Accuracy and adequacy of food supplied in therapeutic diets to hospitalised patients: An observational study

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ABSTRACT

Aim: This study assessed the accuracy (including sources and reasons for errors) and adequacy (of patients' intakes relative to requirements) among patients prescribed therapeutic diets in the hospital setting.

Methods: This observational study was conducted across six wards in a metropolitan tertiary hospital over 14 consecutive days. Meal accuracy was assessed by comparing each individual food or fluid item provided to each patient to items allowed on their specific diet code. Errors were defined by severity (critical or non-critical threat to patient safety) and source (foodservice system, staff or patient). Nutritional adequacy was determined by comparing patients' daily energy and protein intakes to individually estimated requirements. Intakes were considered adequate if consumption was $\geq 75\%$ of requirements.

Results: Meals of 67 patients (31 females, aged 60.019.4 years) were assessed for accuracy for up to two days. Of the total 347 therapeutic meals observed, 69 (19.9%) were inaccurate. A large proportion of these errors were critical (64.8%). Foodservice errors were the most common source. Of the 48 patients with complete dietary intake data, mean energy and protein intakes were 3192 ± 2220 kJ and 33 ± 27 g protein, respectively. Only five and seven patients consumed adequate energy and protein to meet their estimated requirements, respectively.

Conclusion: Patients requiring therapeutic diets during hospitalisation are frequently exposed to food and/or fluid errors that may pose an acute threat to their safety. In addition, prescription of these diets may result in patients being unable to adequately meet their nutritional requirements.

Keywords: Clinical nutrition, foodservice errors, therapeutic diet.

INTRODUCTION

Patient safety and quality is an integral aspect of health care. Despite presence of agencies such as the Australian Commission on Safety and Quality in Health Care, who regulate and monitor patient safety in hospitals through clinical care standards, errors leading to preventable adverse clinical events still occur.¹ Essential patient care in the hospital setting includes not only medical procedures and management, but appropriate nutrition for health and recovery.² That is, in the same way a hospital must deliver safe and accurate medical and nursing care, it should also provide access to accurate and adequate nutrition. As 67–94% of patients depend on hospital food as their sole source of nutrition,^{3,4} errors in meals provided to patients are likely to have a significant impact on health and safety. During hospitalisation, patients may be placed on therapeutic diets associated with medical nutrition therapy.^{2,5} These diets are designed to manage nutrition-related disorders and also play a role in reducing risks of acute and chronic adverse events associated with a patient's underlying medical condition. For example, patients with dysphagia are often prescribed texture modified diets and/or thickened fluids; patients with food allergies or intolerances require diets free from allergens (i.e. gluten or lactose free); and patients with inflammatory bowel conditions or undergoing or recovering from bowel surgery may be provided with low fibre, clear fluid or free fluid diets. If patients are provided with food or fluid items that are contraindicated to their therapeutic diet, acute adverse events can occur. These include aspiration or choking,^{6,7} adverse food reactions (i.e. allergies);^{8–10} exacerbation of underlying medical and/or gastrointestinal problems; symptoms such as abdominal discomfort, nausea and vomiting; and potential procedural delays or complications.^{11–13} Despite the significant effects that foodservice errors may have on patients requiring therapeutic diets, few studies have assessed the prevalence or sources of such errors^{14,15} and these studies are over decades old, limiting their relevance to current clinical practice. In addition to acute safety risks, patients on therapeutic diets who eat inadequately are at risk of chronic issues such as malnutrition, which affects between 20 and 50% of patients in the acute hospital setting.^{3,16,17} Patients' energy and protein requirements are often elevated during hospitalisation because of acute illness, disease or treatments.¹⁸ Additionally, the dietary intakes of hospitalised patients are often poor, which may be due to a number of patient-related (i.e. poor appetite, nutrition impacting symptoms), service-related (i.e. food provision) and care delivery-related factors.^{3,16,18,19} Patients on therapeutic diets are at particular risk of eating inadequately, due to lack of choice or dislike of food (i.e. texture modified diets)^{16,20} or inadequate provision of nutrients (i.e. fluid diets).²¹ Given the severe consequences of

malnutrition for both patients and hospitals,^{18,22,23} assessing dietary adequacy in this high-risk patient group is warranted. However, to date no studies have focused specifically on nutritional adequacy of patients requiring therapeutic diets. This study aims to assess both the accuracy of food and fluid items provided to patients prescribed therapeutic diets and the adequacy of these patients' intakes to meet their estimated energy and protein requirements in the hospital setting.

