



Room Service Improves Nutritional Intake and Increases Patient Satisfaction While Decreasing Food Waste and Cost



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ABSTRACT

Background Room service is a foodservice model that has been increasingly implemented across health care facilities in an effort to improve patient satisfaction and reduce food waste. In 2013, Mater Private Hospital Brisbane, Australia, was the first hospital in Australia to implement room service, with the aim of improving patient nutrition care and reducing costs.

Objective The aim of this study was to comprehensively evaluate the nutritional intake, plate waste, patient satisfaction, and patient meal costs of room service compared to a traditional foodservice model.

Design A retrospective analysis of quality-assurance data audits was undertaken to assess patient nutritional intake between a facility utilizing a traditional foodservice model and a facility utilizing room service and in a pre–post study design to assess plate waste, patient satisfaction, and patient meal costs before and after the room service implementation.

Participants Audit data were collected for eligible adult inpatients in Mater Private Hospital Brisbane and Mater Hospital Brisbane, Australia, between July 2012 and May 2015.

Main outcome measures The primary outcome measures were nutritional intake, plate waste, patient satisfaction, and patient meal costs.

Statistical analyses performed Independent samples *t*-tests and χ^2 analyses were conducted between pre and post data for continuous data and categorical data, respectively. Pearson χ^2 analysis of count data for sex and reasons for plate waste for data with counts more than five was used to determine asymptotic (two-sided) significance and *n*-1 χ^2 used for the plate waste analysis. Significance was assessed at $P < 0.05$.

Results This study reported an increased nutritional intake, improved patient satisfaction, and reduced plate waste and patient meal costs with room service compared to a traditional foodservice model. Comparison of nutritional intake between a traditional foodservice model (*n*=85) and room service (*n*=63) showed statistically significant increases with room service in both energy (1,306 kcal/day vs 1,588 kcal/day; $P=0.005$) and protein (52 g/day vs 66 g/day, $P=0.003$) intake, as well as energy and protein intake as a percentage of requirements (63% vs 75%; $P=0.024$ and 65% vs 85%; $P=0.011$, respectively). Total mean plate waste decreased from 29% (traditional foodservice model) to 12% (room service) ($P < 0.001$). Patient satisfaction ratings indicated improvement with room service across all Press Ganey meal scores: 68th to 86th percentile overall; 64th to 95th percentile for “quality of food”; and 60th to 99th percentile for “flavor of food.” Evaluated during comparable times of the year, patient meal costs decreased by 15% with room service.

Conclusions A patient-centered foodservice model, such as room service, can improve patient nutritional intake and enhance patient satisfaction in a budget constrained health care environment.

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ROOM SERVICE IS A FOODSERVICE MODEL THAT HAS been increasingly implemented across health care facilities over the past 10 years in an effort to improve patient satisfaction and reduce food waste.¹⁻³ This increasing focus to improve patient satisfaction

while providing evidence-based clinical care is expected to occur within the cost-constrained health care environment. Foodservice models are also increasingly being assessed with regard to their impact on patients' nutritional intake.^{4,5} Consequently, comprehensively measuring all key outcomes

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related to foodservice system improvements becomes important to ensure an evidence-based approach to determining optimal foodservice systems for hospitals.

As there is a paradigm shift to more personalized, patient-centered care, patient satisfaction has increasingly become a driver of high-quality care.² Foodservice quality has been linked to patient satisfaction⁶ and, in the United States, room service is increasingly being seen as the foodservice model for hospitals to meet this outcome.^{1,2}

Increasing resource restrictions within the health care system are driving facilities to scrutinize the costs of service delivery and investigate avenues for saving. The provision of food to patients and associated levels of waste are often a priority focus in cost-management strategies.^{1,7} Sources of food waste are varied and can include foodservice model design (bulk cooking and rethermalizing, long lead time forecasting, and in-advance meal ordering), missed meals due to environmental factors (hospital procedure and test scheduling), and individual patient factors (reduced appetite and other impacts of clinical symptoms and treatments, such as nausea or pain).⁷ Foodservice models that can reduce or eliminate these sources of waste are considered optimal from this cost-management perspective.

Hospital malnutrition is a well-documented clinical issue associated with adverse clinical outcomes, increased mortality and morbidity, increased hospital length of stay, and increased costs.⁸⁻¹² Poor food intake is now recognized as an independent risk factor for hospital mortality and clinical dietitians struggle with maximizing patients' nutritional intake in the health care setting.^{11,13} As a result, attention is increasingly being paid to the impact of foodservice models on patients' nutritional intake.^{9,14}

While the room service model has been recommended to improve patient satisfaction and reduce food costs and/or food waste,^{3,4,15,16} few studies have investigated the impact of a room service model on patients' nutritional intake in comparison to their nutritional requirements. The few studies that have measured nutritional intake have been limited to specific patient populations, such as the pediatric population,^{4,17} or small subgroups of the adult patient population, such as cardiac,¹⁸ and therefore, these data may have limited application across other patient populations.

