

THE MY MEAL INTAKE TOOL (M-MIT): VALIDITY OF A PATIENT SELF-ASSESSMENT FOR FOOD AND FLUID INTAKE AT A SINGLE MEAL

J. MCCULLOUGH, H. KELLER

University of Waterloo, Dept Kinesiology, Waterloo, Ontario, Canada. Corresponding author: H. Keller, Schlegel Research Chair Nutrition & Aging, Schlegel-University of Waterloo Research Institute for Aging & University of Waterloo, Dept Kinesiology, 200 University Ave W, Waterloo, Ontario N2L 3G1, Canada, mobile: 519 497 7868, hkeller@uwaterloo.ca

Abstract: *Objectives:* Hospital malnutrition is an under-recognized issue that leads to a variety of adverse outcomes, especially for older adults. Food/fluid intake (FFI) monitoring in hospital can be used to identify those who are improving and those who need further treatment. Current monitoring practices such as calorie counts are impractical for all patients and a patient-completed tool, if valid, could support routine FFI monitoring. The aim of this research was to determine whether the patient-completed My Meal Intake Tool (M-MIT) can accurately represent FFI at a single meal. *Design:* Cross-sectional, multi-site. *Setting:* Four acute care hospitals in Canada. *Participants:* 120 patients (65+ yrs, adequate cognition). *Measurements:* Participants completed M-MIT for a single meal. Food and fluid waste was visually estimated by a research dietitian at each hospital. Sensitivity (Se), specificity (Sp) and overall agreement were calculated for both food and fluid intake by comparing M-MIT and dietitian estimations to determine criterion validity of M-MIT. Patient and research dietitian comments were used to make revisions to the M-MIT. *Results:* Using a cut-point of $\leq 50\%$ intake, Se was 76.2% and 61.9% and Sp was 74.0% and 80.5% for solid and fluids respectively ($p < 0.001$). M-MIT identified a greater proportion of participants (37.2%) as having low FFI ($\leq 50\%$) than dietitians (25.0%), as well as a greater proportion identified with low fluid intake (28.3% vs. 24.6%). Modest revisions were made to improve the tool. *Conclusion:* This study has demonstrated initial validity of M-MIT for use in older patients with adequate cognition. Use of M-MIT could promote FFI monitoring as a routine practice to make clinical decisions about care.

Key words: Food intake, monitoring, malnutrition, hospital, patient.

Introduction

Hospital malnutrition is a very common (1-7) and serious issue that impacts patient health (5, 8-10) and the health care system (9-11). Insufficient food and fluid intake (FFI) can lead to and perpetuate hospital malnutrition (8). Food and fluid intake data from nutritionDAY surveys have highlighted the magnitude and on-going problem of poor intake while in hospital worldwide (12-14). Additionally, low intake predicts key malnutrition-related outcomes such as LOS, mortality, and readmission (4, 9, 15-18). Thus, monitoring patient FFI is a priority while in hospital. Calorie counts where all food and fluid consumed by the patient is recorded and nursing flow sheets (proportion of food consumed from the tray is ticked off by staff as part of their vital health statistics log for a patient) are commonly used to monitor FFI, but are variably reported and in the case of flow sheets, not necessarily used to guide interventions (19, 20). Calorie counts take precious time of nursing staff, and are thus reserved for monitoring intake only for a select number of patients who have been identified for follow-up (19). Patients are a potential resource for reporting on their own food intake. Although a patient-completed tool would not be feasible for all patients, such as those with low literacy, delirium, or dementia, a tool that most could complete could be a mechanism for readily obtaining sufficient detail to make clinical decisions based on FFI. Patient completed tools exist (16), but have yet to be validated and are not widely used outside of clinical research.

The My Meal Intake Tool (M-MIT) is a patient self-completed form that aims to provide an estimate of the patient's food and fluid intake for a single meal. The primary aim of this study was to determine whether the M-MIT was sufficiently valid to be deemed suitable for routine clinical use within acute care hospitals. An additional objective was to revise the M-MIT to improve its clarity and ease of use based on qualitative comments and suggestions from participants and site researchers.

Methods

This study used a cross-sectional multi-site design to determine the validity of the self-completed M-MIT.

Setting & Subjects

Recruited participants ($n=120$) were over the age of 65. The majority of medical and surgical patients are over the age of 65 years (21), and it was logical to use this group to test the validity of M-MIT. For this study, these participants were involved in testing three different clinical tools focused on nutrition care, one of which was the M-MIT and only these results will be presented here. To be included in the study, participants needed to be: admitted from home; likely to be discharged home; admitted to a medical or surgical unit; able to speak and read English or French; not cognitively impaired (as assessed by nursing and ability to complete the written consent process); and likely to be admitted for 2-5 days. Participants

(30 per hospital) were recruited from units in four Canadian hospitals in four different provinces. The participating hospitals were purposefully selected to be diverse in terms of region, type, size, and primary language. In all hospitals, nursing staff that were part of the patients' circle of care made the initial approach to prospective participants to gather initial consent to be approached by the research dietitian, who provided more information about the study and completed the informed consent to participate.

