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Energy and protein intake increases with an electronic bedside spoken meal ordering system compared to a paper menu in hospital patients

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ABSTRACT

Background and aims: Electronic bedside spoken meal ordering systems (BMOS) have the potential to improve patient dietary intakes, but there are few published evaluation studies. The aim of this study was to determine changes in the dietary intake and satisfaction of hospital patients, as well as the role of the Nutrition Assistant (NA), associated with the implementation of an electronic BMOS compared to a paper menu.

Methods: This study evaluated the effect of a BMOS compared to a paper menu at a 210-bed tertiary private hospital in Sydney during 2011–2012. Patient dietary intake, patient satisfaction and changes in NA role were the key outcomes measured. Dietary intake was estimated from observational recordings and photographs of meal trays (before and after patient intake) over two 48 h periods. Patient satisfaction was measured through written surveys, and the NA role was compared through a review of work schedules, observation, time recordings of patient contact, written surveys and structured interviews.

Results: Baseline data were collected across five wards from 54 patients (75% response rate) whilst using the paper menu service, and after BMOS was introduced across the same five wards, from 65 patients (95% response rate). Paper menu and BMOS cohorts' demographics, self-reported health, appetite, weight, body mass index, dietary requirements, and overall foodservice satisfaction remained consistent. However, 80% of patients preferred the BMOS, and importantly mean daily energy and protein intakes increased significantly (paper menu versus BMOS): 6273 kJ versus 8273 kJ and 66 g versus 83 g protein; both $p < 0.05$. No additional time was required for the NA role, however direct patient interaction increased significantly ($p < 0.05$), and patient awareness of the NA and their role increased with the BMOS.

Conclusions: The utilisation of a BMOS improved patient energy and protein intake. These results are most likely due to an enhancement of existing NA work processes, enabling more NA time with patients, facilitating an increase in patient participation and satisfaction with the service.

1. Introduction

Hospital malnutrition is a serious clinical issue, associated with adverse clinical outcomes and increased costs [1]. Consequently, it is essential hospitals identify and implement dietetic interventions to address the contributors to sub-optimal dietary intake to support the provision of optimal nutrition care to patients. Health information technology (HIT) is becoming integral in healthcare and is

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associated with improving healthcare delivery, patient safety, clinical decision-making and curtailing increasing healthcare costs [2–4]. In parallel to the rise in technology, a paradigm shift from a paternalistic medical model to a personalised patient-centred approach [5,6], often referred to as participatory medicine, is gaining momentum [7]. The electronic bedside spoken meal ordering system (BMOS) embraces both, utilising technology to enable increased patient interaction with a Nutrition Assistant (NA) to make preferred and suitable menu selections, answer questions, resolve issues and initiate appropriate dietetic referrals.

In the complex system of healthcare, a variety of factors influence dietary intake, however very few studies have investigated the patient meal ordering component. The recent introduction of electronic systems for meal ordering offers an alternative to the traditional process of a paper menu. These new models enable patient meal selections to be collected at the bedside on handheld electronic devices with the assistance of a NA creating opportunities to increase patient/staff interaction and engage patients in the meal ordering process.

In the few studies on BMOS, the focus has been on improving patient satisfaction [8,9]. However, some studies have also demonstrated increased tray accuracy [8], increased efficiency and effectiveness [9] and labour savings [10,11]. One study identified the potential of a BMOS to optimise dietary intake [11], and another demonstrated patient weight gain [12]. The aim of this study was to determine changes in the dietary intake and satisfaction of hospital patients, as well as the role of the NA, associated with the implementation of an electronic BMOS compared to a paper menu.

2. Methods

The quasi-experimental pre-test post-test cohort study was conducted at a 210-bed private hospital with an average length of stay of 6.0 days for the eligible study wards (which excluded Maternity and day stay patients). The prevalence of nutritionally at-risk patients is not routinely recorded, however the other hospitals within the organisation identified malnutrition prevalence by Subjective Global Assessment (SGA) as 42% [13]. The foodservice and nutrition departments provide a cook-fresh, 7-day menu and utilise the CBORD® Food Management System (FMS) software to manage all of the foodservice and diet office operations. The NAs take menu selections for dinner the same day, and breakfast and lunch for the following day. During the paper menu phase the NAs delivered and collected personalised printed patient menus from the wards, and then entered the selections into the FMS in the diet office. In contrast, during the BMOS phase, the NAs visited all patients and discussed their menu selections at the bedside, entering them directly into FMS on a wireless mobile device. The menu, recipes and food items offered to patients did not change between the two study periods. However, the fact that the BMOS is electronic enables access to all of the available menu items for that meal and potentially more choices to be offered to the patient, compared to the printed personalised menus.

