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Factors predicting adherence to the Canadian Clinical Practice Guidelines for nutrition support in mechanically ventilated, critically ill adult patients☆

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Abstract

Purpose: The aim of this study was to determine factors that are associated with adherence to the Canadian nutrition support clinical practice guidelines (CPGs).

Materials and Methods: We conducted a secondary analysis of data from a prospective observational cohort study of nutrition support practices in 58 intensive care units (ICUs) across Canada, grouped into 50 clusters. Adequacy of enteral nutrition (EN) (energy received from EN ÷ energy prescribed by the dietitian × 100), was used as a marker of adherence to the guidelines. We applied hierarchical modeling techniques to examine the impact of various hospital, ICU, and patient factors on EN adequacy.

Results: The overall average EN adequacy was 51.3% (SE, 1.8%). In a multiple regression analysis, after adjusting for varying days of observation, hospital type (academic 54.3% vs community 45.2%, $P < .001$), admission category of the patient (medical 60.2% vs surgical 39.2%, $P < .001$), and sex of the patient (male 46.5% vs female 52.8%, $P < .001$) were found to be significant predictors of EN adequacy and adherence to the Canadian nutrition support CPGs.

Conclusions: Specific hospital, ICU, and patient characteristics influence adherence to the Canadian nutrition support CPGs. Further research is required to illuminate the mechanisms by which female and surgical patients and community hospitals lead to lower guideline adherence.

1. Introduction

Malnutrition is common among critically ill patients and has a negative effect on clinical outcomes, being strongly associated with increased morbidity and mortality in the intensive care unit (ICU) [1,2]. Artificial nutrition support in the form of enteral nutrition (EN) or parenteral nutrition (PN) is therefore considered an integral part of the standard care received by the critically ill. Recent studies have generated

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evidence to support its use by demonstrating that various nutrition support practices influence clinically important outcomes such as length of stay, morbidity, and mortality [3-7]. Despite these benefits, enteral or parenteral feeding should be adopted with caution because nutrition practices themselves are not without adverse effects or risks [8,9]. Consequently, making decisions regarding the most effective and safe means of feeding patients in the ICU can be challenging.

The Canadian Clinical Practice Guidelines (CPGs) for nutrition support in mechanically ventilated, critically ill adult patients sought to improve nutrition support practices in ICUs across Canada by providing guidance to assist health practitioners in decisions regarding feeding their patients [10]. Previous nutrition support guidelines relied heavily on expert opinion rather than on evidence and failed to meet the criteria for high-quality CPGs [11-14].

A validation study before the widespread dissemination of the Canadian nutrition support CPGs tested the hypothesis that ICUs who were more adherent to the guidelines would have greater success in providing EN [15]. This observational study examined the association between EN adequacy and 5 key recommendations of the Canadian nutrition support CPGs that were most directly related to optimal provision of nutrition support (ie, EN over PN, feeding protocol, early EN, small bowel feedings, and motility agents). Enteral nutrition adequacy was calculated as the amount of energy received by EN divided by the amount that should have been received as per the dietitians' assessment. This study found that ICUs that were more adherent to the guidelines had greater success at providing EN. Enteral nutrition adequacy was greater for patients receiving EN alone, compared with patients who received both EN and PN. For ICUs that used more than the median of PN, EN adequacy was significantly less than ICUs who used less PN. The ICUs that used a feeding protocol had a higher EN adequacy than ICUs that did not use a feeding protocol. Overall EN adequacy was greater in patients who had EN initiated early, within 48 hours, compared with patients who had their EN initiated after 48 hours. In addition, ICUs who used motility agents and small bowel feeding in patients with high gastric residuals also tended to have higher EN adequacy than sites that did not. The validation study concluded that adherence to these guidelines should lead to improved nutrition practices and better outcomes for critically ill patients [15]. Subsequent studies in the critically ill population have supported this conclusion by demonstrating that failing to achieve goal energy is associated with worse clinical outcomes [16].

