 2013[19]/Southeast Asia
Raters: Diet technician or Nutrition assistant		
Simple Screening Tool #1 & #2		
Se 77%-88% Sp 65%-70%; K 0.60–0.76	Acute and long-term cares elderly, $n=142$	Laporte *et al* 2001[13]/Canada
MST		
Se 72% Sp 65%	Elderly with hip fracture, All $n=96$	Bell *et al.* 2013[30]/Australia
Se 58% Sp 79%	No cognitive impairment, $n=36$	
Se 60% Sp 76%; K 0.36	Orthogeriatric units/hip fracture, $n=142$	Bell *et al.* 2014[28]/Australia
MUST		
Se 43–57% Sp 99%; K 0.42–0.56	Orthogeriatric units/hip fracture, $n=142$	Bell *et al.* 2014[28]/Australia
NRS 2002		
Se 71% Sp 70% K0.41	Orthogeriatric units/hip fracture, $n=142$	Bell *et al.* 2014[28]/Australia
MNA-SF		
Se 89% Sp 49%; K 0.37	Orthogeriatric units/hip fracture, $n=142$	Bell *et al.* 2014[28]/Australia

Abbreviations: K, Kappa coefficient; MNA-SF, Mini Nutritional Assessment-Short Form; MUST, Malnutrition Universal Screening Tool; MST, Malnutrition Screening Tool; 3-MinNS, 3-Minutes Nutrition Screening; NRS-2002, Nutrition Risk Screening; Se, sensitivity; Sp, specificity; SNAQ, Short Nutrition Assessment Questionnaire. [a]In these studies, it is not clearly indicated whether the nurses were previously trained for nutrition screening.

frame.[13,14,16–18] With respect to food intake, the question needs to be kept open to all possible reasons as to why intake may be altered (for example, chewing or swallowing problems, fasting periods and so on), and not solely owing to a decrease in appetite;[14,18] furthermore, appetite can be impaired without a reduction in food intake. In addition, a time frame of decreased intake of more than a week needs to be specified, as decreased food intake for only a few days does not raise a sufficient nutrition risk warranting further investigation. Moreover, intake that requires quantification of the proportion of the usual intake[16,19] is challenging in a screening process. A simpler food intake question is required. Finally, in regard to BMI, criteria in some tools[16,17] are not adapted to reflect evidence of different ranges in older adults as compared with young adults.[35,36]

Mandatory standardized screening protocols in hospitals are a top priority for action by the CMTF (Canadian Malnutrition Task Force) and its stakeholders. In the nursing survey conducted in the Nutrition Care in Canadian Hospitals (NCCH) Study, 91% of the nurses responded that they would be willing to integrate a two- or three-item screening tool in the nursing admission assessment.[37] The CMTF aimed to develop, validate and assess the reliability of a feasible nutrition screening tool in the 'real-world' hospital setting. Two studies were conducted: (1) Development of the Canadian Nutrition Screening Tool (CNST), exploration of its criterion validity and predictive validity assessment and (2) Criterion validation and inter-rater reliability assessment of the tool completed by untrained nursing personnel or DT.

SUBJECTS AND METHODS

Review and clearance from each institutional REB (Research Ethics Board) was completed, and patients were required to provide written informed consent. For those unable to give informed consent and where approved by the institutional REB, the designated power of attorney was approached to sign the consent and answer the screening questions. Eligible patients were 18 years or older and newly admitted to a surgical or medical ward of the participating hospitals. Patients admitted directly to ICU, obstetric, psychiatry, palliative or pediatric wards were excluded. Patients underwent a nutrition screening with the CNST and a nutrition assessment using the Subjective Global Assessment (SGA) within 48 h (72 h for weekend) of admission to the floor. The SGA was the gold standard to assess the validity of the CNST and classified each patient as well nourished (SGA A), moderately or suspected of being malnourished (SGA B) or severely malnourished (SGA C).[34] Patient demographics were gathered (age, gender and ethnicity), as well as the admitting diagnosis that was classified under 11 broad categories (Table 2).