All patients admitted to the orthopaedic, orthopaedic rehabilitation, cardiology, oncology, general medical and gynaecology wards during the two weeks of data collection periods were eligible for inclusion. Maternity wards, day stay patients and patients who were nil by mouth or restricted to fluids only were excluded. Baseline pre-implementation data were collected from eligible consenting participants in September 2011 whilst using the paper menu service (paper menu cohort). The BMOS was introduced in May 2012, and the post-implementation data were collected from eligible consenting participants in November 2012 (BMOS cohort). Data were collected by the primary researcher and five final year University dietetic students during a foodservice placement. The data collection processes and tools utilised were the same for both the paper menu and BMOS cohorts. The study proposal received ethics approval (11/119) through the St. Vincent's and Mater Health Human Research Ethics Committee.

A simplified version of the '24-h diet observation/recall' tool used in the Australasian Nutrition Care Day Survey [14] (48hr Diet Observation Chart Supplementary File) was used to estimate food intake over two 48 h periods, encompassing all meals over four days of the seven day menu. Participants were visited after each main and mid meal by student dietitians and their meal consumption was recorded as 0, 25, 50, 75 or 100 percent of all the food served. In addition, each main meal tray was photographed before delivery and after consumption, and in-between meal details were observed and recorded on paper. The nutrition analysis was performed using FMS, which contains the AusNut Special Edition database, and contains nutritional analysis of the menu items and recipes. Based on the photographs, the percentage consumed of each menu item was entered to obtain the energy and protein intake values. The Schofield equation was utilised to calculate estimated energy requirements, and protein requirements were based on 1 g/kg for all patients based on being in the medical classification of minor surgery or rehabilitation.

All consenting participants were provided with two surveys to complete after they had been admitted greater than 24 h and had received at least the three main meals. The validated Foodservice Patient Satisfaction Survey [15] was utilised to gather patient demographic data and measure food service satisfaction (covering meal quality and enjoyment, autonomy, staff consideration, and hunger and food quality). The survey uses an 'always' to 'never' 5-point rating scale for the 38 questions relating to food service satisfaction. However, as this survey only includes one question on the meal ordering service ('I am asked about my food and drink preferences'), a specifically designed Meal Selections Survey was developed to assess patient satisfaction with the meal ordering service and about their interaction with the NA (such as were they visited by a NA and were they provided advice regarding the menu and meal choices). The survey encompassed 5 questions, including yes/no (4 questions), multiple-choice (1 question) and opportunities for further comments (Patient Questionnaires Supplementary File). The survey was piloted and tested for content validity by five dietitians. The survey was modified based on the feedback received, which included a couple of word modifications, and re-tested once more as the dietitians then reached a consensus.

The NA role was compared through a review of work schedules, observation, time recordings of patient contact, written surveys and structured interviews. NA patient contact during menu delivery and pickup was observed and recorded by student dietitians to determine the time spent face-to-face with patients, and to document the communication themes. All NAs were provided with written pre (paper menu) and post-(BMOS) implementation surveys to determine their preferred service model, and to assess if there were changes in the utilisation of their nutrition knowledge; patients' awareness of the NA role; and the level of menu selection assistance provided to patients. The survey encompassed 13 questions, including short answer (6 questions), multiple-choice (4 questions), yes/no (3 question) and opportunities for further comments (Nutrition Assistant Questionnaires Supplementary File). The NAs were also invited to participate in a short structured interview with the primary researcher after the BMOS was introduced to discuss their overall thoughts about both services.

Statistical analysis was performed using SPSS software (version 22, 2013, SPSS Inc., Chicago, IL, USA). The Shapiro–Wilk test was performed to test for normality. Descriptive statistics (mean, count and percentages), Mann–Whitney U and independent *t*-tests were performed to determine significant differences between the two

cohorts and investigate the relationships between continuous variables, and Chi Square tests and z-tests were performed to analyse categorical data. The level of significance was set at $p < 0.05$.