METHODS

An observational study was conducted to assess both the accuracy (i.e. correctness of dietary items) of meals provided to patients on therapeutic diets and the adequacy of patients' intakes (i.e. in relation to their estimated energy and protein requirements). Ethical approval was gained from the hospital's Human Research Ethics Committee (HREC) and its affiliated university's HREC (reference numbers: HREC/13/QGC/162 and AHS/24/14/HREC). Patients were observed across six wards (gastroenterology, neurology, neurovascular, rehabilitation, surgical and urology/surgical; each with 28 beds) at a metropolitan university tertiary teaching hospital in Queensland, Australia. The hospital foodservice used a cold plating system, in which defrosted pre-prepared frozen meals or fresh cooked meals that had been blast-chilled were plated cold and heated using a Burlodge trolley. Meals were delivered by foodservice staff directly from the Burlodge trolley, which simultaneously heats hot foods and drinks (on one side of the meal tray) and refrigerates cold foods and drinks (on the other side of the tray). Patients on low fibre and low allergen diets ordered their meals using paper menus, which were collated and assigned to meal trays in the kitchen. If patients selected an inappropriate food item, this was crossed off the menu by foodservice staff and replaced with an appropriate substitute. For other therapeutic diets (such as fluid-based diets and texture modified diets), a set menu was used and a standard meal provided. Therapeutic diets were prescribed to patients as indicated by medical, surgical or nutritional requirements. Patients were included if they were able to provide informed consent (i.e. aged ≥ 18 years and cognitively intact) and prescribed one of the following therapeutic diets: modified texture/fluid thickness, low allergen, low fibre, clear fluids and free fluids. These diets were chosen as inaccurate provision of food in any of these instances may lead to serious adverse events; therefore strict adherence is imperative for patient safety. Exclusion criteria were previous enrolment in the study or receiving palliative care. A pragmatic approach to recruitment was adopted (i.e. no predetermined sample size) to ensure the data collector could accurately observe patients'

meals. A randomised ward list was used to approach patients until approximately 5–10 patients were enrolled each day. Patients remained in the study until discharge, change of diet code, or reaching 48 hours of enrolment, whichever occurred first. This timeframe was chosen to allow for collection of one full day of dietary intake. Data were collected over 14 consecutive days to capture the full 2-week menu cycle at the study hospital. Foodservice staff members were informed of the study; however, information on the accuracy component was not disclosed in order to avoid any changes in staff behaviour due to being observed (i.e. the Hawthorne effect).²⁴ The data collector was familiarised with the hospital foodservice system and trained in assessing meal accuracy and estimating intake by observing plate waste. The data collection tools and study methods were piloted one day prior to data collection. The accuracy of each meal delivered to all patients enrolled in the study (~5–10 patients per day) was assessed using an observational data collection tool for a maximum of 48 hours (i.e. six main meals). This was done by observing meal trays delivered to patients at each mealtime (i.e. breakfast, lunch and dinner). Each item on the patient's meal tray was checked against a list of items allowed for that specific therapeutic diet and the meal was identified as either accurate (containing all correct dietary items) or inaccurate (containing one or more incorrect dietary items) according to the therapeutic diet. Mid-meal food and fluid items were collected via patient recall and assessed the same way. If a meal was assessed as being inaccurate, the error was then classified as being critical or non-critical. Critical errors were defined as those that posed an immediate risk to patient safety, such as a patient receiving a thin fluid when on a thickened fluid diet. Non-critical errors were defined as those that did not pose an immediate threat to patient safety, but could impact negatively on the patient's nutritional intake, for example a patient receiving a clear fluid meal when on a free fluid diet. No evidence-based definition of a low fibre diet exists, however research suggests <15 g of fibre per day could constitute a low fibre diet.²⁵ Hence, if a main meal on a low fibre diet included ≥ 5 g of fibre it was considered a critical error. Sources of all errors were categorised as being related to the foodservice, if the error was present on meal delivery (i.e. error occurred on plating line or from provision of incorrect dietary items by foodservice delivery staff); other staff; the patient themselves; the patients' family; or another patient. Patients' nutritional intakes were observed over a 24-hour period (i.e. three consecutive main meals) within the 48 hours of accuracy assessment using visual estimation, which has been previously established as a valid and reliable method of collecting dietary intake data.^{26,27} Food intake was recorded in quartiles (i.e. none, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ or all) for each meal component. Consumption of foods brought in from outside the hospital foodservice was also documented. Patients' demographic (i.e. age, gender), medical (i.e. diagnosis, co-