Similarities between the Australian and US health care sectors are evident in the challenges faced by dietitians and foodservices in delivering high-quality, cost-effective, and evidence-based foodservice models that assist patients to maintain adequate nutritional intake within the acute care environment.^{1,2,7,11,16,17} Malnutrition prevalence rates as documented in the literature are also evidence of the ongoing challenges faced globally by dietitians in the identification, assessment, and treatment of this issue.^{8-11,13,19-21}

The aim of this study was to comprehensively evaluate patient nutritional intake, plate waste, reasons for plate waste, patient satisfaction, and patient meal costs associated with room service compared to a manual, paper menu, tray line, set mealtime traditional foodservice model. The hypothesis is that the room service model will show improvements from the traditional foodservice model in

nutritional intake, plate waste, patient satisfaction, and meal costs.

METHODS

Mater Group comprises 5 individual facilities within its South Brisbane Campus (Queensland, Australia). Within this group, Mater Private Hospital Brisbane is a 200-bed private, acute care, adult hospital and Mater Hospital Brisbane is a 126-bed public acute care adult hospital. Both Mater Private Hospital Brisbane and Mater Hospital Brisbane have a similar case mix of patients, designated by subgroup in general medical, surgical, and oncology wards. The organizations' annual malnutrition point prevalence audit data shows comparable malnutrition prevalence rates for 2016 at 24% for Mater Private Hospital Brisbane and 27% for Mater Hospital Brisbane.

In June 2013, Mater Private Hospital Brisbane became the first hospital in Australia to implement room service as a patient foodservice model. At this time, Mater Private Hospital Brisbane transitioned from a traditional foodservice model to room service, using the CBORD Room Service Choice On-Demand module.²² In the room service model, patients order meals from a new single integrated a la carte style menu anytime between 6:30 AM and 7 PM by phoning room service representatives in a central call center. Meals are prepared on demand and delivered within 45 minutes of receiving the order. The remaining facilities on the campus, including Mater Hospital Brisbane, continued using the traditional foodservice model. In this model, patients order their meals via completing a paper menu (cook fresh, 14-day cycle menu) up to 24 hours before meals, which are then collected at a set time by nutrition assistant staff. Meals are delivered at set meal times during the day: breakfast between 6:30 and 7:30 AM; lunch between 11:45 AM and 12:45 PM; and dinner between 5:00 and 6:00 PM.

Menus for both room service and traditional foodservice model were entered into the CBORD Food and Nutrition Solutions (Nutrition Service Suite and Foodservice Suite)^{23,24} and analyzed for nutritional quality and to ensure compliance to therapeutic diets and the New South Wales Agency for Clinical Innovation Nutrition Standards for Adult Inpatients and Queensland Health Nutrition Standards for Meals and Menus.^{25,26}

A retrospective analysis of nutritional intake data collected at Mater Hospital Brisbane traditional foodservice model (pre) in August 2014 and Mater Private Hospital Brisbane room service (post) in May 2015 was conducted. Audits for nutritional intake were not completed for Mater Private Hospital Brisbane before transitioning to room service in June 2013. As Mater Hospital Brisbane and Mater Private Hospital Brisbane shared the same menu, foodservice model (traditional foodservice model), and staff before Mater Private Hospital Brisbane transitioning to room service, using Mater Hospital Brisbane traditional foodservice model audit data was considered appropriate for comparison of traditional foodservice model to room service. A retrospective analysis of routinely collected quality-assurance data in a pre-post study design measured plate waste, patient satisfaction, and overall patient meal costs to enable a comparison of traditional foodservice model (pre) and room service (post) at

Mater Private Hospital Brisbane between July 2012 and May 2015.

Due to the retrospective analysis design of this study, there were several different time points for the data collection between July 2012 and May 2015. Throughout this time period the foodservice model; staffing; equipment and menu content, design, and recipes all remained the same (with the exception of room service implementation changes). Brisbane, Australia, has a subtropical climate with relatively small variation in seasonal temperatures between summer (28° to 29°C [82° to 84°F]) and winter (24° to 25°C [75° to 77°F]) months.²⁷ Minimal changes to food preferences due to seasonal variation are seen and any major influence on food selection in the air-conditioned hospital environment is unlikely.