My Meal Intake Tool (M-MIT)

A small group (n=4) of researchers (PhD dietitian, MSc dietitian, two research associates with measurement experience) was involved in this initial development of M-MIT. Prior clinical and research experience with a variety of FFI forms was used to draft the tool. The draft M-MIT underwent several steps in its development including consideration of instructions, font, scale for estimating intake, non food content (e.g. barriers to intake) and layout. Further drafts were reviewed by five acute care dietitians for face validation (22) and revisions made to promote clarity and ease of use.

The tested version of M-MIT instructed patients to estimate the total proportion consumed of all solid foods they were provided at that meal, by marking the corresponding checkbox: <25%; 25%; 50%; 75%; >75%. The proportions were accompanied by visual diagrams of plates that represented how much food was remaining. To estimate fluid consumption, patients were instructed to list each fluid provided at the meal (e.g. milk, juice, etc.) and to estimate proportions consumed (<25%, 25%, 50%, 75%, >75%) for each, which were also accompanied by visual diagrams of remaining fluid in a cup. The reverse side of the form contained two questions. The first asked how the patient's appetite was at that meal ("Very Good/Good" or "Fair/Poor") and asked the reason (if any) for having a fair/poor appetite. The second question asked the patient about challenges they may have encountered during the meal. Finally, a comment box was provided for the patient to indicate anything else they felt was relevant. A French translation version was also created.

Data Collection

A single meal was used to compare patient-completed M-MIT forms with the criterion of a research dietitian's visual estimations of each participant's consumption. Each hospital was provided funds by the project to hire one of their clinical dietitians in the hospital to conduct data collection for the study. This 'research dietitian' completed consent process and the visual estimations (VE). Training for the study estimation procedures was conducted by teleconference due to geographic limitations; research dietitians were encouraged to practice VE prior to conduct of the study.

The following demographic information was collected at the time of consent based on patients' charts and self-report: gender, year of birth, reason for admission, highest level of

education, and living situation (lives: alone, with spouse, with spouse and other family, with other family/friends). Before the meal, the research dietitian provided participants with the M-MIT and gave no verbal instructions, other than to complete the form after the meal and to place the completed M-MIT in the provided envelope to blind the research dietitian from the patient responses. Participants completed M-MIT independently to the best of their ability after the meal. If participants were physically unable (e.g. writing hand unusable due to an IV line) to complete the form themselves, family members/visitors/staff were allowed to complete it for them. However, proxies were instructed not to make the estimations, but to verbally ask the participant the questions on the M-MIT and record responses without influencing them.

Upon participant completion of the meal, the research dietitian removed the tray from the room and visually estimated the proportion of each food and each fluid item consumed by viewing the amount of food/fluid waste. The research dietitian then conducted a brief standardized follow-up questionnaire consisting of five questions (responses: yes, no, and comments/suggestions for improvement) with the participants; a) instructions easy to follow, b) understand how to identify beverage intake, c) understand how to identify food intake, d) appetite and reasons for low intake question easy to understand, and e) would they make changes to the form. Dietitians recorded responses in writing. Ethics clearance for the data collection was obtained through a University of Waterloo Research Ethics Committee, as well as through the ethics board of each participating hospital.

Analysis

Descriptive analyses (mean, s.d., proportions) were performed for patient demographics, intake according to VE and M-MIT, reasons for low appetite, and challenges experienced. M-MIT forms were reviewed to qualitatively determine challenges and errors in completion made by participants. Chi square, ANOVA, and z-tests were used to determine significant differences among these descriptive statistics, where applicable. Proportions with yes/no responses for follow-up questions on ease of use of the tool were calculated. Patient suggestions for improvements were catalogued and tallied.

To determine criterion validity of the M-MIT, sensitivity (Se), specificity (Sp), and overall agreement with dietitian VEs were calculated. Proportion of each solid food consumed as per VE was summed and an average proportion consumed derived for comparison to M-MIT, where patients reported a single proportion of all solid food items consumed. Both the M-MIT and VE estimations were dichotomized to either $\leq 50\%$ or $> 50\%$ consumed for this analysis. The 50% cut-point was chosen to represent low intake as an association has been demonstrated between eating less than half of the food provided at one meal and LOS (4). Overall agreement represented the proportion of M-MIT and VE estimations that corresponded according to the dichotomized intake results. To calculate Se and Sp,