Study 1—Development of the CNST, exploration of its criterion validity and predictive validity assessment of the tool

In 2010, the CMTF proposed a simple tool that included three key items: weight loss, food intake and BMI. Appropriateness and relevance of the questions and their potential to screen for nutrition risk were based on expert opinion and published evidence.[11,32,38] The questions were designed to address the gaps described previously with other tools. With regard to weight loss and food intake, respectively, the CNST questions are as follows: *Have you lost weight in the past 6 months without trying to lose this weight? Have you been eating less than usual for more than a week?* With respect to *BMI,* criteria were adapted to reflect evidence of different ranges for young adults as compared with the elderly (*BMI* $< 18.5\ kg/m^2$ *for adults aged* < 65 *years and BMI* $< 21.0\ kg/m^2$ *for adults* $\geqslant 65$ *years*).[35,36] BMI was included in the tool to detect patients who had chronic malnutrition, and it was anticipated that measured weight and reported height will be filed in the EMR and BMI automatically calculated, making it feasible for inclusion. In this developmental study, a positive answer to at least one of these three items classified the patient at nutrition risk.

As part of the large prospective, multicenter cohort NCCH study conducted in 18 Canadian hospitals from July 2010 to February 2013,[4] 1014 patients were screened at admission with this draft tool. Trained site coordinators, the majority being dietitians, completed the CNST, conducted SGA and measured weight and height of each patient to calculate BMI.[4] To know the potential of the tool to screen for undernutrition, an exploratory criterion validity assessment was conducted. Prospective data in regard to patients' length of stay (LOS), 30-day readmission and mortality (in hospital or within 30 days of discharge) were also recorded and compared with the final version of the CNST to determine predictive validity.

Study 2—Criterion validity and inter-rater reliability assessments of the CNST

This second study took place from October 2012 to September 2013 in three NCCH study sites (Vitalité Health Network: Campbellton Regional Hospital, New Brunswick; University Health Network: Toronto General Hospital, Ontario; St-Boniface Hospital, Manitoba). The sample size was initially calculated for testing agreement between two raters. Using the Kappa statistic, a sample of 83 subjects achieves 80% power to detect a true Kappa value of 0.80 in a test of H0: Kappa = 0.60 vs H1: Kappa > 0.60, at a significance level of 0.05, when prevalence is equal to 50% (close to the NCCH study).[39] Next, we considered the sample size on the basis of the initial CNST's criterion validity (study 1) and different margins of error. A target sample of 150 participants was set (50/site) as practically feasible to estimate the sensitivity and the specificity with 7 and 10% margin of error[28,40] and to account for potential dropouts or missing data. A site coordinator at each hospital (registered dietitians (2) and nutrition researcher (1) recruited the patients, collected their demographic data and also completed the SGA, blind of the results of the CNST.

The CNST was blindly completed by two different hospital personnel for each patient (Registered Nurse, Licensed Practical Nurse or DT), to measure the inter-rater reliability of the tool. Screening raters per unit were numerous owing to frequent nursing shift rotations, replicating the real-life situation; none received training on how to complete the tool. Each rater asked the two questions of the tool to the patient and weighed (in kilograms) the patient, using the scale available on the ward. However, if a measured weight was available in the medical chart, only one weight measurement from one screening rater was completed. Height was reported by each patient and recorded in feet and inches or meters. If a patient could not report his height, then a measurement was taken (in meters). BMI was calculated by the EMR system where available or by the site coordinator.

Statistical analysis

Descriptive analysis was completed to characterize each study sample, including prevalence of malnutrition and each risk item in the CNST. Comparisons were made between the two samples (Pearson chi-square's, Fisher's or Wilcoxon's tests). Bivariate analysis (Chi-square and Student's *t*-test) between the CNST (risk vs no risk) and clinical outcomes (LOS, overall mortality and 30-day readmission) was conducted using the study 1 sample of participants to determine predictive validity of the tool. Contingency tables classifying the CNST and the SGA (B and C combined as malnourished) results were developed to determine the criterion validity of the tool (sensitivity, specificity, positive (PPV) and negative (NPV) predictive values). Inter-rater agreement was assessed using the Kappa coefficient.[41] Any missing data on the screening tool were recorded as potential information issues in feasibility of the CNST. The analysis was conducted using the SAS 9.3 software (SAS Institute Inc., Cary, NC, USA), and a P-value < 0.05 was considered significant.