To compare the effectiveness of active to passive dissemination of the Canadian nutrition support CPGs, we conducted a cluster randomized control trial (RCT). The data from this trial were used in this study [17]. In May 2003, after a baseline survey of current nutrition support practices, 58 ICUs across Canada, grouped into 50 clusters, were randomized to either active or passive dissemination strategies. The active arm consisted of multifaceted educational intervention where the ICU dietitian received tools and training in conducting interactive workshops and quality improvement. The passive group only received a copy of the CPGs. A follow-up survey was repeated 12 months later to determine changes in practice. The study found no significant differences in the primary end point, change in EN adequacy, between the 2 arms from baseline to follow-up (8.0% vs 6.2%, $P = .54$). However, significant improvements in glycemic control were observed in the active arm compared to the passive arm and in a subgroup of medical patients. No other significant differences in nutrition support practices or clinical outcomes were noted between groups.

Despite the rigorous development process used in their production, together with concerted dissemination efforts, the impact of the Canadian nutrition support CPGs has been modest. The process of changing clinical practice through adopting the recommendations of guidelines is complex and often difficult to achieve. Although this problem is not unique to critical care, it is particularly pronounced in this setting due to the challenges created by the heterogeneity of ICU sites and patient population, the rapid pace of decision making, and multidisciplinary team involvement.

It is recognized that understanding barriers and enablers to guidelines adherence is necessary to enhance our knowledge of clinical decision making. This will, in turn, inform development of appropriate and more effective implementation interventions, helping to narrow the gap between best and actual practice. The objective of this study was to determine the specific hospital, ICU, and patient characteristics that are associated with adherence to the Canadian nutrition support CPGs. On the basis of information from a previous survey in Canada, which concluded that optimal provision of nutrition support may be more likely in academic centers compared with community settings [18], we hypothesized that adherence to the Canadian nutrition support CPGs and, thus, adequacy of EN, would be higher in academic hospitals compared to their community counterparts.

2. Materials and methods

2.1. Study population

This study involved secondary analysis of data collected during the follow-up phase of the guideline dissemination cluster RCT [17]. To be eligible, ICUs had to have at least 8 beds and be affiliated with a registered dietitian. Of the 78 eligible ICUs, a total of 58 ICUs agreed to participate (74% response rate). Twelve of these sites shared staff and procedures with other participating ICUs. To prevent contamination across sites, these ICUs were combined into 4 distinct clusters resulting in a total of 50 clusters. For the purpose of this study, these "clusters" were considered as single sampling units and are therefore referred to as "sites."

In May 2004, a point prevalence survey of nutrition support practices was conducted at each site. All ICU patients who had been mechanically ventilated within 48 hours of ICU admission and had been in the ICU for more than 72 hours were included. Data collection was completed on each consecutive patient, with the aim of accruing data on a minimum of 10 patients at each site.

2.2. Adequacy of EN

It has previously been demonstrated that ICUs whose practices are more consistent with the Canadian nutrition support CPGs are more likely to successfully feed their patients [15] and that these improvements in nutrition support practices result in increased adequacy of EN [19,20]. Consequently, EN adequacy averaged over the first 12 days of ICU stay was used as the primary outcome in this study, being a useful marker for adherence to the guidelines. Use of EN was recorded from time of admission to ICU to a maximum of 12 days. Dietitians provided the calculated daily nutrition prescription for energy for each patient, regardless of whether they had received nutrition support. Average EN adequacy was calculated as energy received from EN divided by the maximum energy prescribed by the dietitian during the 12 days, multiplied by 100. Study days occurring after patients permanently progressed exclusively to oral intake were excluded, but other study days without EN were counted as 0% EN received.