THE MY MEAL INTAKE TOOL (M-MIT)

two-by-two Chi square analyses were used to provide raw counts of how many VE and M-MIT estimations corresponded and Se and Sp were then calculated by hand. Similarly, overall agreement, Se and Sp analyses were also performed to determine the criterion validity of fluid consumption according to the M-MIT. Since both the M-MIT and VE estimations listed each individual fluid, both estimations were averaged to determine the proportion of total fluids consumed and were also dichotomized to $\leq 50\%$ or $> 50\%$ consumed. Se and Sp analyses were also conducted individually for juice, coffee/tea, and milk, which were the most commonly provided fluids. Finally, Se and Sp analyses were also stratified by gender, age ($</\geq 80$ years), education level ($<$ high school vs. graduated high school), and appetite (very good/good vs. fair/poor) to determine if these characteristics affected the accuracy of M-MIT completion. Where possible, z-tests were performed to determine significant differences between Se, Sp, and overall agreement for these characteristics. Sensitivity analyses were also conducted by altering the cut-point for comparison to $\leq 75\%$ and $> 75\%$, as this resulted in more even cell counts within the Chi squares than with the $\leq 50\%/> 50\%$ cut-point. Sensitivity analyses were also completed to determine the effect of missing data on Se, Sp and overall agreement assuming incomplete or incorrectly completed M-MIT forms represented: 1) “low” ($\leq 50\%$) intake, or 2) “sufficient” ($> 50\%$) intake.

A priori, it was determined that Se/Sp values greater than 70% would be considered sufficiently valid as compared to the criterion, considering that the M-MIT is an ‘untrained’ patient self-assessment. However, a lower Sp value was also considered a priori to be acceptable as a greater chance of false positives (which occurs with a higher Se and lower Sp) (23) was of less concern; in practice, it would be preferred to over-identify patients as ‘low intake’ rather than under-identify (21), potentially missing patients who could benefit from intervention. With a sample size of 120, it was determined that if levels of agreement (Se/Sp) between M-MIT and VE were calculated to be 70%, the 95%CI for the true value would be within $\pm 7.5\%$. If levels of agreement were calculated to be 90%, the true value would lie within $\pm 5.5\%$ (24, p.81).

Results

Patient Demographics

Participant characteristics (n=120) are displayed in Table 1. The sample contained 43.3% males and there were no

significant differences among sites for gender distribution ($X^2=1.90$, $p=0.59$). Almost half (47.5%) of the participants were 80 years of age or older with site 1 having a significantly older participant population (mean=85.0 years, $F=10.16$, $p<0.05$) than the other three sites (75.8-76.7 years). There were also site differences in level of education ($X^2=10.06$, $p<0.05$). A majority of participants (62.5%) had at least a high school education, while the most common living situations were alone (41.7%) or with their spouse (40.0%). While inclusion criteria specified being admitted from home, there were three participants included who were admitted from long term care residences. Most participants (77.5%) were recruited from medical wards, with sites 1 and 2 recruiting exclusively from medical wards ($X^2=33.11$, $p<0.001$). Participants had a wide range of reasons for admission, with orthopedic conditions (22.5%) being the most common.

M-MIT Completion

Of the 120 participants, 44 completed M-MIT at breakfast (36.7%), 52 at lunch (43.3%), and 17 at supper (14.2%); data on meal timing was missing for seven participants. Seven M-MIT forms contained notes stating that patients were unable to complete the form themselves and needed help from proxies (usually from nursing or another dietitian). Almost 80% (94/120 participants) provided useable data for the solid food section of M-MIT. Of the remaining 26 incomplete/improperly completed M-MIT forms, some were left completely blank (n=4), or the solids estimation section was left blank (n=13), while the other nine forms were filled out incorrectly. Most of these errors (n=7) involved making multiple checkmarks in the solids estimation section. Over 80% (98/120 participants) provided useable data for the fluid intake estimation. Nine of the 22 incomplete/improperly completed forms were left completely blank (n=4) or had fluid sections that were not filled out (n=5), and thirteen forms had the fluid section incorrectly filled out. The most common error made (n=7) was listing fluids provided without checking proportions consumed. Other errors included: checking a proportion on the “Example” line of the fluids section but not next to the fluids listed (n=2); listing all fluids on one line but making proportion selections on different lines (n=2); and checking off multiple proportions on the same line (n=1). These incomplete or obviously incorrectly completed forms were not included in the initial validity analysis, however they were imputed as $\leq 50\%$ or $> 50\%$ for sensitivity analyses.

Table 1
Participant Hospital Characteristics

Hospital Site	Province	Hospital Type	Approximate # of Beds	Anglophone/Francophone
1	British Columbia	Community	285	Anglophone
2	Saskatchewan	Academic	650	Anglophone
3	Ontario	Community	600	Anglophone
4	Quebec	Academic	1200	Francophone

Table 2
Patient Demographics (n=120)