The Mater Health Human Research Ethics Committee assessed this project as exempt from requiring ethical approval. As a retrospective analysis of deidentified routine audit data, it did not meet the definition of research in accordance with the [Australian] National Statement on Ethical Conduct in Human Research.²⁸

Nutritional Intake

Nutritional intake data were collected by University nutrition and dietetics students during their foodservice internship placements. The data collection was supervised by the nutrition and dietetics department's senior clinical educator, senior foodservices dietitian, and director of nutrition and dietetics, as part of the quality-assurance process. Students were provided 1 day of training in the data collection methodology and use of the tool by the senior clinical educator, including knowledge of serving sizes, and were assessed in the use and scoring of the tool to ensure accuracy and uniformity of data collection between auditors. During these audits, patient demographic data, including age, sex, weight, and height was obtained via hospital records. A meal intake observation tool using a 5-point visual scale (0, 1/4, 1/2, 3/4, all) was used to record the volume of each meal consumed by the patient.²⁹ This tool is a quick way to evaluate intake, has been widely used in practice and has been published in studies with large cohorts.^{13,29} Total nutritional intake was recorded across a minimum 24-hour consecutive period, including all meals and snacks to determine energy and protein intake per day. Nutritional intake audits were undertaken during a 4-day period in August 2014 for traditional foodservice model (at Mater Hospital Brisbane) and May 2015 for room service (at Mater Private Hospital Brisbane). Patients were excluded if they were classified as nil per os, restricted to fluids only, on enteral or parenteral nutrition, younger than 18 years old, critically ill or palliative, did not have a weight recorded, or had less than 24 hours of consecutive nutritional intake data. Number of meals ordered per group was not collected because, although this is set for traditional foodservice model (3 meals and 3 snacks per day), it is not set for room service, and patients are able to order as many or as few meals and snacks as they like.

Nutritional analysis was performed using CBORD Food and Nutrition Solutions,^{23,24} which contains the AusNut Special Edition nutrient database.³⁰ The recorded percentage (volume) of each individual menu item consumed was assessed separately and used to calculate energy (in kilocalories) and

protein (in grams) for individual patient's meals across a 24-hour period.

The patient's weight was used to estimate their energy and protein requirements by subgroup: medical (30 kcal/kg; 1.0 g/kg protein), surgical (30 kcal/kg; 1.2 g/kg protein), and oncology (32 kcal/kg; 1.35 g/kg protein). When body mass index (calculated as kg/m²) was >30, adjusted ideal body weight was used to calculate these requirements to reflect current clinical practice on the wards.³¹⁻³⁷ A comparison was then made to assess percentage of protein and energy consumed against estimated requirements by patient subgroup.

Plate Waste

Plate waste was measured by University nutrition and dietetics students during their foodservice internship placements via quantitative data collection using a 5-point visual scale (0, 1/4, 1/2, 3/4, all) meal intake observation tool^{13,29} at Mater Private Hospital Brisbane during a 4-day period in traditional foodservice model during March 2013, and in room service in May 2015. The 5-point visual scale tool was used to evaluate each of the individual food items on the plate and from that the overall plate waste was calculated. Students were provided 1 day of training in the data collection methodology and use of the tool by the senior clinical educator, including knowledge of serving sizes, and were assessed in the use and scoring of the tool to ensure accuracy and uniformity of data collection between auditors. Overall percentage of plate waste was calculated. All of the edible components of items ordered were evaluated, including beverages, with the exception of bottled water given its nil contribution to energy and protein intake. Patients were excluded if they were nil per os, restricted to fluids only, on enteral or parenteral nutrition, younger than 18 years old, or critically ill or palliative. For patients who had plate waste recorded, a semi-structured interview with each patient was completed to capture reasons for plate waste. Patients were asked, "What would you say is the main reason that you haven't been able to eat your meal today?" Based on previous audit experience, a list of 13 predefined reasons plus "other" was provided for data collectors to select as the main reason(s) that patients reported for not consuming part or all of their meal. Patients were excluded from interview if they were unable to communicate, were in isolation rooms, or did not consent to interview.

Patient Satisfaction

Patient satisfaction was analyzed using the organization's routine Press Ganey³⁸ survey data results for Mater Private Hospital Brisbane within the benchmarking category "Private Hospitals 151 to 300 beds," to measure performance against peer organizations. Seven food domains are measured via Press Ganey survey, including overall satisfaction with meals; courtesy of staff serving food; temperature of the food; quality of the food; flavor of the food; timeliness of the delivery; and special/restricted diet explained. Room service implementation occurred in the second quarter of 2013. Survey results were compared for quarter 1 in 2013 (traditional foodservice model), quarter 1 in 2014 (room service-time 1) and quarter 1 in 2015 (room service-time 2). Survey questions remained the same throughout this period.

Comparable quarter results were analyzed to minimize impact of seasonal fluctuations and variations.

Patient Meal Costs

Total food costs for all patient meals were obtained from foodservice department end-of-month finance expense reports and were compared between traditional foodservice model and room service for Mater Private Hospital Brisbane. Traditional foodservice model data were analyzed for the 5-month period July to November 2012 and room service data for the 5-month period July to November 2014. Comparable 5-month datasets were used to avoid seasonal fluctuations in food costs and use. Australian annual mean inflation rate for food for the period 2012 to 2015 was 2.1% and was considered when evaluating overall patient meal cost data for this period.³⁹ Patient meal costs were calculated and compared as patient food cost per occupied bed day. Occupied bed days were comparable for each period: 43,201 occupied bed days for traditional foodservice model and 42,172 occupied bed days for room service.