2.3. Hospital, ICU, and patient characteristics

Dietitians were asked to complete a form describing the characteristics of their hospital and ICU plus general aspects of nutrition support practice (eg, use of feeding protocol or algorithms). In addition, information was recorded on the personal characteristics and admission diagnosis of each patient included in the study. The type of hospital was classified as academic (ie, teaching) or community (ie, nonteaching). Hospitals were deemed to be academic if they provided training to medical students and residents. If they only had occasional medical students or residents, they were considered as community centers. Other hospital and ICU site characteristics included ICU type (open [ie, patient under care of any attending physician] or closed [ie, patient under care of intensivist]), hospital size (number of beds), ICU size (number of beds), case mix, presence of a medical director, registered dietitian full-time equivalent (FTE) per bed, and use of feeding protocol. Patient characteristics included admission category (surgical vs medical), sex, age, body mass index (BMI), presence of acute respiratory distress syndrome (ARDS), and type of nutrition support received.

2.4. Statistical analysis

Hospital and ICU site level and patient level characteristics were described using means with ranges for continuous variables and counts with percentages for categorical variables, unless indicated otherwise. Differences in these characteristics between academic and community hospitals were examined using the Wilcoxon–Mann-Whitney test for continuous variables, Fisher exact test for dichotomous variables, and χ^2 test for categorical variables. All patients were included in the analysis regardless of the type of nutrition support received (EN only, PN only, EN and PN combined, or none). To fully examine the relationship between site and patient level characteristics and adherence to the Canadian nutrition support CPGs, we conducted a

Table 1 Hospital and ICU site characteristics

Characteristic	All (n = 50)	Academic setting (n =25)	Community setting (n =25)	*P*
ICU beds (mean [range])	18 (7-83)	24 (9-83)	12 (7-27)	<.001
ICU type				.002
Open	9 (18%)	0 (0%)	9 (36%)	
Closed	39 (78%)	24 (96%)	15 (60%)	
Other	2 (4%)	1 (4%)	1 (4%)	
Presence of medical director	48 (96%)	25 (100%)	23 (92%)	.49
Hospital size (mean [range])	451 (131-1847)	581 (137-1847)	321 (131-610)	.001
% FTE RD per ICU bed (mean [range])	4.3 (1.0-10.0)	4.1 (1.0-7.1)	4.5 (1.8-10.0)	.80
Case mix				
Medical	47 (94%)	22 (88%)	25 (100%)	.23
Surgical	48 (96%)	23 (92%)	25 (100%)	.49
Trauma	25 (50%)	14 (56%)	11 (44%)	.57
Neurologic	33 (66%)	17 (68%)	16 (64%)	1.0
Cardiac surgery	15 (30%)	15 (60%)	0 (0%)	<.001
Neurosurgical	17 (34%)	14 (56%)	3 (12%)	.002
Burns	16 (32%)	11 (44%)	5 (20%)	.13
Pediatrics	10 (20%)	2 (8%)	8 (32%)	.07
Other	11 (22%)	8 (32%)	3 (12%)	.17

FTE indicates full-time equivalent; RD, registered dietitian.

Table 2 Patient characteristics

Characteristic	All (n = 612)	Academic setting (n = 378)	Community setting (n = 234)	*P*
Sex				.67
Male	341 (60%)	208 (55%)	133 (57%)	
Female	271 (40%)	170 (45%)	101 (43%)	
Mean age (y; range)	63 (16-95)	60 (16-90)	66 (16-95)	<.001
Mean BMI (kg/m^2; range)	28 (12-93)	27 (12-93)	28 (16-74)	.07
Admission category				<.001
Medical	349 (57%)	179 (47%)	170 (72%)	
Elective surgical	90 (15%)	73 (19%)	17 (7%)	
Emergency surgical	173 (28%)	126 (33%)	47 (20%)	
ARDS	67 (11%)	39 (10%)	28 (12%)	.59
Type of nutrition support received				.003
EN only	444 (73%)	285 (75%)	159 (68%)	
PN only	36 (6%)	16 (4%)	20 (9%)	
EN + PN	92 (15%)	61 (16%)	31 (13%)	
None	40 (7%)	16 (4%)	24 (10%)	