Characteristic	Total Sample % (n)	Site 1 % (n)	Site 2 % (n)	Site 3 % (n)	Site 4 % (n)
Gender					
Male	43.3 (52)	33.3 (10)	43.3 (13)	50.0 (15)	46.7 (14)
Female	56.7 (68)	66.7 (20)	56.7 (17)	50.0 (15)	53.3 (16)
Age					
Mean age (years +/- SD)*	78.4 +/- 8.4	85.0 +/- 7.1	76.7 +/- 6.5	75.8 +/- 8.4	76.2 +/- 8.0
65-69 years	20.0 (24)	6.7 (2)	20.0 (6)	30.0 (9)	23.3 (7)
70-79 years	32.5 (39)	13.3 (4)	36.7 (11)	36.7 (11)	43.3 (13)
80-89 years	35.8 (43)	50.0 (15)	43.3 (13)	26.7 (8)	23.3 (7)
90-99 years	11.7 (14)	30.0 (9)	0	6.7 (2)	10.0 (3)
Highest Level of Education Achieved*					
Primary school or less	10.8 (13)	0	10.0 (3)	3.3 (1)	30.0 (9)
Some high school	26.7 (32)	16.7 (5)	43.3 (13)	30.0 (9)	16.7 (5)
Graduated high school	28.3 (34)	50.0 (15)	16.7 (5)	20.0 (6)	26.7 (8)
Some post-secondary/graduated post-secondary	34.2 (41)	33.3 (10)	30.0 (9)	46.7 (14)	26.7 (8)
Living Situation					
Lives alone	41.7 (50)	53.3 (16)	30.0 (9)	43.3 (13)	40.0 (12)
Lives with spouse	40.0 (48)	30.0 (9)	46.7 (14)	40.0 (12)	43.3 (13)
Lives with other family/friends	13.3 (16)	13.3 (4)	16.7 (5)	13.3 (4)	10.0 (3)
Lives with spouse and other family	2.5 (3)	0	6.7 (2)	3.3 (1)	0
Long term residence	2.5 (3)	3.3 (1)	0	0	6.7 (2)
Unit Type*					
Medical wards	78.3 (94)	100 (30)	100 (30)	60.0 (18)	53.3 (16)
Surgical wards	21.7 (26)	0	0	40.0 (12)	46.7 (14)
Reason for Admission					
Orthopedic	22.5 (27)	40.0 (12)	0	36.7 (11)	13.3 (4)
Respiratory	12.5 (15)	3.3 (1)	23.3 (7)	6.7 (2)	16.7 (5)
Falls/weakness/dizziness	12.5 (15)	20.0 (6)	6.7 (2)	10.0 (3)	13.3 (4)
Cancer	10.0 (12)	3.3 (1)	3.3 (1)	3.3 (1)	30.0 (9)
Cardiovascular	6.7 (8)	10.0 (3)	16.7 (5)	0	0
Gastrointestinal	6.7 (8)	0	10.0 (3)	13.3 (4)	3.3 (1)
Wound/Infection	5.8 (7)	6.7 (2)	6.7 (2)	10.0 (3)	0
General surgery	3.3 (4)	0	0	0	13.3 (4)
Stroke	1.7 (2)	0	0	6.7 (2)	0
Other	17.5 (21)	13.3 (4)	33.3 (10)	13.3 (4)	10.0 (3)
Missing	0.8 (1)	3.3 (1)	0	0	0

* statistically significant difference p<0.05; mean age statistically significantly different among sites with post hoc tests noting difference among site 4 and 1.

Validity of M-MIT

Almost one quarter of participants (22.3%) as identified by the dietitian VE, consumed ≤50% of the solid food provided. Association between dietitian VE and patient M-MIT for solid food were statistically significant ($X^2 = 17.56$; $Se=76.2%$, $Sp74.0%$; $p<0.001$) and absolute agreement between M-MIT

and VE for solid food intake was 74.5%. Sensitivity analyses that included incomplete forms or changed the cut-point for low intake resulted in changes in Se and Sp; assuming M-MIT was reported as ≤50% ($Se=83.3%$, $Sp=60.0%$) vs. >50% intake ($Se=53.3%$, $Sp=78.9%$); cut-point ≤75% for “low” intake ($Se=81.8%$ $Sp=58.0%$).

THE MY MEAL INTAKE TOOL (M-MIT)

Table 3
 Prevalence and reasons patients provided for poor appetite by hospital site

Hospital Site	% with Low Appetite	“I was not interested in eating” (%)	“I had nausea/vomiting” (%)	“I was tired” (%)	“I had pain” (%)	“I ate outside foods and was not hungry” (%)
1	42.9	26.9	7.7	15.4	11.5	0
2	34.8	8.0	0	8.0	0	4.0
3	34.5	13.8	10.3	13.8	6.9	0
4	54.5	0	11.1	14.8	22.2	0

Table 4
 Prevalence of patient reported mealtime challenges by hospital site

Hospital Site	Completed “Challenges” Section (n)	# of M-MIT Challenges (%)		
		0	1	2
1	26	57.7	38.5	3.8
2	25	68.0	32.0	0
3	29	41.4	55.2	3.4
4	27	59.3	33.3	7.4

A slightly lower proportion (21.4%) were identified by the dietitian VE as having consumed $\leq 50\%$ of the fluids provided. Association between dietitian VE and patient M-MIT was statistically significant ($X^2 = 14.55$; $Se=61.9\%$, $Sp 80.5\%$; $p<0.001$) and absolute agreement between dietitian and patient estimations for fluid intake was 76.5%. Sensitivity analyses including incomplete forms or changing the cut-point for low intake resulted in changes in Se and Sp; assuming M-MIT was reported as $\leq 50\%$ ($Se=71.0\%$, $Sp=69.7\%$) vs. $>50\%$ intake ($Se=41.9\%$, $Sp=83.1\%$); cut-point $\leq 75\%$ ($Se=79.1\%$, $Sp=76.4\%$).