morbidities) and nutrition-related data (i.e. weight, height, body mass index (BMI), diet code) were collected from their electronic medical record and bedside charts. All data were entered into SPSS (Statistical Package for the Social Sciences) statistical software, version 22 (IBM, Chicago, IL, USA) for analysis. Accuracy data for each meal were entered as categorical variables (i.e. accurate or inaccurate; critical or non-critical; sources of errors). Descriptive statistics were used to analyse patient demographic data and accuracy data. The number of inaccurate meals was calculated as a percentage of total meal occasions and the proportion of critical versus non-critical errors and the frequency of error sources were described. Oral intake data was entered into a FoodWorks database (Xyris Software, Brisbane, Australia) containing nutritional information of all food provided by the hospital foodservice as well as generic Australian food supply information. This allowed for the calculation of each patient's energy and protein intake over a 24-hour period. Disease-specific estimated energy requirements (EER) and estimated protein requirements (EPR) were calculated using Australian best practice clinical guidelines for patients with specific disease states.²⁸ Patients' oral intakes were reported as a percentage of their requirements and were considered adequate if $\geq 75\%$ of EER and EPR were met, which has previously been shown to be adequate for weight maintenance among hospitalised patients.²⁹ Patients' oral intakes and requirements were analysed descriptively and a one way analysis of variance test was used to determine any association between intake and diet type.

RESULTS

A total of 67 patients' meals were assessed for accuracy. Of these, complete 24-hour nutrition intake data was available for 48 participants for determination of adequacy of energy and protein intake. Most patients (n=53, 79%) were solely reliant on the hospital foodservice system for all food and fluid provision. More participants were male (n=36, 54%) and mean $\pm$ SD age and BMI were 60 ± 19 years and $27 \pm 8 \text{ kg/m}^2$, respectively. Median length of stay was four days (interquartile range 2–7 days). The majority of participants were from gastroenterology (n=38, 57%) and neurology (n=10, 15%) specialties. Of a total of 347 meals observed, 20% (n=68) were inaccurate. There were more critical errors (n=46, 13% of all meals) than non-critical errors (n=22, 6% of all meals). Table 1 describes total and critical errors according to diet code. Low fibre and low allergen diets had the highest proportion of total and critical errors. Examples of critical errors included provision of gluten or lactose containing foods on low allergen diets (gluten-free or low-lactose diets); provision of free fluids on clear

fluid diets; provision of $\geq 5\text{g}$ fibre at any one meal on a low fibre diet; provision of incorrect texture or fluid thickness on texture modified/thickened fluid diets; and provision of solid foods on free fluid diets. Most non-critical errors included the provision of an incorrect meal tray that did not pose a critical threat to patient safety, but would likely result in inadequate oral intake. For example, provision of clear fluids to a patient prescribed a free fluid, low fibre or low allergen diet; or provision of a level of texture below what the patient was considered to be able to tolerate (i.e. puree diet given to patient on a soft diet). Non-critical risks in these cases were determined on a patient-specific basis. The highest proportion of errors occurred at dinner (n=26 of 108, 38%), followed by lunch (n=22 of 96, 32%) and breakfast (n=16 of 111, 24%). Only 32 mid-meals (i.e. morning tea, afternoon tea, supper) were observed, of which four (6%) were inaccurate. The majority of critical errors originated from the hospital foodservice (n=34, 74%), which was consistent across all diet codes. Very few critical errors were due to other staff (n=5, 11%), families (n=4, 9%), the patient (n=2, 4%) or another patient (n=1, 2%).

Table 1: Number of total and critical errors according to diet category

Diet category	Total errors, n	Critical errors, n (% of total errors)
Low fibre	15	15 (100)
Low allergen ^a	8	7 (88)
Clear fluid	8	6 (75)
Modified texture/fluid	25	15 (60)
Free fluid	12	3 (25)
Total	68	46 (68)

^aIncludes gluten free and low lactose diets.