3. Results

Paper menu data were collected across five wards from 54 patients (75% response rate), and the BMOS data collected across the same five wards from 65 patients (95% response rate). The reasons patients declined included: medical reasons/acutely unwell [21] and without reason [7].

There were minimal significant differences between the paper menu and BMOS participant demographics. However, the average length of stay was one day shorter in the BMOS cohort, and the majority of the paper menu service cohort (59%) were admitted for orthopaedic surgery compared to 51% of the BMOS cohort admitted for general medical or gynaecological surgery (Table 1). Overall the study participants (paper menu and BMOS combined) had an average age of 65.1 years, with an average length of stay 9.1 days, an average body mass index (BMI) of 28.5 in the acceptable weight range adjusted for age ≥65 years (25–29.9) [16], self-reported normal appetite and good health, and reflected a similar mix of 'prescribed' diets and diagnoses. The longer length of stay of study participants compared to the hospital population was most likely a result of the study requirement for participants to be in hospital greater than 24 h to be eligible (in order to comment on the meals and meal ordering process), and then a further 48 h to be able to complete all of the data collection. Unsurprisingly given the similarities in the participant demographics, no significant difference in the energy or protein requirements between the two groups was calculated.

3.1. Dietary intake

The observed intake demonstrated an increase in overall consumption across all meals between the paper menu and BMOS cohorts ($p < 0.05$). On average 76% of the paper menu cohort consumed greater than 50% of their main meals, compared to 98% of the BMOS cohort ($p < 0.05$). The number of patients who consumed 100% of their meal increased significantly with BMOS for breakfast and dinner (Fig. 1). Food intake was significantly higher at breakfast compared to other meals (70% consumed all of breakfast, compared to 48% and 46% consuming all of lunch and dinner respectively) ($p < 0.05$) in both paper menu and BMOS cohorts.

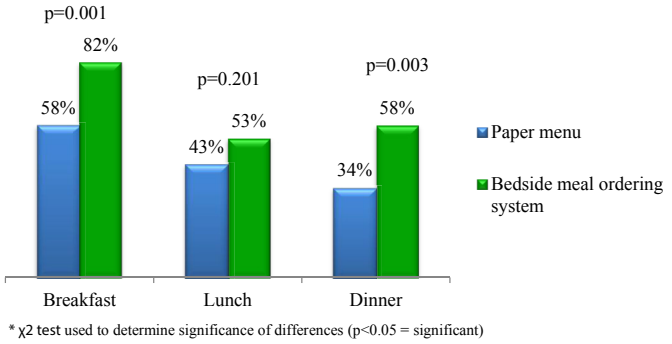

Fig. 1. Comparison of proportion of paper menu and BMOS participants who consumed 100% of the served meal.

The results of the dietary intake analysis from the tray photographs was consistent with the observation findings of an increase in intake between the paper menu and the BMOS across all meals, demonstrating the mean daily energy and protein intake increased significantly ($p < 0.05$) (Table 2). Energy intake increased significantly for all meals ($p < 0.05$), as did protein intakes, averaging between five and nine grams extra per meal (Table 2). These intakes also reflected a significant increase in percentage of energy and protein goals achieved (both $p < 0.05$). Greater than half the BMOS participants met their estimated dietary goals (57% for energy and 50% for protein), compared to approximately 30% of the paper menu participants (31% for energy and 28% for protein).

The BMOS cohort selected a significantly greater number of menu item choices than the paper menu cohort for both lunch and dinner meals ($p < 0.05$) (Table 3). Paper menu participants on

Table 1
Participant demographics.