Data Analysis

Statistical analysis was performed using SPSS software.⁴⁰ For dietary intake and continuous demographic data, descriptive statistics (mean, standard deviation, and percentages) were calculated. Checks for normality were conducted using histograms and Q–Q box plots with the Shapiro-Wilk test applied as required. Log-transformations were undertaken for non-normative data. Independent samples *t*-tests and χ^2 analyses were conducted between pre and post data for continuous data and categorical data, respectively. A Pearson χ^2 analysis of count data for sex and reasons for plate waste for data with counts more than five was used to determine asymptotic (two-sided) significance and *n*-1 χ^2 used for the plate waste analysis. Significance was assessed at $P < 0.05$.

RESULTS

Nutritional Intake

Nutritional intake data were collected for 85 patients for traditional foodservice model and 63 patients for room service. There was no significant difference between participant demographics of age, weight, and sex in the traditional foodservice model vs the room service model (Table 1).

After the introduction of room service, mean energy intake, protein intake, percent of estimated energy requirement, and percent of estimated protein requirement all increased significantly from traditional foodservice model values ($P = 0.005$, $P = 0.003$, $P = 0.024$, and $P = 0.011$, respectively) (Table 2). When analyzed for the oncology, surgical, and medical wards, respectively, there was a significant increase in energy intake, protein intake, percent of estimated energy requirement and percent of estimated protein requirement in the medical wards for room service ($n = 23$) in comparison to traditional foodservice model ($n = 21$) ($P = 0.045$, $P = 0.019$, $P = 0.019$, and $P = 0.021$, respectively). Comparative data for surgical and oncology subgroups is shown in Table 3.

Plate Waste

Plate waste data included a total of 1,428 individual food items served to 244 patients with traditional foodservice

Table 1. A comparison of patient demographic characteristics between a group^a of adult inpatients receiving a traditional foodservice model at the Mater Hospital Brisbane (Australia) in August 2014 and a group^a of adult inpatients receiving room service at the Mater Private Hospital Brisbane (Australia) in May 2015

Characteristic	Traditional foodservice model (n=85)	Room service (n=63)	P value ^b
	←—mean±SD ^c —→		
Age, y	62.9±19.5	66.3±15.1	0.234 ^d
Weight, kg	79.9±24.8	76.9±19.6	0.417 ^d
	←—n (%)—→		
Sex			0.958 ^e
Female	49 (58)	36 (57)	
Male	36 (42)	27 (42)	
	←—mean±SD—→		
EER, ^f kcal/d	2,131±418	2,181±475	0.506 ^d
EPR, ^g g/d	83.9±17.8	83.8±21.4	0.943 ^d

^aPatients from nutritional intake analysis.

^b $P < 0.05$ indicates statistical significance.

^cSD=standard deviation.

^dIndependent sample *t*-test (two-tailed). Data assumptions met. Equal variances not assumed due to Levene's test for equality of variances.

^e χ^2 .

^fEER=estimated energy requirement.

^gEPR=estimated protein requirement.

Table 2. A comparison of energy and protein intake (absolute and percent of requirements) between a group of adult inpatients receiving a traditional foodservice model at the Mater Hospital Brisbane (Australia) in August 2014 and a group of adult inpatients receiving room service at the Mater Private Hospital Brisbane (Australia) in May 2015^a

Variable	Traditional foodservice model (n=85)	Room service (n=63)	P value ^b
	←—mean±SD ^c —→		
Mean energy intake, kcal/d	1,306±514	1,588±652	0.005
Mean protein intake, g/d	52.3±23.9	65.9±29.6	0.003
Proportion of EER, ^d %	63.0±26.4	75.1±33.0	0.024 ^e
Proportion of EPR, ^f %	65.0±33.4	84.7±52.4	0.011 ^e

^aFluid diets excluded for all analyses.

^bIndependent Samples *t*-test (two-tailed). Data assumptions met. Equal variances not assumed due to Levene's test for equality of variances. $P < 0.05$ indicates statistical significance.

^cSD=standard deviation.

^dEER=estimated energy requirement.

^eLog transformed.

^fEPR=estimated protein requirement.