BMI, body mass index (kg/m^3); ARDS, acute respiratory distress syndrome; EN, enteral nutrition; PN, parenteral nutrition.

detailed multifactorial analysis. Because of the hierarchical structure of the data, multilevel modeling techniques were applied, with patient at level 1 and site at level 2, taking into account the within-site and within-patient correlation. As EN adequacy was averaged over 12 days, a fixed linear term was added to the model for patients having less than 12 days of observation. Evaluable days was thus included as a patient level factor so that estimates represent average 12 days EN adequacy. This 2-level model was estimated by restricted maximum likelihood as implemented by the MIXED procedure in SAS v9 (SAS Institute Inc, Cary, NC). Model development was guided by our a priori hypothesis, the results of single predictor models, and the expert opinion of the researchers. To further increase confidence in our model, the exercise was repeated using a backward approach with an exit criteria of $P = .05$. Enteral nutrition adequacy estimates are reported as means with SEs. All tests were 2-sided with statistical significance considered as $P < .05$ and a trend considered as $P < .2$.

2.5. Ethics

Institutional ethics approval was obtained for this analysis from the Health Sciences Research Ethics Board at Queen's University (Kingston, Ontario, Canada).

3. Results

Of the 50 ICU sites included in the analysis, 25 were from academic and 25 were from community hospitals. The ICUs contributed an average of 12.2 (range, 3-44) evaluable patients. The 612 evaluable patients were observed for an average of 10.4 days (range, 3-12 days). Site characteristics are described in Table 1. Academic hospitals are larger institutions with more ICU beds and are of a closed type, compared with community hospitals. Academic hospitals perform more specialist surgeries compared to community hospitals.

Patient characteristics are described in Table 2. Sex, BMI, and ARDS appear balanced between the 2 settings. Academic settings have younger patients and more elective and emergency surgical patients compared to their community counterparts. Parenteral nutrition is used more frequently in the community setting, and patients are more likely not to receive any nutritional support at these sites.

Fig. 1 shows the median, interquartile range, and range of EN adequacy for each of the 12 days of observation. The average 12-day EN adequacy was 51.3% (SE, 1.8%).

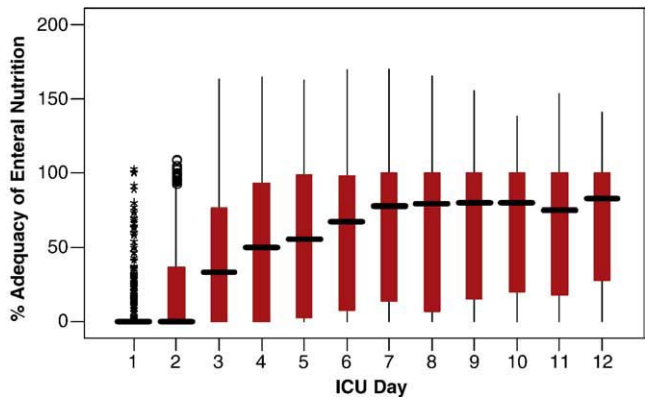

Fig. 1 Percentage adequacy of EN (ie, energy received from EN ÷ energy prescribed by the dietitian × 100) by day of observation in the ICU. Bold horizontal line indicates median; box, interquartile range; whiskers, range; and circles and stars, individual outliers (ie, more than 3/2 times the interquartile range).