RESULTS

Patient characteristics

The two study samples were very similar with respect to demographic characteristics and prevalence of malnutrition (Table 2). Over 52% of the patients were male and aged 66 and 64.5 years, respectively, for study 1 and study 2. According to SGA, half of the patients were malnourished in both studies. Distribution of diagnostic categories was also very similar, although there were a significantly lower proportion of patients with hematopoietic disorders ($P = 0.004$) and infection ($P = 0.05$) in study 2. Study 2 also had a significantly lower proportion of patients admitted to surgical wards ($P = 0.03$) or having two or three diagnoses ($P < 0.001$) (Table 2).

Prevalence of risk items in the CNST

In study 1, weight loss was reported by 42% of the patients, whereas in study 2 reduced food intake was the most prevalent item that identified nutrition risk (62.3% rater 1; 65.9% rater 2) (Table 3). In both studies, very few patients had a BMI lower than the age-adjusted cutoff value to capture a nutrition risk (9.4% in study 1; 10.2% (rater 1) and 5.1% (rater 2) in study 2).

Inter-rater reliability

In study 2, 143 patients were screened twice by approximately 160 different nursing personnel; only one DT participated into the study and screened 12 patients. The raters consistently determined nutrition risk for 94.3% of patients. The inter-rater reliability ($n = 122$) of the final version of the CNST had a Kappa coefficient of 0.88 (95% CI: 0.80, 0.97).

Table 2. Patient characteristics

	Study 1 n = *1014*	*Study 2* n = *150*	P-*value*[a]
Age[b]	66.0 years (54, 77) (18, 98)	64.5 years (52, 77) (18, 97)	0.9
	Percent	*Percent*	
Gender			0.9
Female	48.0	47.33	
Male	52.0	52.67	
Ethnicity (1st ethnicity)			0.3
Canadian	82.0	84.67	
European	11.3	7.33	
Other[c]	6.7	8.00	
SGA B/C	45.0 (42, 48)[d]	50.0 (42, 58)[d]	0.3
Admission Ward			0.03
medical	69.1	78	
surgical	30.9	22	
Primary admission diagnosis[e]			
Cardiovascular	15.7	17.3	0.6
Gastrointestinal	30.4	31.3	0.8
Genitourinary	12.5	8.7	0.2
Respiratory	18.6	13.3	0.1
Musculoskeletal	10.3	12.7	0.4
Neurologic	5.5	4.0	0.6
Autoimmune disease	0.7	1.3	0.3
Metabolic disorder	7.8	5.3	0.4
Sensory-organ impairment	0.99	0.7	>0.9
trauma	2.1	0	0.1
Hematopoietic disorder	8.28	2.0	0.004
Infection	18.52	12.0	0.05
Other	14.09	9.3	0.1
Number of diagnoses			<0.001
1 diagnosis	64.3	81.9	
2 diagnoses	25.8	17.4	
3 diagnoses	9.9	0.7	

Abbreviations: CI, confidence interval; SGA, Subjective Global Assessment. [a]Pearson's chi-square, Fisher's or Wilcoxon's tests as appropriate. [b]Median (q1, q3) (min, max) for age. [c]Includes South Asian, East and Southeast Asian, African, Aboriginal/Native. [d]95% CI is given for SGA B/C. [e]Based on the number of patients having this diagnosis at admission diagnoses; some patient can have more than 1 diagnosis.

Table 3. Prevalence of each item in the Canadian Nutrition Screening Tool that provided a YES answer

	Study 1	*Study 2*	
		Rater 1	*Rater 2*
Weight loss in the past 6 months	42.0%	54.2%	55.9%
Reduced food intake >1 week	35.9%	62.3%	65.9%
BMI <cutoff value	9.4%	10.2%	5.1%

Criterion validity

In the exploratory criterion validity of the CNST (study 1), validity results were deemed very good: sensitivity, 91.7%; specificity, 74.8%; PPV, 74.9%; and NPV, 91.6%. These results showed the promise of the tool, stimulating the conduct of study 2.

Different validity results were observed when the tool was completed by a large number of different raters who did not receive any training on how to complete the CNST, the large majority having no nutrition knowledge, and when the SGA was blindly completed by the site coordinators. Using the scoring 'yes' on any single item identifying risk, the specificity (rater 1: 49.3%, rater 2: 47.8%) and the PPV (rater 1: 63%, rater 2: 66.4%) of the CNST were low, whereas the sensitivity (rater 1: 91.3%, rater 2: 97.3%) and NPV (rater 1: 85.7%, rater 2: 94.3%) were high and consistent with the results of study 1.