Table 3. A comparison of energy and protein intake (absolute and percent of requirements) between a group of adult inpatients receiving a traditional foodservice model at the Mater Hospital Brisbane (Australia) in August 2014 and a group of adult inpatients receiving room service at the Mater Private Hospital Brisbane (Australia) in May 2015 by ward

Variable	Traditional foodservice model ^a	Room service ^b	Difference, mean±SE ^c	P value ^d
	←————— mean±SD ^e —————→			
Energy intake, kcal/d				
Oncology	1,288±474	1,703±801	415±278	0.148 ^f
Medical	1,336±523	1,696±623	360±174	0.045 ^f
Surgical	1,297±526	1,382±509	85±132	0.522 ^f
Protein intake, g/d				
Oncology	45.7±22.1	64.2±32.7	18.4±11.6	0.126 ^f
Medical	55.1±25.1	74.7±28.0	19.7±8.0	0.019 ^f
Surgical	52.5±23.9	58.0±27.3	5.5±6.3	0.382 ^f
Proportion, % of EER^g				
Oncology	58.9±24.5	72.1±32.3	13.1±11.8	0.275 ^f
Medical	64.3±23.1	88.1±39.7	23.8±9.7	0.019 ^h
Surgical	63.2±28.2	63.9±20.1	0.7±5.7	0.904 ^h
Proportion, % of EPRⁱ				
Oncology	49.5±25.0	65.7±32.7	16.3±11.9	0.185 ^f
Medical	76.3±40.1	117.0±67.2	40.6±16.9	0.021 ^f
Surgical	63.5±30.9	66.4±26.5	2.9±7.5	0.705 ^f

^aOncology, n=10; medical, n=21; and surgical, n=54.

^bOncology, n=18; medical, n=23; and surgical, n=22.

^cSE=standard error.

^dIndependent sample *t*-test. Data assumptions met. *P*<0.05 indicates statistical significance.

^eSD=standard deviation.

^fEqual variances assumed due to Levene's test for equality of variances.

^gEER=estimated energy requirement.

^hEqual variance not assumed due to Levene's test for equality of variances.

ⁱEPR=estimated protein requirement.

model in comparison to 1,032 individual food items served to 200 patients with room service. Overall, the mean plate waste decreased significantly from 29% to 12% (*P*<0.001). When analyzed by subgroup, significant decreases were seen in the oncology wards from 34% to 6% (*P*=0.029), and the surgical wards from 31% to 15% (*P*=0.020). While plate waste for the medical subgroup decreased from 20% to 11%, it was not statistically significant (*P*=0.072). Data on patient reasons for waste were compared between traditional foodservice model (reported reasons for waste n=294) and room service (reported reasons for waste n=98). Default meals, inadequate menu, and ordering issues were no longer reported as a reason for plate waste in room service compared to traditional foodservice model (Table 4).

Patient Satisfaction

Improvements in patient satisfaction were seen on five of seven food measures across consecutive and similar quarter periods, and an increase in satisfaction on all food measures during a 2-year period (Figure).

Patient Meal Costs

Compared to a 5-month period for traditional foodservice model, total patient meal costs were decreased by 15% for the equivalent 5-month period for room service. Staffing (full-time equivalent levels) remained unchanged pre and post implementation.

DISCUSSION

As hospital foodservice models increasingly transform to meet a range of key performance indicators within the health care setting, comprehensive measurement of the benefits is crucial. Some research has shown the benefits of room service in decreasing food costs and waste,^{1,4} while other research has evaluated the improvement in patient satisfaction.^{3,15,16} However, there is a paucity of literature on the impact on patient nutritional intake. This is the first study to comprehensively measure the impact of a room service model, incorporating data on nutritional intake specific to patient subgroup in an acute care adult hospital, while also measuring key outcomes around plate waste, patient satisfaction, and meal costs. Systematically measuring each of

Table 4. A comparison of patient reasons for plate waste between a group of adult inpatients receiving a traditional foodservice model in March 2013 and a group of adult inpatients receiving room service in May 2015 at Mater Private Hospital Brisbane (Australia)^a

Patient reason for plate waste	Traditional Foodservice Model (n=294 ^b)		Room Service (n=98 ^b)	
	n	%	n	%
Satiated/satiation	156	53	44	45
Surgery/medical/eating discomfort/nausea/unwell/taste changes	39	13	12	12
Taste/temperature/dislike/texture/appearance	31*	11*	25*	26*
Appetite/hunger	26	9	9	9
Default meal	17	6	0	0
Portion too large	13	4	8	8
Inadequate menu	6	2	0	0
Order system/in advance/eating timeframes	5	2	0	0
Away at time of delivery	0	0	0	0
Diet type/restrictions	1	0	0	0
Treatment by staff/visitor	0	0	0	0
Assistance/environment	0	0	0	0
Other	0	0	0	0

^aData assumptions met. Pearson χ^2 analysis only conducted for counts more than five.

^bn=number of reported reasons. Number of patients, traditional foodservice model=244; room service=200.

* $P < 0.05$.

