University of Alberta

Analysis of variables that impact nutrition care time per case and development of a staffing model for inpatient dietitians

by

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Abstract

This study was undertaken to improve understanding of what factors impact dietitian time per case and to develop a predictive model for determining dietitian staffing levels. Dietitian workload measurement data, nutrition risk classification levels, reason for service codes, age, gender, repeat patients and diagnosis groups for patients seen were obtained for 2002 - 2003. Analysis focused on tertiary care, adults (N=5811) and pediatrics (N=2610). Stepwise linear regression analysis was used to study what factors contributed to total time per case, and to create models for both adults and pediatrics. Length of stay had the largest impact on time per case. The Nutrition Risk Classification (levels 1 to 4) and reason for service (education, malnutrition, enteral and parenteral nutrition) significantly contributed to the model and predicted time per case. Repeat case contributed to the model for pediatrics only. Regression equations may provide an estimate of dietitian time needed per hospitalized patient in tertiary care.

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Introduction

In 1981 the American Dietetic Association Staffing Study Committee stated that, "Little work had been done in regards to establishing staffing standards for the dietetic practitioner" (1). The few studies that had been done were based on existing staffing levels and task responsibilities. There was no consideration of what services should be provided based on clinical outcomes and how long they should take with competent, experienced practitioners. Studies also had not evaluated the effectiveness of dietitian time in terms of the nutrition care provided and outcomes.

Almost 25 years later there have been relatively few studies investigating how to best determine dietitian staffing levels. Moreover, the scope of practice and role of dietitians has changed significantly over the past 20 years. In the 1960s and 70s, patients were prioritized based on whether they were on regular or special diets. Today, risk of malnutrition, acuity of illness or medical complexity, use of nutrition support, and need for nutrition education has a greater impact on patient prioritization.

Determining dietitian staffing needs can be challenging because dietitians provide a service, and the inputs and associated outcomes can vary depending on an organization's philosophy, dietitian scope of practice, and patients' nutrition risk, medical acuity and length of stay. Numerous factors can have an impact on inpatient dietitian staffing needs (Table 1).

Table 1. List of Factors that Impact Inpatient Dietitian Staffing Needs

Factor	Examples
Medical and nutritional acuity	• Types and size of hospital • Percent of admitted patients seen by dietitian • Average length of stay
Process for identifying patients that require service	• Screening versus consults
Standards of care	• Standards for screening , determining what patients are seen and prioritizing • Level of care provided, follow-up, and charting, care maps and clinical practice guidelines
Scope of practice of dietitian	• Role in provision of enteral and parenteral nutrition • Participation as a member of the multidisciplinary team
Nutrition services provided and ratio of inpatient to outpatient services	• Ability of dietitian to refer a patient to outpatient services/ home care services for education to be received
Efficiency of services provided	• Distance of office from wards • Ease of charting • Availability of patient handouts
Model for delivery of care	• Individual versus group
Team communication	• Bed-side rounds, kardex rounds
Use of technology	• Computerized menu automation • Electronic charting
Use of support staff	• Clinical Dietary Technologists used for food preferences, nutrition risk screening, and basic teaching
Non-patient care responsibilities	• Administrative responsibilities, clerical support, teaching responsibilities, etc
Participation in research	• Practice-based research projects done during work time
Competencies and skill level of dietitians	• Experienced versus novice dietitians

Staffing levels need to be in line with a region's or hospital's philosophy. For example, if outpatient services and chronic disease prevention and treatment are valued, more resources may be targeted at ambulatory settings. If a region or hospital values the role of dietitians in providing nutrition support (parenteral nutrition and enteral nutrition) and the prevention and treatment of malnutrition in hospital, more resources may be allocated for inpatient services than outpatient services. Furthermore, if a hospital has fewer outpatient services, dietitians may be inclined to do more inpatient teaching because there are not sufficient resources for the patient to be taught in the community. As a result of the numerous factors that may impact dietitian staffing needs, DeHoog stated that each hospital needs to establish dietitian staffing levels that best suit the patient population of the hospital, medical services, and division of inpatients versus outpatients (1).

The staffing methodologies developed to date have improved understanding of the various factors that impact dietitian staffing. Most studies, however, have been undertaken in the American health care model. Dietetic practice in the United States (US) may involve a different scope of practice, standard of care, use of technology, and use of clinical dietary technologists compared to Canada. Therefore, US models may not apply to the Canadian system. The time work studies that have been done are out of date and do not reflect the current activities of dietitians (1-5). The patient classifications tools developed largely focus on malnutrition, and do not reflect patient needs for education (6-8). In addition, they may place too great a weight on diagnosis (7,8). The medical diagnosis may not have a strong relationship with nutritional acuity and need for nutrition therapy and education. For example, a patient with Crohn's disease may be in remission and have good nutritional status or may be in an active stage of the disease and quite malnourished. Classification tools needs to reflect the different care requirements for the different stages of the disease. The model developed by Simmons and Vaughan (9) does place a greater focus on nutritional acuity. This model, however, does not separate different patient care areas which may have different staffing needs. By lumping together all patient care areas, the model may underestimate care requirements in some patient care areas and overestimate care needs in other areas. The model was developed using a US patient population in the early 90s, and it is not clear how effectively the model can be generalized to other patient populations. Furthermore, the model is time consuming to use because nutritional acuity needs to be measured on all patients in hospital on an ongoing basis. Dietitians may only be providing service to 20 – 50 % of patients, depending on the patient care area.

2.0 Purpose and Objectives

Workload measurement data is used to monitor productivity and to predict staffing changes required when there is a change in service delivery or bed numbers. Dietitians complete workload measurement for all patient care activities, and assign a nutrition risk classification level and reason for service code. The Nutrition Risk Classification Tool was developed in Capital Health for use by all inpatient dietitians. The purpose of the Nutrition Risk Classification Tool is to serve as a foundation for standards of care, and to assist in managing human resources by providing a comparison of dietitian activity within program areas and across sites. This data may be used to develop an improved method for determining dietitian staffing levels.

The purpose of this study is to identify factors that can be used to predict patient care time and to develop a dietitian staffing model for use in inpatient nutrition services. The specific objectives are to:

1) Validate whether the Nutrition Risk Classification tool provides a measure of nutritional acuity, defined by the time and frequency required for patient care;
2) Improve understanding of what factors impact dietitian patient care time per case; and
3) Develop a predictive model for determining dietitian staffing requirements.

The results of this study will be of value to nutrition managers in improving their ability to manage human resources more effectively and to advocate for dietitians when staffing levels are inadequate to meet patient needs.

3.0 Literature Review

Methodology for literature review

Research papers that summarized primary research on the use or development of a classification system and/ or staffing model were sought. Studies on other professions were sought to assist with development of the proposal and to improve understanding of staffing methodologies used by other health professions. This literature review summarizes studies that focused on the dietetic profession.

Pubmed (1966 – Present) was searched November 2002 using mainly descriptor or activity search terms, and to narrow down searches, these were combined with health professions (Table 2). No limits were used. The search was repeated February 2005 (limited to dietitian studies) and no new studies were identified.

Table 2. Search Terms Used for Literature Review

Descriptors or activities	Health Professions
Staffing	Dietitian or Dietician or Dietetics
Workload	Nutrition
Patient acuity	Nurse or Nursing
Productivity	Pharmacy
Patient classification	Social work
Ambulatory group	Physiotherapy
Workload measurement	Occupational therapy

Studies that were not primary research (e.g. reviews) were excluded. In addition, studies were excluded that studied physicians, non-front-line staff such as nurse educators or administrators, health professionals with time structured schedules such as dietary technologists, laboratory staff, pharmacy technicians, and staff who work in operating rooms, labor and delivery, and emergency rooms. Because of the vast amount of research in nursing, nurse studies prior to 1990 were excluded to limit the literature review. The search strategy resulted in 185 abstracts of references. These were reviewed and 56 papers met inclusion criteria; of these, 19 studies focused on dietitians.

For dietetic studies obtained, reference lists were reviewed to identify any papers that may have been missed. Editions of "Future Dimensions in Clinical Nutrition Management", a publication of the American Dietetic Association Clinical Nutrition Managers network, from 1998 – 2002 were reviewed to find submissions that discussed dietitian staffing. A list of dietitian staffing papers developed by the American Dietetic Association in 2002 was reviewed. In addition, nutrition management text books that discussed dietitian staffing were reviewed, including reference lists (10,11) .

Workload measurement systems

Workload measurement systems (WMS) are standardized methods to measure the volume of activity generated by professional staff or a department over a defined period of time. Canadian health care facilities began recording and reporting workload measurement data to Statistics Canada in 1931, and four organizations have been responsible for their maintenance since 1975: Federal/ Provincial Sub-Committee on Productivity, National Hospital Productivity

Improvement Program and The MIS Group (12,13). A Clinical Nutrition WMS was created in 1985 through the cooperation of the Federal/ Provincial Subcommittee of Productivity Improvement and the Canadian Dietetic Association. The objective was to create a "standardized, uniform method of recording and reporting activities that allows for the comparison and analysis of clinical nutrition activities, staff productivity, utilization and cost data either within individual health care facilities or between peer group on a regional or national scale" (12). In February 1994, the MIS Group of the Canadian Institute for Health Information (CIHI) assumed responsibility for the ongoing development and maintenance of workload measurement systems and reporting frameworks (13).