As the specificity of the tool was low, criterion validity was further calculated using at least two YES answers for classifying the patient at nutrition risk instead of only one. In that way, better validity results were obtained as follows: sensitivity, 72.6%; specificity, 85.1%; PPV, 81.2%; and NPV, 77.0% (rater 1). Analyses were carried out with and without BMI to assess the added benefit of weight and height measurements. Results were similar regardless of whether the two-item or the three-item version of the tool was used (Table 4). Thus, the final CNST was defined to include only two items, namely weight change and food intake, in order to promote feasibility and acceptance by busy hospital staff (Figure 1b). Finally, omitting the twelve patients screened by the DT in the sample did not change the results significantly: sensitivity 73.3% (rater 1) and 69.7% (rater 2) and specificity 84.9% (rater 1) and 81.5% (rater 2).

Predictive validity

The final version (risk = 'yes' on both weight loss and decreased food intake) of the CNST significantly predicted clinical outcomes,

including LOS ($P < 0.001$), 30-day readmission ($P = 0.02$, odds ratio (OR) = 1.56 (95% CI: 1.07, 2.27)) and mortality (in hospital or within 30 days of discharge) ($P < 0.001$, OR = 5.37 (95% CI: 2.36, 12.79)). (Table 5).

DISCUSSION

This research highlights important issues regarding the validation process of nutrition screening tools. In study 1, the CNST was completed by the same rater who performed also the SGA, the criterion variable, thus exposing results to bias and inflating validity results. Other studies similarly using the same person to screen and assess nutritional status in the same patient also showed high criterion validity results.[14,20–27] Even without criterion bias, study 1 also had a flaw consistent with other validation studies,[13–15,19–27] in which the screening administrator was highly trained. The screening process of study 1, as well as of these other studies, does not reflect the reality of nutrition screening in practice, which is primarily performed by many untrained nursing personnel in the hospital setting.

In study 2, in which the CNST was completed blindly to SGA by a large majority of the raters having no nutrition knowledge, the tool did not perform as well with respect to its specificity and PPV, requiring adjustment in scoring. Other studies using similar methods to determine criterion validity did not achieve high-validity results (Table 1).[28–31,42] For example, the Malnutrition Screening Tool (MST) in renal inpatients[29] and acute care medical wards[42] showed sensitivity results of 48.7 and 39%, respectively. Furthermore, in an elderly and cognitively impaired population, the MST showed low specificity (55%) and PPV (50%).[30] However, validity results were similar to those in the current study in an ortho-geriatric population.[28] Finally, in these studies,[18–21,29–31] in which nursing personnel screened the patients, the raters benefit from an initial training.

Redefining the CNST by scoring nutrition risk using two YES answers instead of only one improved its specificity without seriously compromising the sensitivity. A high specificity is important in acute care settings as, according to ethical screening, identification of risk must be followed by assessment and treatment.[43] Limited number of dietitians in hospital settings reinforces the importance of using a tool with a high specificity. This criterion validity is enhanced by the predictive validity findings showing that nutrition risk identified be the CNST significantly predicts LOS, 30-day readmission and mortality of patients.

The inter-rater reliability of the CNST surpasses results of previous screening tools. This is particularly important considering the large number of different raters who filled out the tool. This may be the result of having developed refined questions that do not need interpretation by the rater. No other simple screening tools for hospital settings have assessed reliability among a large number of untrained raters with any nutrition knowledge. Notably, in studies in which the MST has been completed by trained nursing personnel, inter-rater results were modest (Kappa 0.28–0.33).[29,30]

This research also showed the possibility of conducting valid nutrition screening without using BMI. This analysis compared and contrasted sensitivity and specificity with and without BMI, demonstrating that two questions in the CNST are able to correctly capture patients at nutrition risk. BMI on its own has a limited capacity to determine malnutrition. Although BMI appears to be useful for identifying underweight cases at the risk