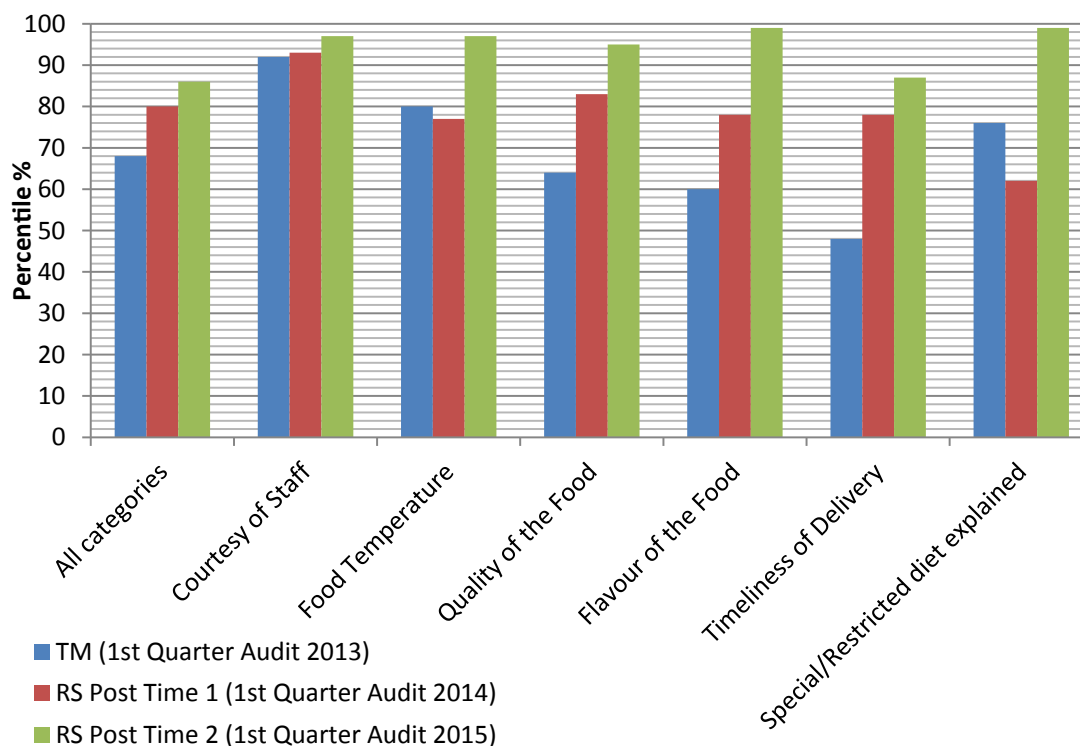


Figure. Press-Ganey³⁸ percentile satisfaction response data for three time points between 2013 and 2015 for adult inpatients of Mater Private Hospital Brisbane (Australia). The three time points included traditional foodservice model (TM) before room service (RS) implementation (n=433), RS post time 1 (within 6 months of RS implementation; n=412) and RS post time 2 (more than 1 year after RS implementation; n=375). n=number of patient responses to food component of survey.

these key outcomes and recognizing the impact and connection each measure can have on the other allows for a balanced, evidence-based approach to foodservice model evaluation.

In popular foodservice literature, the philosophy of room service is that patients can choose to eat when and what they feel like (within therapeutically determined diet compliance limits),^{41,42} leading to the expectation that they will eat a greater proportion of what they order. This premise was supported through these research findings. A focus on foodservice models is becoming increasingly important to clinicians as they search for strategies to enable increased intake for patients in the acute care setting to minimize nutritional risk and negative outcomes associated with malnutrition.

Statistically significant increases were seen in both total energy (kilocalories) and protein (grams) intake in room service in comparison to traditional foodservice model, as well as a statistically significant increase in intake as a percentage of requirements for both energy and protein. This was also seen for the medical subgroup. Many patient populations face significant challenges in meeting their nutritional requirements in the hospital setting and with poor food intake recognized as an independent risk factor for hospital mortality and negative and costly clinical outcomes,^{11,13} foodservice models that facilitate improved nutritional intake can be considered both clinically and financially beneficial.

The oncology population is typically a very difficult patient population to feed because of disease and treatment symptoms, such as poor appetite, feelings of nausea, and being unwell, as well as regular and rapid taste changes due to both disease and treatments.^{3,15-17} These patients often find it difficult to order meals in advance, as indicated in the reasons for waste provided by patients in plate waste data. These patients benefit from being able to eat at times that they feel hungry or have some appetite rather than at predetermined set meal times. A similar benefit is seen in surgical populations who may be fasting for periods of time that regularly coincide with set meal times. This can result in patients who often have higher than normal nutrient requirements^{43,44} having less opportunity to eat due to incompatibility between hospital set meal times and clinical treatment schedules. While room service was anticipated to overcome these barriers and significant increases in energy and protein intake were reached in the medical subgroup, significant differences in energy and protein intake between the traditional foodservice model and room service model were not found for oncology or surgical ward patients in this study. More appropriately powered research is needed with larger numbers of patients per subgroup to further investigate this hypothesis.