The lower sensitivity of fluid estimations based on the complete forms may have resulted from beverage additions or removals from the tray. For example, 24 patients listed ‘water’ on the M-MIT, while only four dietitians listed water in their estimations. Water isn’t commonly listed on hospital meal tickets even if it is provided, which could have caused overestimations on the self-completed M-MIT. Other common errors such as including beverages from other meals could have affected these results as well. These errors would have led to inaccuracies on the M-MIT, thus lowering the overall Se for the fluids section. As a result, individual fluids that were concordant between the VE and M-MIT estimations for complete forms were compared and sensitivity improved: coffee/tea (listed on 51.0% of completed M-MIT forms; $Se=70.6\%$, $Sp=97.0\%$), juice (50.0%; $Se=71.4\%$, $Sp=88.1\%$), and milk (44.9%; $Se=64.3\%$, $Sp=80.5\%$). The lower sensitivity for milk is attributed to the opaque containers, which make it challenging to visually estimate.

When participants were stratified by gender, age, education, and appetite the only statistically significant difference in validation statistics identified was in overall agreement between males and females for solid intake ($z=2.723$, $p<0.01$). Z-tests for statistical differences in Se/Sp could not be completed for any of the demographic characteristics or appetite due to low cell counts. There was no difference in completion rate of the M-MIT for any of these demographic characteristics. There was no difference in completion rate of the solid intake estimation for appetite level. There was however a significant difference in completion rate of the fluid intake estimation for appetite level; only 7.1% of participants with a “Very Good/Good” appetite did not complete their fluid intake estimation, while 23.1% of participants with a lower than normal appetite did not complete the fluid intake estimation ($X^2=4.942$, $p=0.026$). The fluid intake estimation requires the patient to list out all of their beverages and estimate how much of each was consumed, so it’s possible that participants with a lower appetite (who were likely not feeling well) did not bother to complete the fluid estimation, which required more writing than the solid section. Descriptive analyses for appetite and challenges reported on the second page of M-MIT are provided by hospital in Tables 3/4.

Patient Perceptions & Revisions Made to M-MIT

In general, participants indicated that the M-MIT was easy to complete: 84% indicated that the instructions were easy to follow; 77% reported that they understood how to identify how much fluid/beverages they consumed; 84% reported that they understood how to identify how much food they ate;

however, 40% said they would make changes to the form. The majority of comments were focused on clarifying the estimation sections, specifically: providing clearer step-by-step instructions; removing the < and > symbols; provision of “0%” and “100%” options; providing word cues “0% - I ate none” (or “I drank none”) and “100% - I ate all” (or “I drank all”); improving the visual diagrams to look more like food/fluid; and inclusion of a space for patients to report food saved for later. On page two of M-MIT the responses to “How was your appetite at this meal?” were clarified (i.e. fair/poor changed to “less than usual”) and more options were added to the question “Did you have any challenges at this meal?” including an “I had no challenges” option. Finally, at the end of page two, the question, “Who completed this form?” was added (patient, family/friend/volunteer, or staff member). The final version of M-MIT along with a clinician guidance document, are available at: www.nutritioncareinCanada.ca/resources and in Figure 1 and Figure 2.

Figure 1
My Meal Intake Tool, page 1
Discussion

MY MEAL INTAKE

Patient Name: _____
Room #: _____
Date: _____

This form helps us understand how you are eating. Please complete this form after you have finished this meal. If you need help, let us know.

- List all drinks on your tray; this includes juice, tea/coffee, milk, drink supplements, etc.
- Place an 'X' in the circle to indicate how much you consumed of each beverage
- For the food on your tray, place an 'X' in the circle to indicate how much you ate overall; this includes the main dish, side dishes, soup, bread, dessert
- List any food or beverages you are saving to eat at a later time
- Turn the page over and answer the remaining questions

What meal is this? Breakfast Lunch Supper

What and how much did you drink?	0% I drank none	25%	50%	75%	100% I drank all
Example: Milk	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How much of all the food on your tray did you eat?	0% I ate none	25%	50%	75%	100% I ate all
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please list any items (food or beverages) being saved for later: _____

Please turn over →

were more challenges with estimating fluids than food. Se and Sp for food intake were both at least 74% and while Se for overall fluid intake was lower than desired (61.9%), this value improved when fluids were individually itemized and compared. Revisions made to the tool post validation are anticipated to further improve sensitivity and specificity. Future work should confirm validity of this revised version and determine if proxy respondents (family, staff, volunteers) can also accurately complete the M-MIT, as approximately 20% of patients included in this study did not complete the tool as anticipated, despite having completed informed written consent.