In 1996 a framework was created that could be applied to the following disciplines: inpatient nursing, speech and language pathology, child life/recreation, clinical nutrition, occupational therapy, pastoral care, physiotherapy, psychology, and social work (13). This framework provides for comparability of data across all allied health professionals. Categories of the WMS include patient care activities and non-patient care activities. Patient care activities may be direct (require patient's presence) or indirect (do not require patient's presence). Non-patient care activities include departmental administration and support, clinical teaching and research. Actual time in minutes is recorded retrospectively. New referrals, active carryovers, active patients and attendance days are also captured.

Dietitian inpatient staffing models

The majority of research on dietitian staffing requirements can be classified as one of the following:

- Clinical productivity or time work studies for activities or level of care (1-5,14)
- Dietitian staffing based on patient classification and acuity (6-8)
- Benchmarking to compare level of staffing among similar facilities. Usually ratios of dietitians to patients or beds are compared (15,16)
- Dietitian staffing predicted based on patient nutritional acuity factors (9)

Prior to the 1980s, research primarily focused on productivity studies: workload statistics and time required to perform various tasks (4). Bartscht (5) formulated equations for use in calculating the number of hospital dietitians required based on existing staffing levels and task responsibilities. Another study by Casey (3) used work sampling to determine productivity time standards and identified seven steps for a hospital to create a staffing model. Staffing was based on standards for what patients are seen, what activities are performed, and the number of patients.

In 1979, the American Dietetic Association created a Dietetic Staffing Study Committee who undertook to develop staffing guidelines (4). The committee intended to do a large scale survey of nutrition clinics and health care facilities. In the end, a smaller study was done to determine time estimates and frequency levels for each activity in the nutrition care matrix. An in-depth, self administered questionnaire was mailed to a randomly selected sample of 300 dietitians. Data collected included time estimates for the completion of patient-specific nutrition care activities; time estimates for non-patient specific nutritional care and related activities; and characteristics of the facility, the practitioner's background, and the practitioner's workload that may affect the amount of time spent performing the activities of interest to the study. A nutrition care matrix was developed that had three levels of care: basic, intermediate and in-depth, and 25 specific tasks were identified. Hospital characteristics and the practitioners' background or workload were found to have little impact on the time estimates. Based on this study, a method for determining staffing needs was developed by the committee and was tested by several health care facilities throughout the United States. The method involves the hospital collecting productivity data and estimates staffing from activities, time, and frequency.

Most early staffing models did not consider the nutritional acuity of patients. Patient nutritional acuity is based on 1) the activities required to care for patients, 2) time required for each activity and 3) the frequency with which the activities must occur to provide quality nutrition care. Nutritional acuity is not measured by the diagnosis or the risk factors themselves. DeHoog (1) was one of the first researchers to consider patient nutritional acuity. She completed a productivity study that determined staffing based on the number of patients at nutrition risk. Patients at nutrition risk were identified based on a one day survey and retrospective chart review. Clinical productivity was measured during a four-week time management study. Staffing needs were determined from the data collected including the percent of patients deemed at risk and an analysis of the time study. Based on this study, 4 categories of levels of care were created: basic care, preliminary nutrition screening, moderate risk, and high risk. Staffing needs were based on the number of patients in each category. Relative value units or RVUs (standard times in 5 minute intervals) were created for screening, assessing, monitoring and for follow-up care (17). Patient care time was calculated by multiplying the number of patients in each level by the frequency of tasks and the RVU for each task. Total work hours available were calculated considering non direct care (administrative responsibilities, student education, meetings, medical rounds) and non productive care (coffee breaks, personal time, delays for records, patients, elevators). Using the methodology developed by DeHoog and colleagues, dietitian-patient ratios and frequency of monitoring patients, which assume 80 % of time in direct patient care, were summarized for 4 levels of care (17):

- Level 4 intensity (complex/in depth)- 1 dietitian:10-15 adult patients or 15 pediatric patients seen daily or every other day;
- Level 3 intensity (major/advanced)- 1 dietitian: 16-20 adult or pediatric patients, or 20-30 NICU patients seen every 2-3 days;
- Level 2 intensity (moderate/intermediate)- 1 dietitian: 20 -25 adult or pediatric patients or 16-12 NICU patients, seen every 4-5 days
- Level 1 intensity- 1 dietitian: 50 adult or pediatric patients seen every 6-7 days.

Gobberdiel (14) also considered nutritional acuity in estimating staffing needs. Two categories of clinical activity, basic nutrition care and in depth nutrition care, in addition to a diagnosis category and weighted diet order, were used to estimate staffing needs.

A Canadian study identified activities performed by dietitians, categorized as patient care activities or patient care support activities (18). Data was collected for 6 months and D-units (5 minute time intervals) were obtained for each task. Staffing requirements were calculated based on the number of patients who were at risk of malnutrition or who were on modified diets (e.g. 45 %), average time required per patient (e.g. 1 hour) and total patients (based on total beds and length of stay). The staffing requirements were based on the assumptions that all patients on a modified diet should be assessed and that all patients at nutrition risk should be screened and given appropriate nutrition therapy.

In 1992, a committee of dietitians from the Ontario Dietetic Association Clinical Managers Practice Group developed a manual that outlined a step-by-step process for determining staffing requirements (19). The process used the Clinical Nutrition Workload Measurement System, Guidelines for Management Information Systems in Canadian Health Care Facilities (20), the time ladder data collection system and standards of nutritional care. A hospital would collect data using these tools and calculate staffing based on changes in bed counts and revisions to nutritional standards of care. The methodology recommended screening charts to identify patients who should have received nutrition care but were missed. This methodology was labor intensive and required ongoing data collection.

Lutton and colleagues (7) used a classification system to consider nutritional acuity along with dietitian productivity. Lutton created four levels of care: basic, intermediate, advanced intermediate, in-depth. Level of care is assigned at the time of the patient's admission (7). This study found that level of care could not be identified by using only diagnosis group (DRG), diagnosis, diet order, or nursing acuity level. Using the amount of dietitian time required for each level of nutrition care, and the average number of patients per care level per patient area, the staffing needs can be determined.

More recently, Ford and Fairchild (6) developed patient classification systems to assist with managing dietitians and determining staffing needs. Ford and Fairchild's (6) objective was to "define nutritional standards of practice using a classification system to prioritize care". The patient classification system was designed as a foundation for standards of care. Seven classifications were created to identify a patient's nutrition risk and priority. Used as part of a comprehensive program, the patient classification system has assisted with tracking of dietitian productivity, and more efficient and effective provision of patient care. The authors have used the tools to assist with justifying and realigning staffing. This system did not apply to ambulatory care services. A separate study investigated ambulatory nutrition services and created a productivity index (21).

Shavink-Dillerud, Hiller and colleagues (8,22) created the most comprehensive staffing model found and includes both inpatient and outpatients. As part of a Clinical Nutrition Staffing Task Group for the Department of Veterans Affairs (VA), they developed guidelines to replace outdated guidelines that were published in 1964. The inpatient guidelines were based on a four level patient classification tool based on nutrition risk: 1) Normal Nutrition Status; 2) Mildly Compromised Nutrition Status; 3) Moderately Compromised Nutrition Status and 4) Severely Compromised Nutrition Status. Prospective workload data was collected in 27 VA medical centres and data was analyzed to determine which variables significantly affected the time spent in the provision of nutrition care services. Nutrition status (determined based on the classification tool), bed section and length of stay explained 32 % of the variation in patient time requirements. Average time requirements, determined for 18 patient clusters based on length of stay, patient care area and patient classification, were used to determine staffing required. For the outpatient area, the variables education received or not received, intervention provided or not provided, visit type (reoccuring or non-recurring) and medical centre type explained 25 % of the variance in time requirements. There was a great deal of variability on the time spent providing group services and therefore this data needs to be site specific for incorporation into the model. Non-patient data was also collected; this data also varied widely among the participating centres and therefore in using the model, sites need to collect their own time data or provide their best estimates of time spent in providing non-patient care services.

The model was validated by comparing predicted staffing with actual staffing for 80 VA medical centres (8,22). Construct validity was evaluated by each of the participating medical centres and was based on the ability of the model to predict a full-time equivalent (FTE) appropriate for meeting workload needs. Seventy-nine of the 80 facilities accepted the model predictions as appropriate for workload needs. For 73 % of the medical centres, the total FTE was within 95 % confidence interval as predicted by the model. For another 17% of medical centres, the FTE was within +/- 0.3 FTE.

Simmons and Vaughan (9) developed a formula using patient acuity descriptor to predict the direct patient care hours required to deliver "medical nutrition therapy". The Patient Acuity Tool (PAT) was developed by the Clinical Nutrition Management Dietetic Practice Group of the American Dietetic Association in 1991-1992. The study included collection of patient demographic information and direct patient care time for 92 facilities (n=3321). Patients were mainly distributed among medical, surgical, cardiology and intensive care units. Multiple regression analysis was used to determine what predicted medical nutrition therapy time. Age, gender, and applicable descriptors from 27 item patient acuity tool were considered for the model. Gender and 21 of 27 acuity descriptors (e.g. special food needs, need for laboratory data evaluation, alterations in GI status, need for nutrition counseling, etc.) were statistically significant in the equation.

Studies have found different nutrition care times per patient to complete tasks such as screening, nutrition therapy and education, and metabolic support (1,2,9,17). Time per patient varies from 80 minutes to 225 minutes depending on the activities performed and the complexity of the patient's care (1,2,9,17) . The variability in the studies is a result of different patient populations, facilities, methods of classifying activities, and activities included. The study by Simmons and Vaughan (9) found a large variance in the time per patient for the various activities.