Overcoming barriers to reduced intake have predominantly focused to date on strategies to improve menu content quality, variety, and choice, including providing high-protein/energy-enriched choices and supplements; ward-based strategies, such as protected meal times; spoken bedside menu ordering models, and increased interactions with meal order staff.^{5,45-49} The room service model delivers on many of these strategies, but also addresses the traditional limitations around timing of meals (no set meal times) while simultaneously expanding menu choice and availability throughout the day (most menu items available across the day) to

facilitate a truly patient-centered approach. The redesign of the menu for room service allows for increased flexibility and selection of items through the “build your own” concept, such as for sandwiches and omelets, as well as an increased scope of the types of items considered for menu inclusion, given the short-order nature of this model (such as burgers and pizzas), which would not be suitable for a bulk cooking in advance model. Therefore, this menu may be considered a more appealing and higher-quality menu with regard to both the number and type of items available, contributing to increased nutritional intake through item acceptability, irrespective of service design. However, it is the nature of the room service design (cook on demand) that allows these types of items to be offered. This comprehensive approach to providing patients with a wide range of high-quality foods at a time when they feel like eating is most likely to drive increases in intake.

Nutritional intake is often inferred via plate waste studies.^{7,16} Kuperberg and colleagues⁴ reported on increased nutritional intake in a pediatric population similar to Williams and colleagues,¹⁷ but neither measured intake relative to requirements. A study of adult cardiology patients¹⁸ reported an increase in energy intake, primarily from fat sources, but no change in protein intake. They focused on the specific characteristics of the cardiology patient, including body mass index and the relative contribution of macronutrients carbohydrate vs fat to total energy intake and the associated risks of these. Intake data were collected via patient completed self-reported intake sheets. Doorduijn and colleagues¹⁴ used food order data as a measure of food intake to report on nutritional intake in a room service style model (“At Your Request”), but did not have data for their pre (non-room service) model to compare, and only assessed intake against nutritional status (body weight, hand grip strength, and Malnutrition Universal Screening Tool⁵⁰ score).

This study showed a reduction in overall plate waste (29% to 12%) to levels significantly lower than traditional, order in advance, preplated meal models, which range between 20% and 40%.⁷ This is consistent with a reduction seen in another room service study.¹⁶ The premise of room service is that patients can order “what they want, when they want it” resulting in greater intake and therefore less waste. Bulk service systems whereby the patient can choose what they feel like at the time of eating from a bulk service trolley have reported up to 50% less plate waste compared with preplated systems, but have the added waste of bulk food unserved from the trolley.⁷ The benefit of cook on demand room service is that it enables an increase in patient intake, while reducing both individual patient plate waste and eliminating bulk cooking waste typically seen in order in advance, bulk cooking models. This study showed significant reductions in plate waste in patient populations that are typically most difficult to feed, such as the oncology population. When comparing reasons for waste between traditional foodservice model and room service, while the most common reason remained the same (satisfied/satiation), the next most common response for leaving food differed between the two groups. Traditional foodservice model group listed feeling nausea/unwell/discomfort/taste changes, whereas room service group listed taste/temperature/dislike of foods. The traditional foodservice model group also listed default meals (not getting a meal that the patient ordered) as a reported

reason for plate waste as well as difficulty ordering meals so far in advance, with patients not knowing what they would feel like eating the next day. In contrast, there are no default meals in the room service model and no requirement to order in advance.

The positive impact of room service on patient satisfaction is commonly reported in the literature. It has been reported as both a driver and an outcome of this model.^{1,2,6} Consistent with previous research, this study demonstrated increases in patient satisfaction via Press Ganey survey.³⁸ Improvements were seen on five of seven food measures across consecutive and similar quarter periods and an increase in satisfaction on all food measures during a 2-year period. Aase² describes multiple factors that may impact on patient satisfaction as it relates to food, including other aspects of clinical care, reduced patient anxiety in general, and the effect of personable service and connection with patients by meal order and delivery staff. Conversely, food may be considered an important aspect in mitigating anxiety, stress, and suffering of a patient.² It could also be expected that patients with greater control over their meal choices and times would report greater satisfaction. Room service addresses a number of these factors through increased staff to patient interactions and patient control in meal ordering when compared to a traditional foodservice model. A key point of difference from the traditional foodservice model that might be beneficial to patient satisfaction is the elimination of structured meal times, focusing the hospital's meal service around the patient's clinical treatment schedule, rather than being driven by the organization's operational production schedule.

A reduction in food costs expected with room service has been reported in the literature.^{4,51} This study reported a 15% reduction in total patient meal costs with room service, which may be attributed to a number of factors. Food costs can be affected by a number of variables within a foodservice system or model. These include the number and type of patients and corresponding diet complexities; therapeutic diet menu integration and associated additional production of items for special diets; lead time between patient meal ordering, cooking and delivery; and the misalignment of meal time and clinical procedure schedules, resulting in missed meals and production of additional or extra meals. In the transition to room service in this study, menu redesign to a single a la carte restaurant style menu occurred. The clinical and foodservice dietitians worked closely with the executive chef to ensure 97% of therapeutic diets were integrated into the single menu, eliminating the cost of producing extra items for special diets. The removal of bulk cooking and corresponding overproduction waste is also expected to have contributed to the reduction in food costs. It is likely that a reduction in overordering of extra meals for patients who did not receive their choice (eg, patients who did not get to place a meal order or had their diet requirements change after completing their original menu order) was a significant contributor to the reduction in waste with a corresponding impact on the reduced costs. The timeliness of meal ordering in the room service model ensures that patient's diet requirements are current when they order their meals, and the meals are cooked to order. All of these variables link to potential sources of waste that contribute to meal costs. By

eliminating many of these sources of waste, room service can result in cost savings compared with traditional models as found in this study.