Figure 2
My Meal Intake Tool- page 2

How was your appetite at this meal?
 Very good/Good
 Less than usual

Why was your appetite less than usual?
 I was not interested in eating
 I had nausea/vomiting
 I was tired
 I had pain
 I ate other foods and was not hungry
 No specific reason
 Other: _____

Did you have any challenges at this meal?
 I needed help to sit up to eat
 I needed help opening food packages
 I needed help to eat and/or drink
 I did not like the food
 I had problems chewing/swallowing
 I was not allowed to eat because I am having a test today
 I did not get what I had ordered (if selective menu)
 The environment was not appetizing
 Other: _____
 I had no challenges

Other comments to share with us about your food intake: _____

Who completed this form? Patient Family/Friend/Volunteer Staff

This is the first known patient-completed assessment of FFI that has undergone testing to determine capacity for patients to complete and their accuracy in doing so. The completion by approximately 80% of participants suggests that for most cognitively able patients, M-MIT would be feasible; patients generally reported the tool to be easy to use, although there

The Integrated Nutrition Pathway for Acute Care (INPAC) (25) is a consensus and evidence based pathway focused on early detection of malnutrition, prevention and treatment. Based on work of the Canadian Malnutrition Task Force, it is known that intake $\leq 50\%$ during the first week of admission independently results in a longer LOS (8); even well-nourished patients who do not eat their food stay longer in hospital. Thus, food intake monitoring, as recommended in INPAC, could identify these low consumers sooner and potentially improve outcomes if intervention is coupled with identification.

THE MY MEAL INTAKE TOOL (M-MIT)

Others have also noted that food intake monitoring in facilities is a relevant quality indicator (26). Self-administration of food monitoring could engage patients in their recovery and provides them with an opportunity to identify challenges they are having with meals. M-MIT provides the opportunity to clarify why intake may have been low (e.g. did not like food), which could result in different staff (e.g. dietary technicians or assistants) responding to needs while reserving more complex cases for the dietitian's expertise. In addition to further validation work for M-MIT, future research could also be conducted on implementation of M-MIT in practice. Issues to investigate include: patient capacity for completion during their stay, including the most appropriate frequency; patient perception of their food intake and importance to recovery, due to monitoring; steps post completion and how this impacts nursing, food service and dietitian work flow and resources; and if implementation actually does change what happens to the patient. Some of these issues can be addressed in the current More-2-Eat project, being conducted by this research team. More-2-Eat is focused on evaluating the implementation of INPAC in five Canadian hospitals. M-MIT is used to capture food intake data for some participants. Whether or not an additional patient-completed form will be incorporated into the care routine of these hospitals has yet to be determined.

M-MIT identified more participants (37.2%) as having low FFI than dietitians did (22.3%), as well as identifying more participants with low fluid intake (28.3%) than dietitian VE (21.4%). However, the differences in prevalence of low intake as identified by M-MIT vs. dietitians were not statistically significant. M-MIT can be used as an indicator that suggests the need for follow up, thus over-identifying low intake could be an acceptable burden, considering the harm that patients experience with unidentified low intake (4). Processes to confirm reasons for low intake and instituting interventions as a result of low-intake need to be developed if M-MIT is used routinely in hospital care; a developmental evaluation of an implementation project is currently underway to identify feasible processes and resource requirements.

Strengths and Limitations

This is the first attempt to create and validate a feasible patient self-completed FFI monitoring tool. There are strengths but also several limitations to this study. First, a limited number of researchers and clinicians (only dietitians) were involved in the development of the draft M-MIT. As patients are intended as the users of M-MIT, data were collected via interview on their opinions of how the tool could be improved. Further work prior to extending the tool to use with other groups who might also use the tool (e.g. nursing staff, volunteers) on clarity of concepts is required. Criterion validation usually is conducted by comparing a new method with a gold standard measure (27). In the case of FFI, pre- and post-meal weighing of food items is generally considered the gold standard (20,28); however, this method is expensive, time-consuming, and disruptive to

the normal eating routine (28-30). VE has also been validated against the food weighing method in various clinical settings (28-30), so it was decided that VE by trained dietitians would be an acceptable criterion for this initial study. Use of visual estimation for the criterion rather than weighing of food waste post consumption is a limitation of the current study, but the promising results suggest that future validation work with M-MIT using food waste weighing as the comparator is warranted. The inclusion of four dietitians (one per hospital), with their potential differences in estimation skill is also a limitation. Training was provided, but inter-rater reliability of these dietitians was not assessed. However, dietitians involved in the study were experienced in estimating FFI and the training for the protocols within the study attempted to standardize their estimations.