Staffing ratios have limited value because they vary depending on a large number of variables. For example, staffing ratios may need to be higher for a facility with a shorter length of stay (9). Staffing ratios assist with benchmarking among facilities. Edelstein (16) compared staffing levels in pediatric hospitals in the United States and Canada and found, of 52 respondents, the mean hospital size was 175 beds and the mean ratio of dietitians to patients was 1:59 (1:24-1:150). Compher and Colaizzo (15) compared staffing patterns for hospital clinical dietetics and nutrition support from 1986 – 1989. These researchers found that the actual staffing for the nutrition support dietitian is 90 % below the need based on a recommendation of 1 full-time dietitian for 15 patients. The researchers recommended that there should be one full-time nutrition support dietitian for 10-20 patients, depending on other responsibilities of the dietitian, and if the dietitian is responsible for electrolyte and glucose management, a full-time dietitian should have a caseload of 10 patients maximum.

Unfortunately, no studies were found that investigate the relationship between staffing levels and patient outcomes. Theoretically inadequate staffing can potentially lead to poor patient outcomes in the following areas:

- Ability to prevent or reverse weight loss and/or other indicators of malnutrition (e.g. laboratory values). Prevalence of malnutrition is associated with a longer length of stay (23,24)
- Appropriate provision of enteral or parenteral nutrition;
- Ability to meet diet modifications upon discharge from hospital;
- Patient satisfaction with nutrition therapy and education.

4.0 Methodology

Participants

Nutrition Service, Capital Health, manages 65 full-time equivalents (FTE) in 7 facilities in Capital Health, with approximately half of these positions providing inpatient services. A full-time equivalent (FTE) is based on a full work week and 7.75 hour day or 2022.75 hours annually. Two tertiary care hospitals were included in the study: University of Alberta Hospital and the Royal Alexandra Hospital.

Workload measurement data

Workload measurement is recorded using a tool called Service Log, which is maintained in Capital Health by Regional Costing and Patient Information (Health Records). Dietitians have been doing Service Log since 1997 on a daily basis for all patients they provide care for. As of April 2002, the procedures for Service Log were changed to be more consistent with the Workload Measurement Guidelines for Clinical Dietitians, Canadian Institute for Health Information (CIHI) (13) and to provide additional statistical data for Nutrition Service.

The Capital Health Inpatient Nutrition Risk Classification Tool (Appendix 1) was developed between 1999 and 2001 in Nutrition Service, Capital Health. The tool was developed by the Coordinator, Standards and Practice and the Nutrition Team Leaders. The Nutrition Risk Tool identifies patients who require care more urgently, and therefore are a higher priority, and provides a foundation for standards of care. The tool classifies patients based on their need for nutrition support (parenteral or enteral nutrition) and education, and risk of malnutrition. Diagnosis is not factored into the tool. Risk levels include the following:

- Level 1- Patient is well nourished.
- Level 2- Patient has mild malnutrition or has a medical condition that is impacted by nutrition therapy and has received education in the past.
- Level 3- Patient has moderate malnutrition or has a medical condition that is impacted by nutrition therapy or has not received past education.
- Level 4- Patient has severe malnutrition or has a highly acute/ unstable medical condition that is impacted by nutrition therapy.

Selecting the patient's risk level requires that only one indicator be present within a classification level. Patients risk levels are assessed each time the dietitian provides a service for the patient and therefore risk levels may change throughout a patient's admission as his/her status changes.

To create the tool, all dietitians were surveyed regarding what patients they would place in each nutrition risk category (lowest to highest risk), and to provide the criteria they use to classify patients in their area of practice. A literature review was completed to identify evidence based practice or "best practice" regarding classification of patients on the basis of nutrition risk. The tool was piloted by the Nutrition Team Leaders to evaluate ease of use. Dietitians tested the tool on 10 patients and submitted any concerns or questions regarding classification of the patients. March 2002, dietitians received an in-service on use of the tool.

Since April 2002, dietitians have been expected to document the patient's classification along with service log for all inpatients seen. A reason for service code was also added as a statistical code for service log which includes the same categories that are on the nutrition risk classification tool:

- Parenteral Nutrition: the patient is receiving parenteral nutritional peripherally or centrally.
- Enteral Nutrition: the patient is being fed via a tube-feed.
- Risk of Malnutrition: the patient is malnourished or eating poorly, and the patient is orally fed.
- Nutrition Education: the patient requires education to manage a medical condition.

A reason for service code is recorded only if applicable and only one code is selected. If more than one code is applicable, the above list is considered a hierarchy (highest to lowest) and the higher priority code is selected.

International Codes for Diseases (ICD-10) are used in Capital Health for diagnoses. These codes are entered for inpatients by Health Records. Diagnoses were grouped using ICD-10 Chapters (Appendix 2)

Creation of database

Workload measurement data was obtained from Regional Case Costing, Capital Health for the year 2002 - 2003. Service log data and health record data was extracted into a Microsoft Access 97 database. Data was provided for patients (cases) for all services provided by the dietitians, referred to as events. Regional Case Costing also provided patient data from Health Records including patient identification number, main diagnosis code (ICD-10), age, gender, length of stay, and admission and discharge dates.

A unique identifier was needed to relate data from multiple tables and combine the data into one table. Most tables had an event code; therefore, a unique event was created to combine tables. There were events that repeated (e.g. more than one service or mode of service for each event or more than one provider per event). Unique events were created for each patient by using Structure Query Language (SQL Server) to create queries and combine data tables (Appendix 3). The database had 156 084 events (including inpatients and outpatients). Inpatient events without risk codes or reason codes (16 % of inpatients) and all outpatient events were removed. Cases with missing data were also excluded (Appendix 4). The final database had 56 538 events.

Data was divided into the following groups: adult- tertiary care, pediatric- tertiary care, adult province wide, pediatric province wide, adult community, rehabilitation, mental health adult, and mental health pediatric. A decision was made to limit analysis to tertiary care hospitals to provide a more homogenous group for analysis. Province wide services and mental health were excluded. Province wide services (e.g. renal and transplant programs) differ than other tertiary care programs because patients are followed prior to and after hospital admissions in ambulatory care programs. Within tertiary care hospitals, patients may receive service in multiple program areas during an admission, and it was not possible to determine time per case within a program area. Time per case for the entire hospital admission was therefore studied. Patients were divided into adult tertiary care and pediatric tertiary care.

The data was reviewed for completeness. The percent of time spent providing patient care was compared with the allocated FTE to determine time recorded for direct patient care. It is expected that dietitians should spend on average 60-70 % of time providing direct patient care.

Data analysis

The database was imported into Statistical Package for the Social Sciences (SPSS version 11.5 for Windows) for data analysis. Time per case was calculated from the sum of time for all events during a patient's admission. Descriptive analysis, including mean, medians, standard deviation and frequencies, was used to explore the data. One-way analysis of variance and post-hoc multiple comparison of means (Tukey HSD) was used to examine differences between groups ($p<0.05$). The following data was used for analysis: risk code (from first event), service code (from first event), length of stay, age, gender, diagnosis group, and repeat visit within the year. Number of events per hospital stay was not used because of its relationship to time and length of stay. Data was entered into a multiple linear regression (MLR) model with the natural log of total time per case as the dependent variable. Using stepwise linear regression, which only includes significant variables in the model ($p<0.05$), it was determined which factors have a significant impact on time per case. Dummy variable were used for categorical variables (e.g. gender, risk codes, service codes, diagnosis groups). One dummy variable was left out when entered into the linear regression model. For risk and service codes, the first variable was left out of the model. For diagnosis groups, the final dummy variable was left out of the model. The analysis was repeated for acute care and pediatrics. For pediatrics, a dummy variable for neonatal critical care was added because the time per case was found to be lower for this area compared to other pediatric areas.

Analysis included an evaluation of the assumptions for MLR to ensure they were not violated and that linear regression analysis was an appropriate method for analysis (25). The assumptions used in MLR and methods to evaluate whether they were violated include:

1) The error terms ε_i are normally distributed
   - histogram and normal probability plots of standardized residuals
2) The error terms are independent of past error terms (no serial correlation)
   - evaluation of Durbin-Watson statistic
3) The error terms have equal variances (homoscedasticity)
   - plot of the dependent variable against the standardized residuals, and partial plots of independent variables against the standardized residuals created.
4) The independent variables are not correlated with each other (no multi-collinearity)
   - evaluation of variance inflation factor (VIF), tolerance, and condition index

Outliers were assessed to study their influence on the estimated regression coefficients using Cook's Distance. Adjusted R-squared, was used as a measure of goodness of fit for the models.

5.0 Results

Evaluation of accuracy and reliability of data

The data was reviewed for completeness. A comparison of total patient care time and full-time equivalents (Table 3) found that there likely were dietitians who did not complete their workload measurement consistently, particularly in pediatrics. There were 59 % of full-time equivalents reported in workload measurement. Previous analysis of workload data in Capital Health and by other researchers has found that dietitians spend an average of 70 % of their time on direct patient care activities, therefore it is likely that at least 10 % of workload data is missing (2,3).

Table 3. Total Patient Care Time compared to Actual Full-Time Equivalents (FTE) in each Program Area for Tertiary Care Hospitals

Program Area	Total Patient Care Time (h)	FTE	% FTE
Cardiology	1689	1.4	60.0
Critical Care/ Burns	3949	2.9	64.3
Medicine	7586	6.8	56.5
Neurology	1018	1.0	50.0
Pediatrics	4095	5.2	39.3
Surgery	5924	3.5	84.0
Total	**24261**	**20.8**	**59.0**

Summary of demographic data

The mean length of stay for all adult patients admitted was 10.9 days for adults, ranging from 6.4 days for surgery to 34 days for a geriatric unit, and for all pediatric patients admitted was 8.3 days. The length of stay was longer for patients who were seen by the dietitian than the mean length of stay of all patients admitted (Table 4).