Data	Paper menu	Bedside meal ordering system	P value[a]
Age [years, mean ± SD]	65 ± 14	66 ± 13	0.765
Gender [% female]	69%	59%	0.258
Length of stay (days, mean ± SD)	9.8 ± 9.7	8.5 ± 11.9	0.010
Weight [g, mean ± SD]	80 ± 19.5	79 ± 18.2	0.751
Body mass index [mean ± SD]	29.6 ± 5.9	27.8 ± 5.5	0.364
Appetite [% normal or better]	75%	73%	0.582
Health, self-reported [% excellent, very good & good]	87%	78%	0.291
Diet types [n (%)]			0.101
Full	20 (37%)	29 (45%)	>0.05
Light	26 (48%)	20 (31%)	<0.05
High protein/high energy	0 (0%)	2 (3%)	>0.05
Cardiac/diabetic	4 (7%)	2 (3%)	>0.05
Texture modified	3 (6%)	5 (8%)	>0.05
Allergy	1 (2%)	7 (11%)	>0.05
Medical classification [n (%)]			0.000
Cardiac/Survey	6 (11%)	2 (3%)	<0.05
Oncology/Surgery	6 (11%)	10 (15%)	>0.05
Orthopaedic/Surgery	9 (17%)	33 (51%)	<0.05
General Medical/Gynaecology/Surgery	32 (59%)	12 (19%)	<0.05
Orthopaedic Rehabilitation	1 (2%)	8 (12%)	<0.05
Estimated dietary requirements			
Energy [kJ, mean]	7441	7667	0.455
Protein [g, mean]	80	81	0.660

[a] χ2 test and z-test used for nominal data, t-test used for parametric data and Man-Whitney U test used for parametric data to determine significance of differences ($p < 0.05$ = significant).

Table 2
Participant dietary intake comparison.

Data		Paper menu	Bedside meal ordering system	P value[a]
Daily energy intake	[kJ, mean ± SD]	6273 ± 1818	8273 ± 2043	0.000
	(kJ, range)	(2769–10,499)	(3465–13,201)	
	Breakfast [kJ, mean ± SD]	1483 ± 735	2222 ± 1116	0.001
	Lunch [kJ, mean ± SD]	1684 ± 565	2399 ± 858	0.000
	Dinner [kJ, mean ± SD]	1668 ± 762	2937 ± 903	0.000
Daily protein intake	[g, mean ± SD]	66 ± 25	83 ± 24	0.001
	(g, range)	(22–135)	(29–134)	
	Breakfast [kJ, mean ± SD]	13 ± 7.8	18 ± 10	0.007
	Lunch [kJ, mean ± SD]	22 ± 11	27 ± 10	0.028
	Dinner [kJ, mean ± SD]	24 ± 16	33 ± 16	0.009
Energy goal achieved				0.010
	<50%	8%	2%	
	51–75%	23%	11%	
	76–99%	39%	30%	
	>100%	31%	57%	
Protein goal achieved				0.016
	<50%	8%	4%	
	51–75%	36%	15%	
	76–99%	28%	30%	
	>100%	28%	50%	
Mean energy goal achieved [%]		86%	110%	0.001
Mean protein goal achieved [%]		86%	105%	0.020

[a] t-test used for parametric data and Man-Whitney U test used for parametric data to determine significance of differences ($p < 0.05$ = significant).

Table 3
Comparison of the number of menu items selected between the pre- and post-participants for breakfast, lunch and dinner.

		Paper menu (n = 242)	Bedside meal ordering system (n = 286)	P value[a]
Menu items selected [n (%)]		237 (97.9%)	286 (100%)	
Default/no selection [n (%)]		5 (2.1%)	0 (0.0%)	
No. of menus with extras/write-ins [n (%)]		20 (8.5%)	NA	
Breakfast items selected [n (%)]				0.522
	1–3	1 (1.3%)	1 (1.0%)	>0.05
	4–6	23 (28.8%)	28 (27.2%)	>0.05
	7–9	41 (51.3%)	62 (60.2%)	>0.05
	≥10	15 (18.8%)	12 (11.7%)	>0.05
Lunch items selected [n (%)]				0.001
	1–3	10 (12.5%)	1 (1.1%)	<0.05
	4–6	38 (47.5%)	36 (38.7%)	>0.05
	7–9	24 (30.0%)	50 (53.8%)	<0.05
	≥10	8 (10.0%)	6 (6.5%)	>0.05
Dinner items selected [n (%)]				0.005
	1–3	6 (7.8%)	6 (6.7%)	>0.05
	4–6	41 (53.2%)	14 (15.6%)	<0.05
	7–9	21 (27.3%)	60 (66.7%)	<0.05
	≥10	9 (11.7%)	10 (11.1%)	>0.05

[a] $\chi 2$ test and z-test used to determine significance of differences ($p < 0.05$ = significant).

average selected more items at breakfast (70% selected seven or more items compared to 40% for lunch and 39% for dinner), whereas the BMOS participants selected more items at dinner (78% selected seven or more items compared to 72% for breakfast and 60% for lunch).