VE was made by collecting participants' meal trays after they were done their meal and estimating the remaining waste based on what was originally provided. Participants weren't observed while they were eating. Thus, if participants threw out items or saved them for later, this could have caused dietitians to assume that those items were consumed causing an over-estimation of intake. However, if this occurred, this would have decreased the observed measures of agreement, which suggests that these measures of validity may have been underestimated in this investigation. As mentioned, a "saved for later" section was added to the revised M-MIT so that future users do not count these items as consumed.

There was a lack of randomization in the meals that were selected for food intake monitoring. Meals were chosen at the site dietitians' discretion. This could have influenced validation results. For example, differing appetites at different mealtimes may have had an effect on the accuracy of intake estimation. Alternatively, some foods (e.g. milk, cereal at breakfast) can be more difficult to estimate consumption than foods provided at other meals (e.g. a sandwich at lunch). However, in this study intake was crudely dichotomized to $\leq 50\%$ and $> 50\%$, which likely eliminated some of these potential differences in estimation accuracy due to type of food provided. Randomization or a quota system could be used to promote an even number of breakfasts, lunches, and suppers monitored in a future study.

Finally, it is possible that non-response bias may have occurred due to the healthy volunteer effect (31). There was no information collected on those eligible patients who declined to participate in the study and it's possible that those who declined may have been more frail/sick than those who agreed to participate. Participation rate was not calculated, as ethics clearance only allowed nursing staff to approach prospective patients about participating and not information on who declined participation. It is just as likely that this process was influenced by nursing routines and capacity to approach patients on certain shifts, than patient characteristics.

Conclusion

This study has shown initial validity of the patient administered M-MIT using VE as the comparator. Further work to validate the tool is warranted, using more rigorous methods of food waste measurement. This tool can be used in cognitively able medical and surgical patient populations. Where a patient cannot complete M-MIT, volunteers, families or staff can complete and future studies should confirm the validity of proxy administration. Processes to follow up low intake ($\leq 50\%$) as identified on M-MIT need to be developed for each hospital, as resources are site specific.

Funding: This research is funded by Technology Evaluation for the Elderly Network, which is supported by the Government of Canada through the Networks of Centres of Excellence (NCE) program.

Conflict of Interest: The authors declare no conflicts of interest.

Ethical standard: Ethics review was provided at five separate institutions for this study. Study protocol was unaltered.