Table 3 Single predictor models of site or patient level characteristics and EN adequacy

Characteristic	% Difference in EN adequacy (SE)	*P*
ICU site characteristics		
Hospital type: academic vs community	+5.1 (3.5)	.16
ICU type: closed vs open	+9.7 (4.1)	.02
Hospital size: >355 vs <355 beds	+4.9 (3.1)	.12
ICU beds (per bed)	+0.0 (0.1)	.70
FTE RD (per bed)	+0.9 (0.9)	.33
Feeding protocol: yes vs no	+3.6 (3.6)	.32
Cluster RCT: active vs passive arm	−1.7 (3.1)	.59
Patient characteristics		
Age (per y)	−0.1 (0.1)	.27
Sex: male vs female	−6.6 (2.2)	<.01
Admission category: medical vs surgical	+20.1 (2.2)	<.001
BMI (per kg/m^2)	−0.0 (0.1)	.82
ARDS: yes vs no	−5.1 (3.6)	.17

FTE RD, full time equivalent registered dietitian; RCT, randomized control trial.

Table 3 shows results of single predictor models of specific hospital, ICU, and patient level characteristics associated with EN adequacy, adjusting for evaluable days in the ICU. Only ICU type, admission category, and sex were significant. Closed ICUs have higher EN adequacy than open ICUs (53.2% vs 43.5%, $P = .02$). Enteral nutrition adequacy was higher in the medical patients compared to surgical patients (60.2% vs 40.2%, $P < .001$). Male patients had lower EN adequacy than female patients (48.2% vs 54.8%, $P = .005$). A trend was observed for hospital type, hospital size, and ARDS. Academic sites had an average EN adequacy of 53.1% (SE, 2.2%) compared to 48.6% (SE, 2.6%) at community hospitals ($P = .16$). Larger hospitals had a higher EN adequacy compared to their smaller counterparts (53.3% vs 48.4%, $P = .12$), and patients with ARDS attained lower EN adequacy (46.9% vs 52.0%, $P = .17$).

In the multiple regression model of specific hospital, ICU, and patient level characteristics associated with EN adequacy, hospital type (academic 54.3% [SE, 2.0%] vs community 45.2% [SE, 2.4%], $P < .001$), admission category (medical 60.2% [SE, 1.9%] vs surgical 39.2% [SE, 2.1%], $P < .001$), and sex (male 46.5% [SE 1.9%] vs female 52.8% [SE 2.0%], $P < .001$) were found to be significant predictors of EN adequacy.

4. Discussion

The process of translating evidence into clinical practice through CPGs is complex. Gaining a greater understanding of the factors that influence adherence to CPGs in this unique critical care setting will help to maximize the benefits and narrow the gap between best and actual practice. This study capitalized on existing data to address an important research question which, to our knowledge, has not been explored to date. The results support our a priori hypothesis that adherence to the Canadian nutrition support CPGs is higher in academic hospitals compared to community hospitals. In addition, patient characteristics, namely, admission category (medical vs surgical), and sex are also important factors associated with EN adequacy and adherence to the guidelines.

Previous studies have demonstrated that academic hospitals have a higher quality of care than community hospitals [21,22]. It may be that it is the high patient volume, typical of academic hospitals, that leads to better outcomes rather than the teaching status [23]. In this analysis, we were unable to ascertain the mechanism by which academic hospitals affected nutrition practices. It should be noted that EN adequacy was found to be suboptimal in both hospital types, being less than 70%. Although strategies to improve adherence to the Canadian nutrition support CPGs must consider the specific needs of health practitioners in community hospitals, academic centers should not be excluded from such initiatives.

Intensive care unit type was identified as an important factor associated with EN adequacy and adherence to the guidelines in a single predictor model but not in the multivariate model. Although ICU type was not statistically significant in the final model, it was shown to be a borderline variable at $P = .06$. This suggests that the structural model of critical care delivery may influence quality of patient care. Studies suggest that ICUs operating in the closed format may have improved efficiency and standardization of care, leading to better clinical outcomes [24]. Our results appear to corroborate these findings; we believe that the role of this characteristic in influencing adherence to guidelines is of similar importance to hospital type. In our study, all academic centers were large institutions that had ICUs operating under a closed format, whereas community hospitals were significantly smaller and had either open or closed ICUs. We were therefore unable to assess the independent effects of these characteristics because of their colinearity.