Table 3 also demonstrates that only 8.5% of the paper menu cohort had extra menu items recorded. This may indicate these patients did not realise they had the opportunity to request extra foods that were not on the menu. The BMOS cohort had the opportunity to order from the entirety of meal options for that day and were not limited to what was printed on the paper menu.

3.2. Patient satisfaction

Overall foodservice satisfaction was very high from both cohorts, with 84% of the paper menu and 82% of the BMOS participants rating their overall satisfaction with the foodservice as 'very good' or 'good' ($p > 0.05$). No participants from either cohort rated their overall satisfaction with foodservice as 'poor' or 'very poor'.

Only three of the thirty eight survey questions recorded a significant difference in responses between the paper menu and BMOS participants. Not surprisingly, the one question that related to the BMOS 'I am asked about my food and drink preferences' was reported more often in the BMOS group ($p = 0.003$). The only other significant differences were 'chewing is difficult for me' ($p = 0.044$), and 'the crockery and cutlery are chipped and/or stained' ($p = 0.029$), both reported more often in the BMOS group who consumed more energy and protein.

Whilst overall foodservice satisfaction remained constant, significantly more (80%) of the BMOS cohort preferred the BMOS, 14% preferred the paper menu service, and 6% didn't mind either

option ($p < 0.05$). Verbal and written feedback from patients and anecdotal feedback from the wards from a variety of hospital staff indicated an enhanced NA presence on the wards. This outcome wasn't specifically measured as part of the study, but offers another positive benefit to the foodservice and nutrition departments, as well as the individual NAs.

3.3. NA role

An important outcome of the NA role analysis was there was no additional time required for the NAs to complete their tasks during the BMOS phase. However, the mean NA time with patients increased significantly from 0.33 to 3.5 min per patient per day ($p < 0.05$). This time enabled direct patient interaction, allowing for assistance with preferred and suitable menu choices. The patient interaction enabled opportunities for patients to order items that weren't written on the menu, to ask questions, as well as have their concerns heard and a resolution provided.

Fifty percent of the NAs preferred the BMOS prior to implementation, and the same 50% reported preferring the BMOS after implementation. However, the interviews revealed that of the 50% that expected to and reported preferring the paper menu, all agreed that there were many potential benefits to the patients and opportunities to utilise their nutrition knowledge and skills with the BMOS. All of these staff felt that over time when they were comfortable and confident with the new process that the BMOS would be their preferred system.

4. Discussion

Numerous dietetic strategies have been implemented to address the issue of hospital malnutrition. However, this is the first comprehensive hospital study to investigate utilising NAs and incorporating HIT to personalise the meal ordering process and offer a wider variety of menu choice for the purpose of enhancing the service to improve dietary intake. This study demonstrated that dietary intake increased significantly with a BMOS and enabled patients to exceed their individual dietary goals. Patients increased both the quantity of menu items they selected, as well as the percentage of overall meal being consumed using the BMOS.

Patterns of observed dietary intake in this study were consistent with findings of other Australian hospital studies, with a significantly greater quantity of the meal being consumed at breakfast compared to the other main meals [14,17]. However, the nutrition analysis identified that patient energy and protein intake continued to increase significantly over the day, with dinner being the highest contributor to dietary intake. The number of menu items selected at each main meal also didn't correlate with the dietary intake, suggesting that the menu items offered at lunch and dinner may be more nutrient dense than those at breakfast. Perhaps, given these findings, a greater variety of energy and protein dense breakfast items could be encouraged to take advantage of the time patients are consuming a greater proportion of their meal.