A total of 48 (n=20 female) patients' dietary intakes were assessed relative to estimated requirements. There were no differences in age, gender or diet codes between patients who were and were not included in dietary analyses. Mean energy and protein intakes were $3192 \pm 2220\text{kJ}$ and $33 \pm 27\text{g}$, respectively. Patients' mean EER were $8363 \pm 1502\text{kJ}$ and mean EPR were $81 \pm 15\text{g}$. On average, patients consumed $39 \pm 26\%$ of EER and $40 \pm 32\%$ of EPR. Figures 1 and 2 depict patients' energy and protein intakes relative to requirements. Only five (10%) and seven (15%) patients ate adequately in regards to energy and protein, respectively.

Figure 1: Patients' estimated energy requirements compared with energy intakes (n=48).

Figure 2: Patients' estimated protein requirements compared with protein intakes (n=48).

Note: Outlier (low protein requirement of 38g).

Table 2 describes mean percentages of EER and EPR met according to diet code. Patients on fluid-based diets had the poorest intakes relative to their estimated requirements. Patients on clear fluids met on average 19 and 11% of their EER and EPR, respectively; and those on free fluids met 29% of their EER and EPR.

Table 2: Percentage of EER and EPR met (mean $\pm$ SD) according to diet code

Diet code (n)	Energy (kJ)	Protein (g)
Clear fluid (8)	19 $\pm$ 12	11 $\pm$ 9
Free fluid (12)	29 $\pm$ 24	29 $\pm$ 29
Modified texture/thickness (14)	51 $\pm$ 23	56 $\pm$ 29
Low allergen (3)	54 $\pm$ 7	62 $\pm$ 5
Low fibre (7)	52 $\pm$ 30	60 $\pm$ 36

DISCUSSION

The present study assessed the accuracy (i.e. prevalence of errors) of meals provided to patients on therapeutic diets and the adequacy of patients' intakes in regards to their estimated energy and protein requirements. Overall, approximately one in five meals provided was inaccurate, of which, more than two-thirds posed a critical threat to patient safety. Most of the critical errors in the current study originated from the hospital foodservice. This is of concern, given the vast majority of hospitalised patients who rely solely on the hospital foodservice for provision of nutrition.^{3, 4} In addition, more than 85% of patients receiving therapeutic diets ate inadequately in comparison to their individually determined energy and protein requirements. This study found that a significant proportion of patients on therapeutic diets were exposed to critical food-related errors that may have an acute influence on their safety. Despite the risks associated with inaccurate provision of dietary items on certain therapeutic diets, there is a lack of evidence around the accuracy of food delivered to hospital patients. Other studies assessing meal accuracy in hospitals found similar error rates (9–15%)^{14,15} to the current study (13%). The lower incidence of critical errors observed in the study by Glover et al. (9%) may be due to the inclusion of standard diets (in addition to therapeutic diets),¹⁵ which would not produce errors due to allowing unrestricted food choices. The study by Folio et al. assessed therapeutic diet errors only and found a similar error rate (15%) to the current study; however types of therapeutic diets assessed and sources of errors were not reported.¹⁴ In addition, these studies are much older and were conducted in the US hospital setting, so are not widely generalisable as foodservice systems are likely to have undergone much change in the last few decades. Further research is needed around the frequency, sources and reasons for foodservice errors, given the number of patients found to be exposed to these errors in the current study. The proportion of critical errors in the current study was higher among certain therapeutic diets. For example, around a third of meals provided to patients on low fibre and low allergen diets were critically inaccurate compared to texture modified diets and fluid-based diets ($\leq 12\%$). The high error rates in low fibre meals may, in part, be due to lack of consensus around what constitutes a low fibre diet.²⁵ It is possible that ambiguity in this definition may contribute to poor staff awareness of acceptable menu items for the low fibre diet. Similarly, determining appropriate options for low allergen diets (gluten free and low lactose) may be difficult for staff given the diversity of food items available within hospital foodservice (i.e. packaged items, bulk food, meals prepared from multiple ingredients sourced from different suppliers). As texture modified and fluid-based diets are clearly visible (i.e. if foods are pureed, fluids are