We also identified a lower level of adherence to the guidelines for surgical patients compared to medical patients. This may be a reflection of the controversy that exists regarding the provision of nutrition support in these patients [25]. After general anesthetic, gastric motility is reduced and gastric emptying may be delayed. Consequently, it is common practice, although not supported by evidence, to withhold enteral fluids and nutrition until bowel sounds are heard. However, postoperative enteral feeding appears to be safe and beneficial in these patients [26,27]. In addition, complications arising after gastrointestinal surgery such as anastamotic breakdown, ileus, or ischemia are a contraindication to EN, necessitating the delivery of nutrition via the parenteral route. The presence

of such controversy, and cases in which postoperative complications arise, may delay establishment of nutrition support, leading to lower EN adequacy as observed here. Further exploration of this comparison between medical and surgical patients is warranted.

We are unaware of any biologic reasons why adherence to the Canadian nutrition support CPGs is more difficult in male compared to female patients. We are unable to explain this difference through a greater proportion of males having surgical admissions, being severely ill, being older, or having a greater BMI. When we repeated this analysis using baseline data from the guideline dissemination cluster RCT, we found no association between sex and EN adequacy in either a single predictor or a multivariate model (unpublished data).

Although a major strength of this study, the use of existing data is also associated with several limitations. First, EN adequacy is a relevant marker for adherence to the guidelines being directly related to 5 key recommendations of the Canadian nutrition support CPGs. However, this measure fails to capture several of the 17 recommendations included in the guidelines such as appropriate use of PN, composition of EN, composition of PN, and intensive insulin therapy; therefore, we are unable to evaluate adherence to these specific recommendations.

Second, data were only collected on an average of 12 patients per site and at only one point in time. The range of 3 to 44 evaluable patients per site for 3 to 12 days of observation indicate that some sites contributed data on only a few patients. We can only speculate that this may be due to a lack of eligible patients in smaller ICUs or noncompliance with data collection due to time constraints. In addition, ICUs with less than 8 beds and not affiliated with a registered dietitian were excluded from the study. We acknowledge that because of the eligibility criteria and the heterogeneity of the critically ill population, the EN adequacy of the patients included in our data set may not be representative of usual nutrition support practices and adherence to the CPGs across all ICUs.

Third, the data set does not include health practitioner level or micro-organizational level characteristics. Health practitioner characteristics are an exhaustive list that includes age, sex, profession, educational level, work experience, as well as psychobehavioral characteristics (eg, self-efficacy, motivation). Previous research on adherence to guidelines suggests that personal characteristics of the health practitioner are the most important factors influencing adherence because the action of following recommendations of CPGs is mediated by these individuals [28]. A study examining the relationship between physician adherence to smoking cessation CPGs found that the rather crude macro-organizational variables, such as hospital size and teaching status, as evaluated in our study, explained little of the variation in health practitioner adherence, whereas micro-organizational factors, such as education practices, feedback mechanisms, and leadership support, appeared to be important correlates of adherence [29]. In our study, after controlling for subjects with less than 12 days in the ICU, site only explained 7% of the total variance. Hospital type explained 26% of the site level variance (or 2% of total), whereas sex and admission category explained 14% of the patient level variance (or 13% of total). Therefore, more variance is attributed to patient characteristics than to hospital characteristics, but neither explains much of the variation.

Further research is required to illuminate the mechanisms by which patient sex, admission category, and hospital teaching status influence adherence to the Canadian nutrition support CPGs. In addition to the hospital, ICU, and patient characteristics, future studies should focus on health practitioner and micro-organizational characteristics. A greater understanding of the barriers and enablers to guideline adherence in the critical care setting will assist in designing effective knowledge translation strategies, thus optimizing clinical practice and potentially impacting on patient outcomes.

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