Table 4. Summary of Descriptive Data (Length of Stay, Age and Gender) for each Program Area

		Length of Stay (days)			Age (years)			Gender (M)	
	N	Median	Mean	Std. Dev	Median	Mean	Std. Dev	Freq.	%
Adult	5806	14.0	23.2	30.6	66	62.9	19.4	2988	54.3
Pediatric*	2610	7.0	13.0	18.3	0	2.6	4.8	1465	55.8

* Infants younger than age 1 have an age entered as "0".

Summary of workload data

An event represents provision of a service for a patient on a particular day. It may include a face-to-face visit with the patient or significant other, or indirect care (e.g. reviewing laboratory data). Median time per different types of events varied from 12 to 45 minutes, and had a large standard deviation (Table 5). Pediatric areas spend the least amount of time with patients which may be associated with more frequent monitoring of patients. Pediatric, neonatal intensive care and adult critical care/ burns had the most events per patient (Table 6). There was a large range in time spent with patients, reflected by the large standard deviation, and the data is skewed as indicated by a large difference between the median and mean times.

Table 5. Median and Mean Time (Minutes) Per Event[1] for Each Inpatient Program Area

Program Area	N events	Median time (min)	Mean time (min)	Std. Dev (min)
Adults				
Cardiology	1583	45	39.3	19.8
Critical Care/ Burns	6619	30	28.8	16.8
Medicine	9486	40	37.3	23.4
Neurology	1949	30	29.9	18.9
Surgery	9437	30	32.7	20.8
Women's Health	148	30	30.2	24.7
Pediatrics				
NICU[2]	1262	12	12.7	7.2
Pediatric	6321	20	24.1	16.3

1 An event represents provision of direct or indirect service on a day during the patient's hospital stay.
2 NICU = Neonatal Intensive Care Unit

Table 6. Median and Mean Number of Events[1] and Median and Mean Time (Minutes) Per Case for Each Inpatient Program Area[2]

Program Area	N Cases	Median Events (#)	Mean Events (#)	Std. Dev Events	Median Time (min)	Mean Time (min)	Std. Dev Time
Adults							
Cardiology	427	2	4.6	7.0	75	175.8	280.7
Critical Care/ Burns	508	3	6.0	7.5	80	170.8	243.6
Medicine	2848	2	5.0	8.5	85	172.8	296.9
Neurology	330	2	4.3	5.0	75	129.8	162.7
Surgery	1706	3	5.9	8.2	75	190.0	311.5
Women's Health	27	2	2.4	2.8	45	73.9	74.9
Pediatrics							
NICU[3]	1262	4	7.0	9.7	37	88.4	144.0
Pediatric	1309	4	6.5	9.6	80	156.5	253.9

1 An event represents provision of direct or indirect service on a day during the patient's hospital stay.
2 Program area refers to the program the patient was admitted to.
3 NICU = Neonatal Intensive Care Unit

The majority of patients for adults had a risk level of 3 (45.9 %) and the fewest patients had a risk level of 1 (8.3%) (Table 7). In pediatrics, 84 % of patients had a risk level of 3 (43.5 %) or 4 (41.4 %). The majority of patients were receiving nutrition support (enteral or parenteral nutrition) (Table 8).

Table 7. Summary of the Distribution of Nutrition Risk Classification Levels (1 to 4) for Patients Seen in Each Program Area

Program Area	Level 1		Level 2		Level 3		Level 4		Total
	#	%	#	%	#	%	#	%	n
Adults									
Cardiology	68	4.3	295	18.6	942	59.5	278	17.6	1583
Critical Care/ Burns	35	0.5	296	4.5	3208	48.5	3080	46.5	6619
Medicine	676	7.1	3428	36.1	4033	42.5	1349	14.2	9486
Neurology	30	1.5	373	19.1	958	49.2	588	30.2	1949
Surgery	281	3.0	1909	20.2	5941	63.0	2733	29.0	10864
Women's Health	49	33.1	77	52.0	19	12.8	3	2.0	148
Total	**1139**	**3.7**	**6378**	**20.8**	**15101**	**49.3**	**8031**	**26.2**	**30649**
Pediatrics									
NICU[1]	0	0	2132	20.9	4435	43.4	3654	35.7	10221
Pediatric	30	0.5	568	9	2754	43.6	2969	47	6321
Total	**30**	**0.2**	**2700**	**16.3**	**7189**	**43.5**	**6623**	**40.0**	**16542**

1 NICU = Neonatal Intensive Care Unit

Table 8. Summary of the Distribution of Service Provided for Patients in each Program Area

Program Area	Education		Malnutrition		Enteral		Parenteral		Total
	#	%	#	%	#	%	#	%	#
Adults									
Cardiology	250	15.8	508	32.1	710	44.9	115	7.3	1583
Critical Care/ Burns	42	0.6	480	7.3	4600	69.5	1497	22.6	6619
Medicine	669	7.1	5588	58.9	1959	20.7	1270	13.4	9486
Neurology	57	2.9	425	21.8	1382	70.9	85	4.4	1949
Surgery	229	2.4	3614	38.3	2861	30.3	2733	29	9437
Women's Health	24	16.2	96	64.9	8	5.4	20	13.5	148
Total	**1271**	**4.3**	**10711**	**36.7**	**11520**	**39.4**	**5720**	**19.6**	**29222**
Pediatrics									
NICU[1]	1	0	100	1	6568	64.3	3552	34.8	10221
Pediatric	236	3.7	1764	27.9	3084	48.8	1237	19.6	6321
Total	**237**	**1.4**	**1864**	**11.3**	**9652**	**58.3**	**4789**	**29.0**	**16542**

1 NICU = Neonatal Intensive Care Unit

Nutrition risk classification tool and nutritional acuity

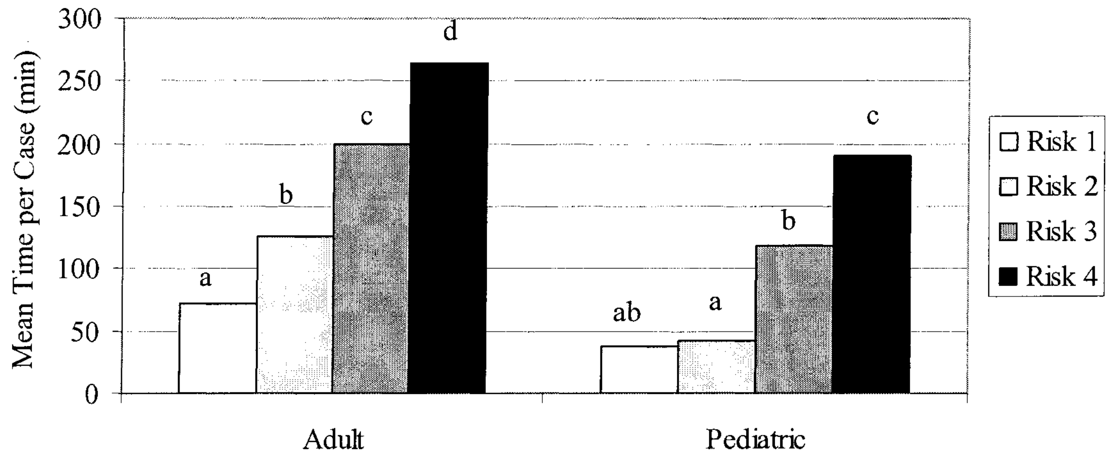
Nutritional acuity is defined as the time and frequency of care needed to provide nutrition services. As the risk levels increase, the mean time spent per case increases (Figure 1). For adults all risk levels were significantly difference ($p<0.05$) but for pediatrics, risk 1 and risk 2 time per case was not significantly different. Similarly, as the risk levels increase, the mean number of events (or visits) with patients also increases (Figure 2). Similarly, for risk levels the difference in visits was significant for adults but not for risk 1 and 2 in pediatrics ($p<0.05$). This provides support that the Nutrition Risk Tool provides a measure of the patient's nutritional acuity.

Factors impacting dietitian time per case

Patients who were receiving parenteral nutrition took the most time per case ($p<0.05$) (Figure 3). Adult patients who were seen for education took the least amount of time per case ($p<0.05$); differences in time per case for education, malnutrition and enteral nutrition were not significant for pediatrics.

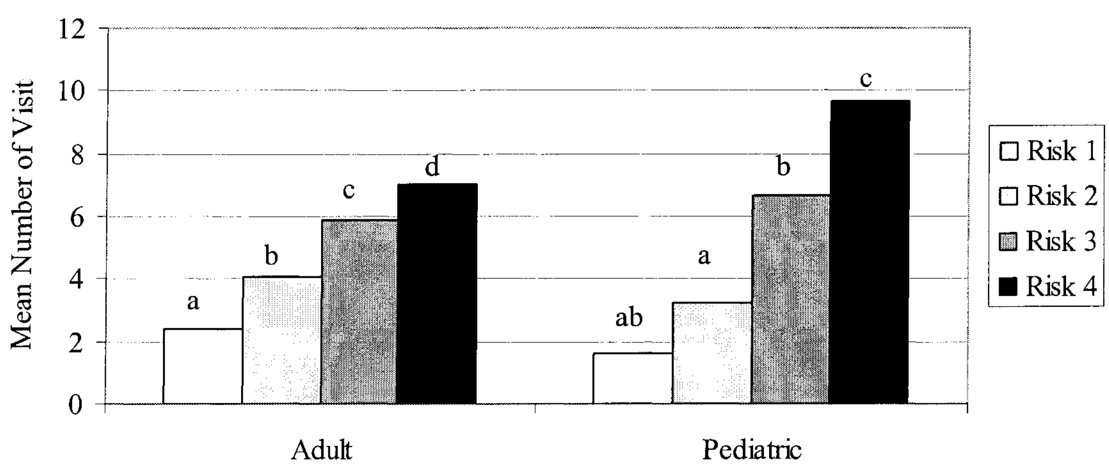
As length of stay increases, the time spent per case increases significantly (Figure 4). This is likely due to monitoring patients who are at high nutrition risk throughout their hospital stay.