thickened or fluids only are to be provided), it may be easier for staff to broadly identify appropriate items for these diet categories. However, different requirements within these diets may be more difficult to detect (i.e. mildly vs. moderately thickened fluids, minced moist vs. puree diet, free fluid vs. clear fluid) and this is likely to be where errors occur. The proportion of critical meal errors also varied according to meal time. Of main meals, the rate of critical errors increased over the day from 8% at breakfast, to 13% at lunch and 20% at dinner. Previous research has suggested that greater menu complexity and increased variety of choice may contribute to higher error rates at the evening meal.¹⁴ However, as menu options and plating methods in the current study were similar for lunch and dinner, other factors may have played a role in higher error rates observed at dinner and supper. For example, the number of foodservice staff available after hours (i.e. at delivery of evening meals) is fewer and there may be less access to more senior staff, support or training around meal accuracy. Whilst staffing profile was not monitored in this study, the higher error rate observed at the supper mid-meal (29%) compared with morning and afternoon tea (15 and 0%, respectively) suggests that future research should investigate the impact staffing profile may have on error rates. There is likely to be a number of factors contributing to food-related errors among patients requiring therapeutic diets. As mentioned earlier, poor definitions of certain diets, high number and turnover of food items within the foodservice system and complex menus may make it difficult for staff to identify accurate items for therapeutic diets. A range of organisational, service and care-related issues may also play a role, such as the meal ordering system, poor communication and documentation of dietary changes, high number and turnover of foodservice staff, high workload and stress and lack of clear guidelines or protocols for accurate provision of food to patients. Many of these issues could be addressed with adequate staff education, training and resources and excellent organisation, management and communication between foodservices and clinicians. However, more research is needed to better understand the reasons why food-related errors occur and their underlying causes. These issues should be assessed within the local hospital context in order to develop strategies appropriate to that organisation, its staff and patients. This study also found that the adequacy of patients' intake to meet their nutritional requirements was suboptimal. Patients' mean energy and protein intakes were significantly lower than their estimated requirements, with patients meeting approximately 40% of these requirements. Previous studies have shown inadequate energy and protein intakes among hospitalised patients are common, especially when prescribed therapeutic diets such as modified textured diets.^{4,16,19} Across all 24-hour observations, only five (10%) and seven (15%) patients ate adequately in regards to energy and protein (i.e. met $\geq 75\%$ of their requirements),

respectively. However, it should be noted that eight patients were prescribed a clear fluid diet, which is known to be inadequate.³⁰ Despite this, given the severe consequences of malnutrition,^{3,18,31} these results are of concern; especially, considering the majority of patients studied were from gastroenterology or neurology specialties, who may have increased requirements due to surgery or decreased intake due to gastrointestinal symptoms or chewing or swallowing difficulties.¹⁸ There are many possible reasons why patients on therapeutic diets eat inadequately, and these may relate to the patients themselves or the hospital environment. For example, patients may have increased nutritional requirements or experience a poor appetite, nausea or vomiting, taste or smell changes, or chewing or swallowing problems associated with acute illness, chronic disease or treatments.¹⁸ They may not like the foods provided in the hospital and being on a therapeutic diet (such as texture modified, thickened fluids or clear/free fluid diets) can further restrict food choices. The therapeutic diets may not have contained enough nutrition to meet patients' needs, which was likely the case for patients on fluid-based diets in the current study. For example, patients prescribed clear and free fluid diets had the poorest intakes, consuming less than 20% of their estimated energy and protein requirements on average. Whilst this study did not assess the amount of energy and protein provided to patients on therapeutic diets to assess the nutritional adequacy of these diets, this highlights an area of interest for future research. Finally, service and care delivery factors such as poor tray placement, lack of feeding assistance, interrupted or missed meals due to procedures, inadequate nutritional screening and referral and lack of nutrition support may also affect patients' dietary intakes.¹⁸ This study is the first to report the accuracy and adequacy of meals provided to patients requiring therapeutic diets in the hospital setting. The number of critical errors among these diets is alarming, given their potential for acute effects on patient safety. As most errors originated from the foodservice, strategies targeting all levels (organisational, system and individual staff levels) are needed to minimise their occurrence. Further research is needed to determine the underlying causes of different sources of dietary errors in order to develop appropriate and effective strategies. Also, the majority of patients on therapeutic diets ate inadequately to meet their nutritional requirements, which may be placing them at risk of malnutrition. There are a number of factors that may contribute to this; however, the provision of adequate nutrition to patients on all therapeutic diets by the hospital foodservice is a fundamental step in helping patients to achieve dietary adequacy.

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