In transition to room service, there was also a removal of routine mid-meals/snacks ordered for patients on specific therapeutic diets, which are expected to have contributed to the overall decrease in food costs. Interestingly, rather than a reduction in nutritional intake, which might have been expected after this removal, patient nutritional intake increased overall. Further research into meal ordering and intake patterns in the room service model may be useful to determine preferred intake patterns and allow adjustment of menu items to support additional increases in intake.

This study included a comprehensive measure of key outcomes associated with the redesign of a foodservice model from traditional foodservice model to room service. Nutritional intake showed increases not only with regard to total energy and protein intake, but also as a percent of patient requirements. When assessing inter-ward data, subgroup samples were small; therefore, this is a potential area for further research. Overall plate waste decreased and patient meal costs decreased with the elimination of several points of food waste. Patient satisfaction increased across all measures related to food.

The principle limitation of this study was the retrospective analysis of quality audit data based on a cross-sectional convenience sample. This resulted in several different time points for data collection during a period of 2½ years, with the risk of other factors and internal hospital changes possibly affecting data quality. Also, data were used from two different hospitals (one private, one public) for the evaluation of nutritional intake data because audits for nutritional intake were not completed for Mater Private Hospital Brisbane before transitioning to room service. This introduced the possibility that hospital-specific factors might have influenced the research findings. However, very few changes were made within the hospital foodservice environment during this period and the foodservice model; staffing; equipment; and menu content, design, and recipes all remained the same (with the exception of room service implementation changes). A randomized controlled trial was not a feasible option within this live hospital environment; however, a strategic pre–post approach within a shorter defined timeframe would be recommended for future room service implementation research.

Another limitation is related to the number of auditors collecting data. Nutritional intake and plate waste data were evaluated from the department's routine ongoing quality-improvement program and collected by final-year nutrition and dietetics students during their foodservice internship placements. As a result, there were 18 student dietitians involved in this data collection, which poses a risk of inconsistencies between individuals for the recording of the observational data. In an effort to overcome this risk, training in the data collection methodology and the use of data collection tools was conducted before the commencement of data collection, and the students were assessed in their use and scoring of the tool.

Collecting meal intake data in the live hospital environment can be difficult and a limitation of studies focusing on this outcome measure. The most comprehensive method of

weighing individual meal items before and after patient meals are delivered and consumed is often considered the most accurate measure of intake and has been referred to as the imperfect gold standard.⁵² This was deemed too difficult on such a large scale and not feasible in this live hospital environment. This study used a meal intake observation tool to evaluate nutritional intake and plate waste, which records items as a percentage rather than weight. While this tool has been used in other studies to measure nutritional intake,^{13,29} it has not been validated and is, therefore, a limitation of this study.

This study evaluated data for nutritional intake collected over a relatively short time period (4 days per site). Due to this short data collection period, exclusion criteria and the requirement for minimum 24 hours of consecutive meal order data, a relatively small number of patients were included per subgroup (medical, surgical, and oncology). While the small datasets met the assumptions for statistical analysis, this resulted in reduced power of statistical comparisons. Future studies should aim to achieve greater patient numbers to allow sufficient power to analyze these effects in subset population groups.

While patient satisfaction data from the Press Ganey survey³⁸ is a well-recognized peer benchmarking tool, data collection is retrospective, and can be received up to 3 months post patient discharge. Using a validated patient satisfaction tool during hospital admission at the time of meal experience would add to these data and the subsequent evaluation of patient satisfaction could ideally include both patient satisfaction tools.

Finally, as this study was conducted in an acute care adult hospital setting, more studies are warranted to explore the generalizability of results to other geographical populations and settings including pediatric, senior living, or rehabilitation (long-term) facilities.

CONCLUSIONS

Redesign of hospital foodservice models is increasingly a focus to drive improved patient satisfaction and cost savings, but also to influence clinical outcomes associated with nutritional intake. Implementing room service, a patient-centered model of care, can demonstrate benefits across key measures related to nutrition and foodservice. The significant focus on evidence-based clinical care within health care should also apply to foodservice model redesign, with the expectation of improvements in key measures, including clinical outcomes, as well as organizational efficiency and cost-effectiveness measures. Measuring and reporting key outcomes in a comprehensive, balanced framework not only promotes improved clinical treatment of patients, but also informs ongoing research into evidence-based foodservice models, bringing together the financial, operational, and clinical drivers of both foodservices and clinical dietetics.

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