Figure 1. Mean Time per Case for Each Nutrition Risk Classification Level



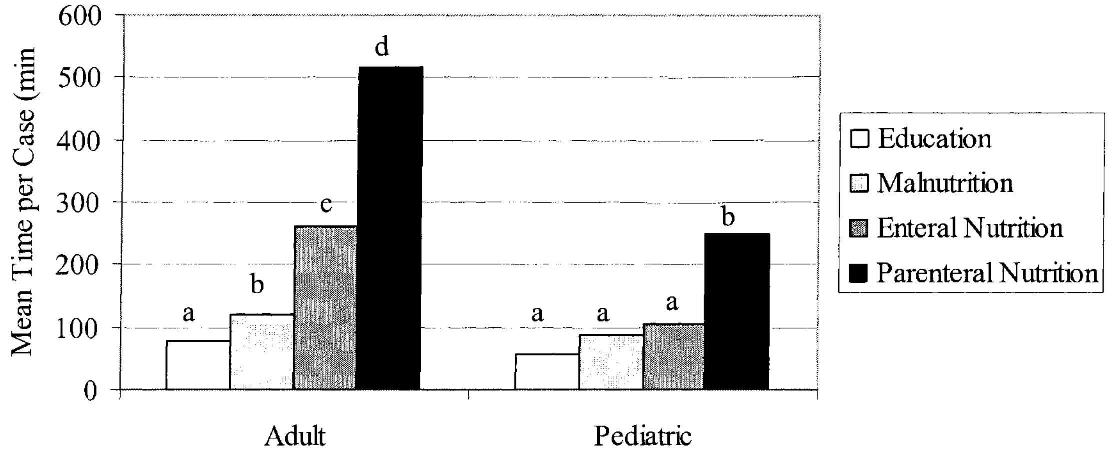
* Letters (a,b,c,d) indicate significant differences between categories, p<0.05

Figure 2. Mean Number of Visits for Each Nutrition Risk Classification Level



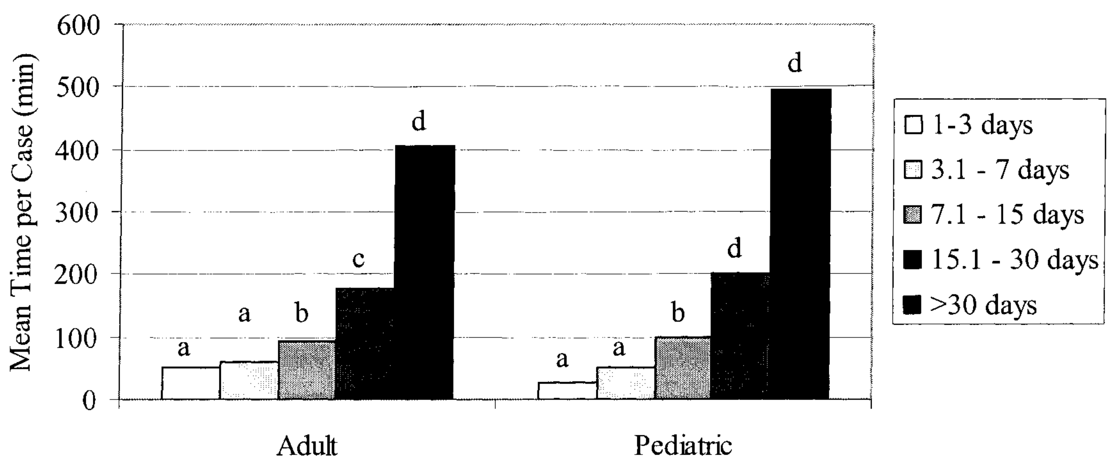
* Letters (a,b,c,d) indicate significant differences between categories, p<0.05

Figure 3. Mean Time per Case for Each Service Provided



* Letters (a,b,c,d) indicate significant differences between categories, p<0.05

Figure 4. Mean Time per Case for Each Length of Stay Category



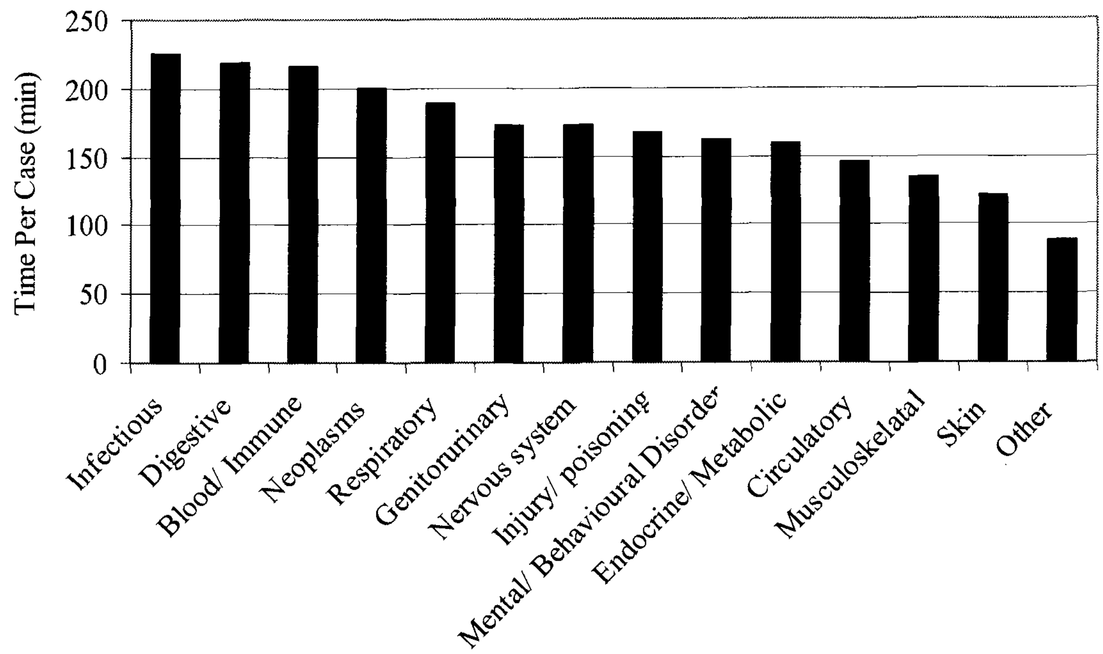
* Letters (a,b,c,d) indicate significant differences between categories, p<0.05

For adults, almost all International Disease (ICD)-10 codes accounted for less than 1 % of cases; congestive heart failure was the highest and accounted for 2.6 % of cases. For pediatrics, low birth weight accounted for 16.7 % of cases, preterm infants for 5.4 % of cases, and chemotherapy for 3.9 % of cases. All others accounted for less than 3 % of cases, and the majority less than 1 %. To study the relationship between diagnosis and time per case, diagnoses were grouped using International Disease Code (ICD)-10 chapters. The most frequent diagnosis groups for adults were circulatory (18%), injury (18%), digestive (15%), respiratory (12%), and neoplasms (12%). The most time per case was spent for patients with infectious, digestive, blood/ immune, neoplasm, and respiratory diseases (Figure 5). The most frequent diagnosis groups for pediatrics were perinatal conditions (43%), congenital abnormality (18%), respiratory (9%), injury/ poisoning (6%), and digestive (5%) diseases. The most time per case for pediatrics was spent with patients with a genitourinary condition (e.g. renal failure) (Figure 6); however, this represents only 18 cases.

Adult males took more time per case than females (p=0.018) (Table 9). There was no gender difference seen for pediatrics.

There was a weak relationship between time per case and age for adults and pediatrics (excluding NICU). The Pearson correlation was -0.071 for adults and -0.143 for pediatrics (p=0.000) (Figure 7).

Figure 5. Mean Time per Case for Each Diagnosis Group for Adult Patients (Most to Least)



There were 15.1 % of adult patients and 29.7 % of pediatric patients with more than one hospital stay during the year. Both adult and pediatric patients who had more than one hospital stay required more time per case compared to those who did not (p=0.000); the difference was greater for pediatrics (Figure 8).