In addition, the BMOS enabled a significant increase in NA time for direct patient interaction and participation, assistance with preferred and suitable menu choices and offered an increased menu choice. Consequently, the patients reported preferring the personalised service the BMOS enabled due to feeling informed and involved in their decisions, having questions and concerns resolved immediately, being more efficient, and environmentally friendly. The results of this study suggest that patient participation and feelings of involvement may have a significant impact on patient dietary intake beyond food service satisfaction. Other studies have indicated the benefits of increased menu choice for improving dietary intake [18], increasing patient involvement through interaction with a NA for improving satisfaction [19,20], and patient wellbeing/emotions as an important predictor of dietary intake [21].

Poor appetite is the most frequently reported reason for poor dietary intake [14,22], with some of the contributors to appetite beyond patient illness relating to the patient's mood, depression status and feelings of social isolation [23]. In addition, patient eating patterns and meal preferences can change over the period of their hospitalisation, such as a preference for smaller more frequent meals [24]. This study has demonstrated that patient engagement through HIT has created an opportunity to increase dietary intake, and may be a valuable strategy to enhance feelings of engagement and consequently the appetite of patients. The NA can offer an important link between the patient and their meal, and assist patients to make suitable menu choices to meet their requirements and food and meal pattern preferences.

The staff satisfaction was predominantly a result of a change in work practice from office-based administration duties to utilising their nutrition knowledge and skills to directly care for and assist patients. Staff acceptance and increased satisfaction with a substantial change in their daily operations and departmental role is crucial for the long-term success of the service, as well as for widespread potential for adoption by other healthcare facilities. An unexpected benefit for the individual staff and the foodservice and nutrition departments was an enhanced staff presence on the wards, providing an opportunity for education, and an enhanced feeling of value by the NAs.

The principal limitation of this experimental study was the pre-test post-test cohort design. A randomised control trial was not a feasible option within a live hospital environment with the rollout of a new electronic system affecting the entire hospital. The two cohorts of participants were closely matched by gender, anthropometry, medical classification and dietary requirements, so it is unlikely that these factors would have had a significant impact on the results. However, the nutritional status of patients using the SGA would have provided additional useful information demographic data of this study population. As there were five student dietitians involved in the data collection, there may be inconsistencies between individuals for the recording of the observational dietary intake data. However, the results of the observational data reflected the analysis of the photographed dietary intake, suggesting there were minimal discrepancies. While the month of the year in which the two studies were undertaken were close (September/November), there was some difference in the mean monthly temperatures in those months (21.7° and 24.7 °C respectively) but any major influence on food selection in the air conditioned environment of the hospital is unlikely.

There were minimal significant differences in patient demographics between the two cohorts, and although in an acceptable weight range for age, a number of the patients may have been malnourished or at risk of malnutrition [14]. Imposing dietary restrictions on older, post-surgical patients with a long length of stay is potentially detrimental, with lower weights and malnutrition associated with a higher mortality risk [16]. With the average prevalence of malnutrition reported in the Australian (and international) acute healthcare setting 20–50% [25], the potential of a BMOS for improving hospital patient dietary intake and providing targeted advice and education is still a significant finding. Future research is required to identify if the BMOS has the same potential to improve patient dietary intake across all hospital patient populations, with a particular focus on patients at highest risk.

This study reflects the first comprehensive evaluation of the impact of a hospital BMOS, demonstrating significant improvements in dietary intake which is associated with improved patient outcomes and LOS [26–28]. In addition, patient satisfaction, staff

satisfaction and dietetic foodservice presence on the wards were noted. There is an enormous potential for hospitals and dietitians to re-orientate services and embrace patient participation through the adoption of HIT to support practice, maximising the efficiency and effectiveness of dietetics care.

Ethics

The study proposal received ethics approval (11/119) through the St. Vincent's and Mater Health Human Research Ethics Committee.

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Author contribution

Kirsty Maunder: Determined the study design, involved in the collection and collation of study results, statistical analysis and drafted the manuscript.

Carmel Lazarus: Assisted in the study design, involved in the collection and collation of study results and in the review of the manuscript.

Karen Walton: Assisted in the study design, statistical analysis and in the development and review of the manuscript.

Peter Williams: Assisted in the study design and in the development and review of the manuscript.

Maree Ferguson: Assisted in the development and review of the manuscript.

Eleanor Beck: Assisted in the development and review of the manuscript.

Conflicts of interest

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.clnesp.2015.05.004.

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