References

1. Morley JE. Protein-energy malnutrition in older subjects. *Proc Nutr Soc* 1998;57:587-592.
2. Mudge AM, Ross LJ, Young AM, Isenring EA, Banks, MD. Helping understand nutritional gaps in the elderly (HUNGER): A prospective study of patient factors associated with inadequate nutritional intake in older medical inpatients. *Clin Nutr* 2011;30: 320-325.
3. Hickson, M. Malnutrition and ageing. *Postgrad Med J* 2006;82: 2-8.
4. Allard J, Keller H, Jeejeebhoy K, Laporte M, Duerksen DR, Gramlich L, Payette H, Bernier P, Vesnaver E, Davidson B, Teterina A. Malnutrition at hospital admission – Contributors and effect on length of stay: A prospective cohort study from the Canadian Malnutrition Task Force. *J Parenter Enteral Nutr* 2016;40(4): 487-497.
5. Isabel M, Correia MI, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. *Clin Nutr* 2003;22(3):235-239.
6. Corish CA, Kennedy NP. Protein-energy undernutrition in hospital in-patients. *Br J Nutr* 2000;83:575-591.
7. Ray S, Laur C, Golubic R. Malnutrition in healthcare institutions: A review of the prevalence of under-nutrition in hospitals and care homes since 1994 in England. *Clin Nutr* 2014;33:829-835.
8. White JV, Guenter P, Jensen G, Malone A, Schofield M, Group AM, Force AM. Consensus statement: Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition: Characteristics recommended for the identification and documentation of adult malnutrition (undernutrition). *JPEN* 2012;36(3):275-283.
9. Agarwal E, Ferguson M, Banks M, Batterham M, Bauer J, Capra S, Isenring E. Malnutrition and poor food intake are associated with prolonged hospital stay, frequent readmission, and greater in-hospital mortality: Results from the Nutrition Care Day Survey 2010. *Clin Nutr* 2013;32:737-745.
10. Lim SL, Ong KCB, Chan YK, Loke WC, Ferguson M, Daniels L. Malnutrition and its impact on cost of hospitalization, length of stay, readmission and 3-year mortality. *Clin Nutr* 2012;31:345-350.
11. Curtis L, Bernier P, Jeejeebhoy K, Allard JP, Duerksen DR, Gramlich L, Laporte M, Keller H (2016) The costs of malnutrition in acute care: A report of the Canadian Malnutrition Task Force. *Clinical Nutrition*, 2016 Sept 19.
12. Dupertuis YM, Kossovsky MP, Kyle UG, Raguso CA, Genton L, Pichard C. Food intake in 1707 hospitalised patients: a prospective comprehensive hospital survey. *Clin Nutr* 2003;22(2):115-123.
13. Schindler K, Pernicka E, Laviano A, P Howard, Schütz T, Bauer P, Grecu I, Jonkers C, Kondrup J, Ljungqvist O, Mouhieddine M. How nutritional risk is assessed and managed in European hospitals: A survey of 21,007 patients findings from the 2007-2008 cross-sectional nutritionDay survey. *Clin Nutr* 2010;29:552-559.
14. Thibault R, Chikhi M, Clerc A, P Damon, P Chopard, L Genton, M Kossovsky, Pichard C. Assessment of food intake in hospitalized patients: A 10-year comparative study of a prospective hospital survey. *Clin Nutr* 2011;30:289-296.
15. Allard JP, Keller H, Teterina A, Jeejeebhoy KN, Laporte M, Duerksen DR, Gramlich L, Payette H, Bernier P, Davidson B, Lou W. Factors associated with nutritional decline in hospitalised medical and surgical patients admitted for 7 d or more: a prospective cohort study. *Br J Nutr* 2015;114:1612-1622.
16. Hiesmayr M, Schindler K, Pernicka E, Schuh C, Schoeniger-Hekele A, Bauer P, Laviano A, Lovell AD, Mouhieddine M, Schuetz T, Schneider SM. Decreased food intake is a risk factor for mortality in hospitalized patients: The NutritionDay survey 2006. *Clin Nutr* 2009;28:484-491.
17. Lainscak M, Farkas J, Frantal S, Singer P, Bauer P, Hiesmayr M, Schindler K. Self-rated health, nutritional intake and mortality in adult hospitalized patients. *Eur J Clin Invest* 2014;44(9): 813-824.
18. Jeejeebhoy KN, Keller H, Gramlich L, Allard JP, Laporte M, Duerksen DR, Payette H, Bernier P, Vesnaver E, Davidson B, Teterina A. Nutritional assessment: comparison of clinical assessment and objective variables for the prediction of length of hospital stay and readmission. *Am J Clin Nutr* 2015;101: 956-965.
19. Keller H, Allard JP, Laporte M, Davidson B, Payette H, Bernier P, Jeejeebhoy K, Duerksen DR, Gramlich L. Predictors of dietitian consult on medical and surgical wards. *Clin Nutr* 2015;34:141-145.
20. Palmer M, Miller K, Noble S. The accuracy of food intake charts completed by nursing staff as part of usual care when no additional training in completing intake tools is provided. *Clin Nutr* 2015;34(4):761-766.
21. Canadian Institute for Health Information. Defining High Users in Acute Care: An Examination of Different Approaches. CIHI, Ottawa, 2015.
22. Streiner DL, Norman GR. Health Measurement Scales – A Practical Guide to their Development and Use. Oxford Medical Publications, Oxford University Press Inc., New York, p. 1995:58-59, 147-150.
23. Hajjan-Tilaki K. Receiver Operating Characteristic (ROC) curve analysis for medical diagnostic test evaluation. *Caspian J Intern Med* 2013;4(2): 627-635.
24. Hulley SB, Cummings SR, Browner WS, Grady DG, Newman TB. Designing Clinical Research – Fourth Edition. Lippincott Williams & Wilkins, Philadelphia, 2013:p. 39, 79, 81.
25. Keller HH, McCullough J, Davidson B, Vesnaver E, Laporte M, Gramlich L, Allard J, Bernier P, Duerksen D, Jeejeebhoy K. The Integrated Nutrition Pathway for Acute Care (INPAC): Building consensus with a modified Delphi. *Nutr J* 2015;14: 63-74.
26. van Damme N, Buijck B, van Hecke A, Verhaeghe S, Goossens E, Beekman D. Development of a quality of meals and meal service set of indicators for residential facilities for elderly. *J Nutr Health Aging* 2016;20(5): 471-477.
27. Jones JM. Validity of nutrition screening and assessment tools. *Nutrition* 2004;20:312-317.
28. Hanks AS, Wansink B, Just DR. Reliability and accuracy of real-time visualization techniques for measuring school cafeteria tray waste: Validating the Quarter-Waste Method. *J Acad Nutr Diet* 2014;114(3): 470-474.
29. Williamson DA, Allen HR, Martin PD, Alfonso AJ, Gerald B, Hunt A. Comparison of digital photography to weighed and visual estimation of portion sizes. *J Am Diet Assoc* 2003;103:1139-1145.
30. Berrut G, Favreau AM, Dizo E, Tharreau B, Poupin C, Gueringuili M, Pressinaud P, Ritz P. Estimation of calorie and protein intake in age patients: validation of a method based on meal portions consumed. *J Gerontol A Biol Sci Med Sci* 2002;57A(1): M52-M56.
31. Delgado-Rodriguez M, Llorca J (2004) Bias. *J Epidemiol Community Health* 2004;58:635-641.