Figure 6. Mean Time per Case for Each Diagnosis Group for Pediatric Patients (Most to Least)

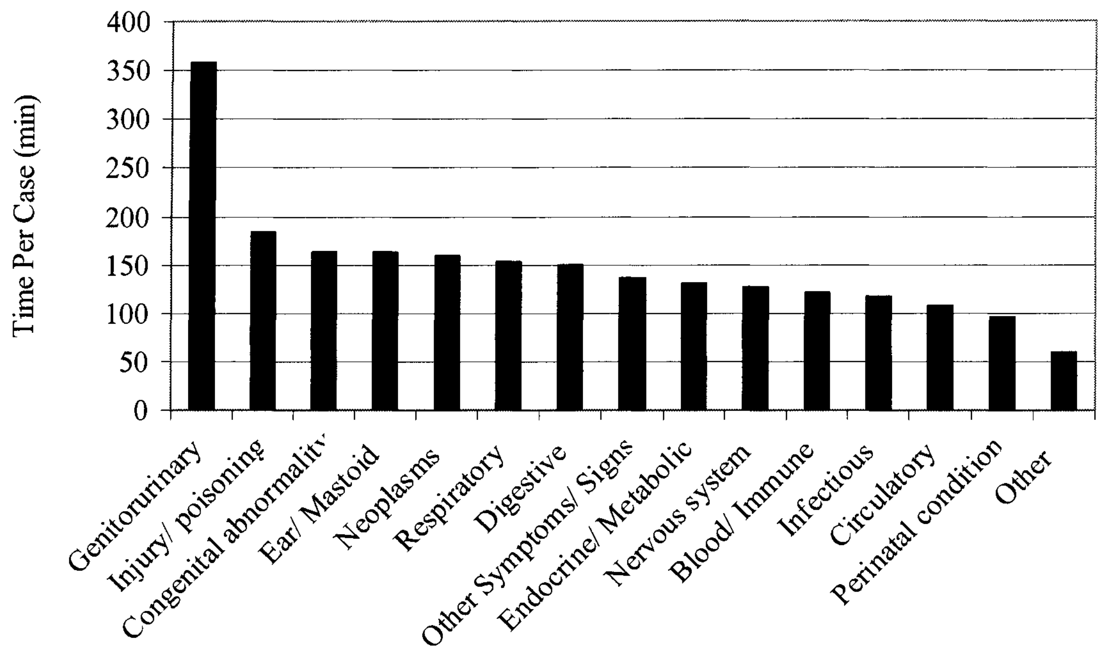


Table 9. Time per Case for Males and Females

	Adults				Pediatrics			
	N	**Median**	**Mean**	**Std. Deviation**	**N**	**Median**	**Mean**	**Std. Deviation**
Males	2988	85	183.3	298.7	1465	54	123.7	220.5
Females	2817	75	165.4*	278.8	1145	57	125.3	204.0

* t-test p=0.018

Figure 7. Scatter Diagram for Time per Case versus Age

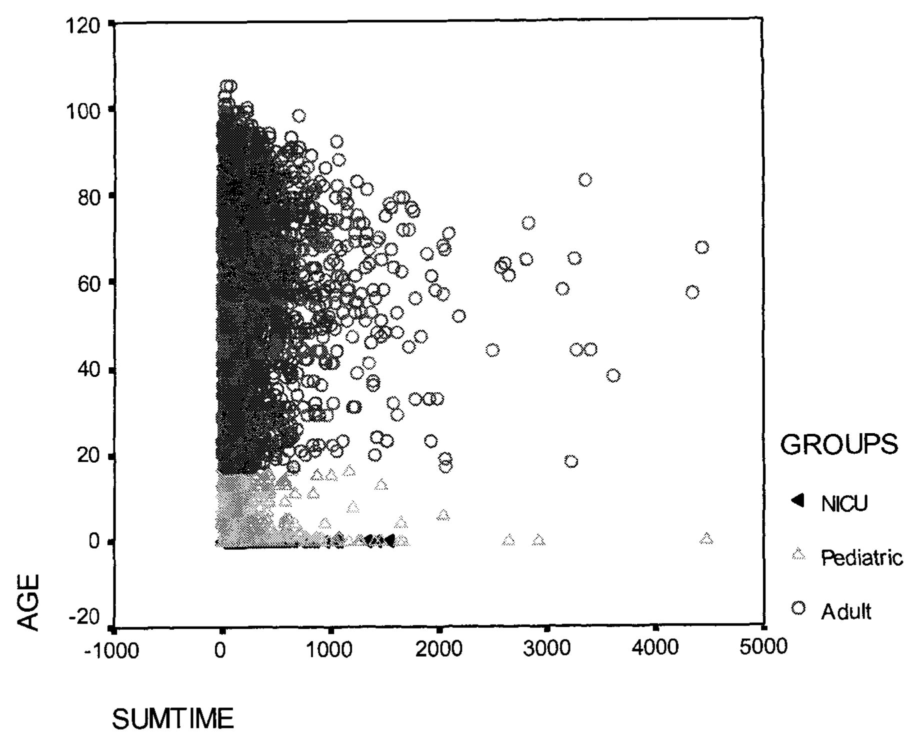
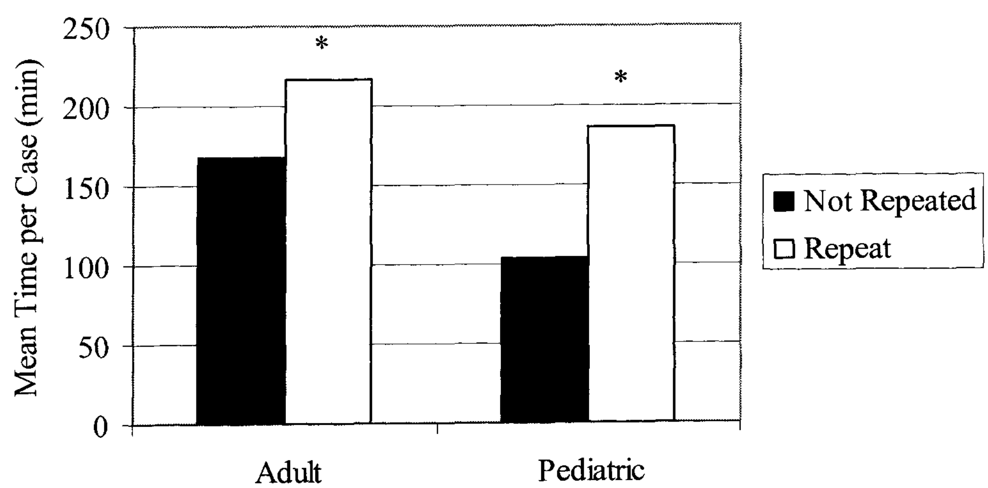


Figure 8. Time per Case for Patients Who Repeated Within the Year and Patients With Only one Case per Year (* indicates p<0.05)



Regression analysis to study factors associated with time per case

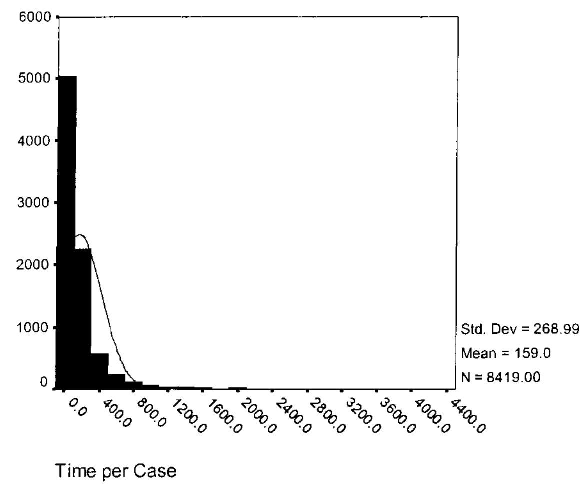
Data was entered into a multiple linear regression model. Total patient time per case and length of stay underwent natural log transformation to achieve a more normal distribution (Figure 9 and 10). No assumptions for linear regression analysis were found to be violated.

Variables were entered into a multiple linear regression model stepwise to identify a model with a strong goodness of fit and fewest variables. Entering nutrition risk levels and service codes into the model produced an adjusted R-squared of 0.209 for adults (Table 10). For pediatrics, an additional variable was added to adjust for patients in neonatal intensive care; an adjusted R-squared of 0.343 was obtained (Table 11). Nutrition risk levels and service codes are done upon admission and are predictive of time required per patient.

The best model for adults included length of stay (in addition to nutrition risk levels and service codes); the adjusted R-squared was 0.406 (Table 12). The best model for pediatrics included nutrition risk levels, service codes, length of stay, and repeat admissions (adjusted R^2=0.591) (Table 13). Length of stay provided the greatest contribution to time per case for both adults and pediatrics, but was even more important for pediatrics. For adults and pediatrics, the addition of the five most frequent diagnoses groups improved the model slightly. Repeat admission, gender, and age had a small but significant relationship to time per case for adults, but only provided a slight improvement of goodness of fit.

Figure 9. Histograms Time per Case and LN Log Transformation of Time per Case

Time per Case



LN Log Transformation of Time per Case

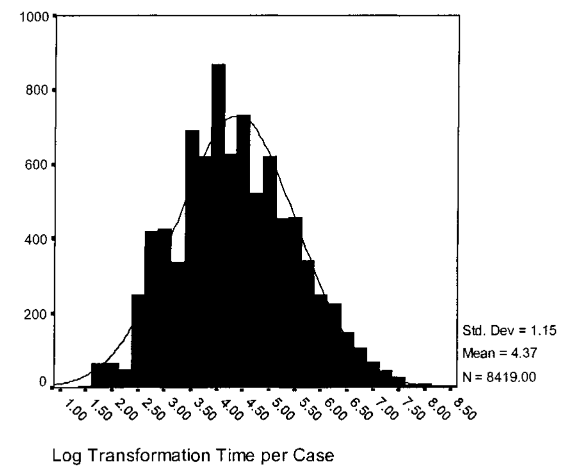
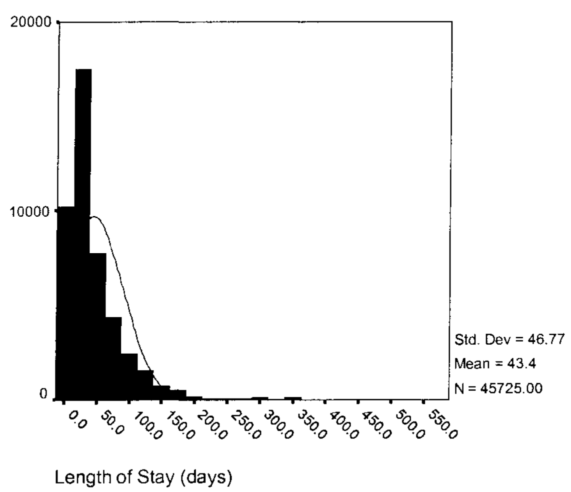