Table 4. Criterion validity of the Canadian Nutrition Screening Tool

	3 questions (including BMI)[a]		*Final version (2 questions)*[a]	
	Rater 1 (n = *129*)	*Rater 2* (n = *140*)	*Rater 1* (n = *123*)	*Rater 2* (n = *133*)
Sensitivity	72.6%	66.7%	72.9%	67.2%
Specificity	85.1%	80.8%	85.9%	80.3%
Positive predictive value (PPV)	81.2%	78.7%	82.7%	77.6%
Negative predictive value (NPV)	77.0%	69.6%	77.5%	70.7%

Abbreviation: BMI, body mass index. [a]Two YES answers = Malnutrition risk.

a Initial version

Ask the patient the following questions	**YES**	**NO**
Have you lost weight in the past 6 months **without trying** to lose this weight? *If the patient reports a weight loss but gained it back, consider it as NO weight loss.*		
Have you been eating less than usual **for more than a week**?		
BMI Adult < 65 years: BMI <18.5 kg/m^2? Adult ≥ 65 years: BMI < 21.0 kg/m^2?		
One "YES" answer indicates nutrition risk		

b Final version

Ask the patient the following questions	**YES**	**NO**
Have you lost weight in the past 6 months **without trying** to lose this weight? *If the patient reports a weight loss but gained it back, consider it as NO weight loss..*		
Have you been eating less than usual **for more than a week**?		
Two "YES" answers indicate nutrition risk		

Note: *If the patient is uncertain regarding weight loss, ask if clothing is now fitting more loosely.*
If the patient is unable to answer the questions, a knowledgeable informant can be used to obtain the information.

Figure 1. Canadian Nutrition Screening Tool.

Table 5. Predictive validity of the Canadian Nutrition Screening Tool (Study 1)

	Predictive Validity
Length of stay (days)	*P*-value < 0.001
Not at nutrition risk (Median q1, q3)	6.0 (4, 9)
At nutrition risk (Median q1, q3)	8.0 (5, 13)
30-day Readmission	$\chi^2 = 5.92$; *P*-value = 0.02 Odds Ratio (95% CI) = 1.56 (1.07, 2.27)
Not at nutrition risk	18.2%
At nutrition risk	25.8%
Mortality (in-hospital and 30 days post discharge)	*P*-value < 0.001 Odds ratio (95% CI) = 5.37 (2.36, 12.79)
Not at nutrition risk	1.6%
At nutrition risk	8.0%

of death,[44] few patients trigger the low BMI cutoff value, even when these are age-adjusted, as in this study. For instance, BMI lower than the reference ranges was observed in 10% or less of our samples. This number is lower than the overall prevalence of malnutrition of 45% using the SGA. Moreover, the feasibility of including BMI in a screening tool can be questioned, as only approximately 45% of the weights were already available in medical charts in study 2, indicating that 55% had to be measured by raters. BMI data were calculated automatically in 24% of EMR, whereas it had to be calculated by the screening raters or the site coordinators in 46 and 29% of cases, respectively, increasing workload and leaving room for human error. However, it must be noted that although a valid screening can be conducted without using BMI, height and weight are vital data to be obtained at admission and regularly during hospitalization, as these parameters are required for the overall nutrition care process that follows screening.

The research presents some limitations. The predictive validity of the final CNST has been assessed with the NCCH study patients, as a large sample was needed. In this study, however, the tool was completed by site coordinators. Moreover, the tool was refined for the second study, with slightly different wording. The process of scoring with the final tool and referral to dietitians still needs to be assessed, as this was not a part of this research. In the second study, the REB for only one site allowed the inclusion of cognitively impaired patients to participate in the study ($n = 6$). Thus, the validity of the CNST in a population that cannot answer the questions and require a proxy needs further investigation. Finally, the validity of the CNST has been assessed at hospital admission only; its validity for a weekly rescreening is unknown.

CONCLUSION

To our knowledge, the CNST is the first tool designed for hospital use whose validity and reliability have been tested by a large number of primarily untrained nursing personnel. This represents more closely the reality of a hospital setting. The favorable validity and reliability results of this simple tool support its inclusion in the nursing admission questionnaire for initial screening. As part of the nutrition care process, patients screened at nutrition risk will require a nutrition evaluation, in which the first and prioritization step would be the SGA by a dietitian, a physician or other trained professionals. For patients classified as malnourished (SGA B or C), comprehensive nutrition assessment and treatment are indicated.

CONFLICT OF INTEREST

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