Figure 10. Histograms of Length of Stay and LN Log Transformation of Length of Stay

Length of Stay



LN Log Transformation of Length of Stay

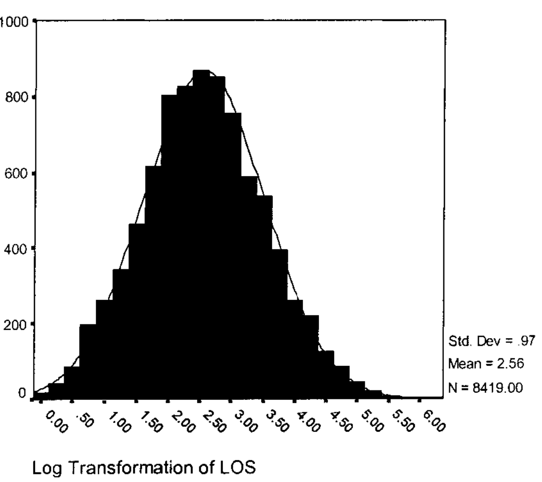


Table 10. Adult Model: Linear Regression Analysis (Stepwise) to Determine Log Time per Case Using Nutrition Risk Levels and Services Provided[1]

Variables	B (SE)[2]	Sig T[3]
Included In the Equation:		
Risk 2	0.306 (0.051)	.000
Risk 3	0.593 (0.050)	.000
Risk 4	0.549 (0.061)	000
Malnutrition	0.091 (0.043)	.034
Enteral Nutrition	0.778 (0.051)	.000
Parenteral Nutrition	1.448 (0.065)	.000
Constant[4]	3.701 (0.052)	.000

[1]Adjusted R-squared = 0.209
[2]SE = standard error
[3] Sig T < 0.05
[4] Constant represents excluded dummy variables: risk level 1 and education

Table 11. Pediatric Model: Linear Regression Analysis (Stepwise) to Determine Log Time per Case Using Nutrition Risk Levels and Services Provided[1]

Variables	B (SE)[2]	Sig T[3]
Included In the Equation:		
Risk 3	0.601 (0.050)	.000
Risk 4	0.718 (0.057)	.000
Enteral Nutrition	0.754 (0.053)	.001
Parenteral Nutrition	1.620 (0.070)	.000
NICU patient	-1.026 (0.049)	.000
Constant[4]	3.394 (0.051)	.000
Excluded Variables:		
Risk 2		.634
Malnutrition		.482

[1]Adjusted R-squared = 0.343
[2]SE = standard error
[3] Sig T < 0.05
[4] Constant represents excluded dummy variables: risk level 1 and education

Table 12. Best Model Adults: Linear Regression Analysis (Stepwise) to Determine Log Time per Case [1]

Variables	B (SE) [2]	Sig T [3]
Included In the Equation:		
Risk 2	0.215 (0.044)	.000
Risk 3	0.479 (0.044)	.000
Risk 4	0.522 (0.052)	.000
Malnutrition	- 0.208 (0.038)	.000
Enteral Nutrition	0.342 (0.045)	.000
Parenteral Nutrition	0.958 (0.057)	.000
Log Length of Stay	0.511 (0.012)	.000
Constant [4]	2.744 (0.050)	.000

[1] Adjusted R-squared = 0.406
[2] SE = standard error
[3] Sig $T < 0.05$
[4] Constant represents excluded dummy variables: risk level 1 and education

Table 13. Best Model Pediatrics: Linear Regression Analysis (Stepwise) to Determine Log Time per Case [1]

Variables	B (SE) [2]	Sig T [3]
Included In the Equation:		
Risk 3	0.455 (0.040)	.000
Risk 4	0.556 (0.045)	.000
Enteral Nutrition	0.385 (0.044)	.000
Parenteral Nutrition	0.914 (0.059)	.021
Log Length of stay	0.034 (0.001)	.000
Repeat admission	0.158 (0.038)	.000
NICU patient	0.884 (0.044)	.000
Constant[4]	3.336 (0.048)	.000
Excluded Variables:		
Risk 2		.693
Serv 2		.191

[1] Adjusted R-squared = 0.591
[2] SE = standard error
[3] Sig T < 0.05
[4] Constant represents excluded dummy variables: risk level 1 and education

6.0 Discussion

This study sought to validate that the Nutrition Risk Classification Tool provides a measurement of patient nutritional acuity. Nutritional acuity is based on the nutrition care activities required, time needed and the frequency that services are provided. This study found that the risk classification level upon admission was predictive of the total nutrition care time for the hospital stay and the number of visits with the patient. Other researchers have also found nutrition risk classification to be associated with time per patient (8). Nutritional acuity descriptors have also been found to be associated with time per patient (9).

Average time per case was in the range of other studies that have estimated time for comprehensive nutrition care, including monitoring of patients (2,17). The study by Shavink-Dillerud and colleagues reported mean times that are generally shorter than time per patient in this study, which may be because data was collected only until 31 days of admission (8). The study by Simmons and Vaughan (1999) found a mean of 43.3 ± 34.2 minutes for patients in the study, which was a quarter of the time spent for patients in this study, which is likely due to the short length of stay of patients included in that study (9).

Of the variables available for analysis, length of stay was most strongly related to time required per case. The need for ongoing monitoring of nutritionally at risk patients explains the association of length of stay and time per case. The mean time per case for pediatric areas was shorter than for adults, likely because the length of stay was on average shorter for pediatric patients than adult patients. Shavink-Dillerud and colleagues also found that patients with a longer length of stay took more time, and they therefore grouped patients based on both length of stay and risk level (8). Simmons and Vaughan chose not to include length of stay in their regression analysis because they felt length of stay should not be associated with acuity (9). Their study population was different in that over 65 % of patients had a length of stay shorter than 7 days and therefore did no require ongoing monitoring. In this study only 8 % of adult patients and 16 % of pediatric patients had a length of stay shorter than 7 days; approximately half the population had a length of stay greater than 30 days.

Other studies have found that diagnosis is not associated with time per case (7). Simmons and Vaughan did not include diagnosis in their regression model because no diagnosis contributed to more than 4 % of the total population (9). A similar result was found in this study; in adults no single diagnosis contributed to more than 3 % of the population. In this study, certain diagnosis groups required more time per case and therefore significantly contributed to the regression model. These diagnoses tend to be the ones that place patients at higher nutrition risk. For example, in adult patients diagnoses such as cancer, gastrointestinal disorders, pneumonia, renal failure and chronic obstructive lung disease would be associated with higher nutrition risk and these patients required more time per case.

Patient who had more than one admission during the year (repeat patients) required significantly more time, particularly in the pediatric population. These repeat patients were likely more medically unstable and therefore required more ongoing nutritional intervention.

Gender was associated with time per case for adults, and males required almost 20 more minutes on average per case. It is not known why male patients would require more time. Despite being significantly associated with a longer time per case, adding gender to the regression model did not provide much impact on the goodness of fit of the regression model. There was a small but significant negative correlation between age and time per case, but age also did not have much impact on the goodness of fit of the regression model. Simmons and Vaughan also found gender and age to be weak indicators of time per case (9).

In this study, nutrition education was not entered into the model because it was the fourth dummy variable for service provided and its value is contained within the constant. Patients who were seen for education had the least time per case. In contrast, Simmons and Vaughan found the need for comprehensive counseling to be the strongest predictor of time (9). Clinical practice may be different at the hospitals in this region compared to the American hospitals in that nutrition counseling is generally not as high a priority in hospital; there is more focus on improving patient's nutritional status and providing nutrition support. Comprehensive nutrient intake analysis, laboratory data evaluation and need for evaluation of energy requirements were also predictors of time in they study by Simmon and Vaughan, and these services would be associated with provision of enteral and parenteral nutrition in this study.

Using linear regression analysis, it was possible to obtain a regression model that had a reasonable goodness of fit. Using the Nutrition Risk Classification Level and service provided, an adjusted R-squared was obtained that was similar to the study by Simmons and Vaughan. Using 21 acuity descriptors and gender, the adjusted R-squared in the best regression analysis was 0.310. For this study, an adjusted R-squared of 0.209 for adults and 0.343 for pediatrics was found when entering only the nutrition risk levels (levels 2-4) and services provided (malnutrition, enteral and parenteral nutrition). The best regression equation for adults included nutrition risk levels, service provide and length of stay. The goodness of fit was improved slightly by the addition of repeat patient, digestive, circulatory or injury diagnosis groups, age and gender. The best regression equation for pediatrics included nutrition risk levels, service provided, length of stay, and repeat patients. Adding the perinatal, congenital and digestive diagnosis groups slightly improved the goodness of fit. Generally it is preferable to have a linear regression model with the fewest variables to achieve the best goodness of fit. Increasing the model's complexity by adding the additional variables is likely not worth the small improvement in goodness of fit.

No other study found analyzed adults and pediatrics separately. Separating these populations was important because the variables differed in their impact on time per case. For example, repeat patients were more important for pediatrics, and gender and age were found to be significant for adult only. In addition, time per case was on average less for pediatrics than adult areas.

Study limitations

There are several limitations to the study that should be considered. There was no monitoring of workload data collection to validate that workload data was an accurate reflection of time spent. All staff had received training on how to do service log and the database included a large number of cases. Therefore, it is not expected that inter-rate variability would have had much impact on the results.

Another limitation is that variables that may impact time per case such as program area, dietitian, and assessment versus follow-up visits could not be analyzed in the regression equation because they vary throughout an admission. Staffing needs may vary among program areas because of the work flow. For example, in a critical care area, there are bed-side rounds with the health care team where changes to the patient's nutrition care plan may be made. Patients are located together and the health record may be more easily accessible. In medicine, it may be more difficult to access patient charts, patient care rounds are held for team communication with changes to the nutrition care plans made following rounds, and patients work flow may be less efficient. In neonatal intensive care, time for an assessment would be less because patients have little medical history that needs to be reviewed.

The data collected is based on actual workload data and may not predict ideal staffing levels. If an area is understaffed, then the time per case may be less than what would be ideal to achieve good patient outcomes. Similarly, if an area has more staff, dietitians may follow patients more closely and have a higher time per case. It is difficult to assess if staffing levels are appropriate, and if higher staffing levels would produce better patient outcomes. Staffing levels should be based on defined standards of care, and reflect the staff required to assess and follow patients who require nutrition care based on specific criteria. In this region, there is not a defined standard of care that can be used to define inputs and outputs associated with staffing levels.

This study did not consider whether the staffing levels would result in positive patient outcomes. Outcomes as a result of nutrition therapy and education are difficult to study because it is not known if outcomes are associated with dietitian care or other medical care, and outcome data is not routinely collected. There is an assumption made that if there is sufficient staffing for dietitians to provide nutrition therapy and education for those patients that require services (e.g. those patients at nutrition risk) then improved patient outcomes can be obtained. These nutrition outcomes are obtained by achieving patient goals which assist in improving medical outcomes.

In order to use the tool to estimate staffing, the percentage of patients that require nutrition care would need to be known, and the average distribution of their nutrition risk levels and services, average length of stay, and for pediatrics, the percentage of repeat patients and patients in neonatal intensive care. The regression equations may be used to estimate dietitian staff required as beds are added or removed, and then ongoing monitoring of staff productivity can assist in ensuring staff levels are appropriate. Prior to using the regression equations to estimate staffing, additional work should be done to test the predictive validity of the regression equation to estimate dietitian staffing. An assumption is made that because the regression equations were based on actual workload data from this region, then the equations would predict staffing levels in keeping with current levels of staffing, and if the acuity of patients increased (e.g. more patients requiring parenteral nutrition) then the tool would recommend staffing enhancements. The tool would need to be tested with actual scenarios to estimate staffing.

For this study, only direct patient care time was analyzed. Dietitians perform many activities that benefit patients, but are not direct patient care. For example, dietitians teach health care providers including medical residents about nutrition therapy, create education handouts for patients, attend department and program meetings, participate in continuing education including journal club and conferences, and participate in practice based research. None of these activities would be captured in the analysis, despite their benefit to patients and the hospital. When funding requests for dietitians are done, usually an assumption is made that dietitians spent approximately 30 % of their time doing non-patient care activities. This is consistent with what other studies have found (2,3,8). There can, however, be significant variability among program areas and inpatients versus outpatients for non-patient care time.

7.0 Conclusions and Applications

This study has helped to validate that the Nutrition Risk Classification tool can provide a measure of nutritional acuity for inpatients and can be used along with workload measurement data to help clinical nutrition managers estimate time required for nutrition therapy and education.

This study has helped to improve understanding of what variables affect the time required to deliver nutrition therapy and education for inpatients within a tertiary level Canadian hospital. Level of nutrition risk and service provided at the first visit were found to be good predictors of time required per patient. Length of stay was found to have a strong association with time per patient, likely because time is needed for monitoring patients, particularly those at high nutrition risk. Regression equations can be used to develop an estimate of time required. By studying other types of facilities and programs (e.g. community hospitals, mental health, province wide services), it may be possible to create addition standard time requirements for other types of services. Shavink-Dillerud and colleagues found differences in standard time requirements among rehabilitation and nursing home level facilities compared to acute care (8). Standard time requirements for groups of patients who have different length of stay and nutrition risk classifications may also be created.

This study is a first step in development of guidelines for staffing in Canada. More work needs to be done in creating national standards of care and definitions of quality nutrition care to support the development of staffing standards.

8.0 Bibliography

(1) DeHoog S. Identifying patients at nutritional risk and determining clinical productivity: essentials for an effective nutrition care program. Journal of the American Dietetic Association 1985 Dec;85(12):1620-1622.

(2) McManners MH, Barina SA. Productivity in clinical dietetics. Journal of the American Dietetic Association 1984 Sep;84(9):1035-8, 1041.

(3) Casey T. How to determine dietitian staffing requirements. Hospitals 1977 May 16;51(10):82, 84, 86-7.

(4) Identification of clinical dietetic practitioners' time use for the provision of nutrition care. Journal of the American Dietetic Association 1981 Dec;79(6):708-715.

(5) Bartscht KG. This technic sets minimum staffing requirements. Modern hospital 1968 Sep;111(3):96-97.

(6) Ford DA, Fairchild MM. Managing inpatient clinical nutrition services: a comprehensive program assures accountability and success. Journal of the American Dietetic Association 1990 May;90(5):695-704.

(7) Lutton SE, Baker MM, Billman RV. Levels of patient nutrition care for use in clinical decision making. Journal of the American Dietetic Association 1985 Jul;85(7):849-851.

(8) Shavink-Dillerud M, Lowery JC, Striplin D. Development and utilization of a patient acuity based clinical nutrition staffing model. Future Dimensions in Clinical Nutrition Management 1999;18(3):1-9.

(9) Simmons ML, Vaughan LA. Patient nutrition acuity as a predictor of the time required to perform medical nutrition therapy. Journal of the American Dietetic Association 1999 Nov;99(11):1367-1372.

(10) Nutritional assessment and support / Anne Grant, Susan DeHoog. 4th ed., rev. and expanded. ed.

(11) Handbook for clinical nutrition services management / M. Rosita Schiller, Judith A. Gilbride, Julie O'Sullivan Maillet.

(12) National Hospital Productivity Improvement Program. Clinical Nutrition Workload Measurement System. Ottawa: Health and Welfare Canada; 1989.

(13) Canadian Institute for Health Information. Diagnostic and Therapeutic Services, Clinical Nutrition. Guidelines for Management Information Systems in Canadian Health Care FacilitiesOttawa: Health and Welfare Canada; 1996. p. 3.1-3.47.

(14) Gobberdiel L. A new strategy for cost-effective care: clinical dietetic staffing by diagnosis. Journal of the American Dietetic Association 1986 Jan;86(1):76-79.

(15) Compher C, Colaizzo T. Staffing patterns in hospital clinical dietetics and nutrition support: a survey conducted by the Dietitians in Nutrition Support dietetic practice group. Journal of the American Dietetic Association 1992 Jul;92(7):807-812.

(16) Edelstein SF. Staffing and fee levels for clinical nutrition services in pediatric hospitals in the United States and Canada. Journal of the American Dietetic Association 1991 Dec;91(12):1591.

(17) Grant A, DeHoog S. Nutritional Assessment and Support. 4th edition ed. Seattle: Anne Grant/Susan DeHoog; 1991.

(18) Somers JP, Mulroney RA. Workload measurement study to develop staffing guidelines for the clinical inpatient dietitian. Journal of the Canadian Dietetic Association 1983 Jul;44(3):246-250.

(19) Ontario Dietetic Association. Staffing Guidelines for Clinical Nutrition Services in Health Care Facilities. 1st ed. Don Mills Ontario: Ontario Hospital Assocation; 1992.

(20) National Hospital Productivity Improvement Program. Clinical Nutrition Workload Measurement System. Ottawa: Health and Welfare Canada; 1989.

(21) Bell LS, Fairchild MM. Development of a productivity index to increase accountability of ambulatory nutrition services. Journal of the American Dietetic Association 1989 Apr;89(4):517-519.

(22) Hiller L, Lowery JC, Davis JA, Shore CJ, Striplin DT. Nutritional status classification in the Department of Veterans Affairs. Journal of the American Dietetic Association 2001 Jul;101(7):786-792.

(23) Kyle UG, Genton L, Pichard C. Hospital length of stay and nutritional status. Current opinion in clinical nutrition and metabolic care 2005 Jul;8(4):397-402.

(24) Kyle UG, Pirlich M, Schuetz T, Lochs H, Pichard C. Is nutritional depletion by Nutritional Risk Index associated with increased length of hospital stay? A population-based study. JPEN. Journal of parenteral and enteral nutrition 2004 Mar-Apr;28(2):99-104.

(25) Chatterjee S, Hadi AS, Price B. Regression Analysis by Example. 3rd edition ed. New York: Wiley; 2000.

Appendix 1: Capital Health Adult and Pediatric Nutrition Risk Classification Tool

Level 4	Level 3	Level 2	Level 1
Capital Health Adult Inpatient Nutrition Risk Classification			
Severe Malnutrition □ Albumin< 21 nutritionally related (e.g. not valid indicator in critically ill or liver failure patients because dilution/ synthesis related). □ NPO > 7 days plus evidence of moderate malnutrition (see level 3) □ < 75 % usual weight □ < 69 % of ideal weight □ Refeeding syndrome **Nutrition Support** Parenteral Nutrition: □ New TPN start □ Poor glycemic control (<3 or >13) □ Critical electrolyte levels: ▪ K< 3.0 or > 5.5 ▪ Phos < 0.60 or >2.0 ▪ Mg <0.55 or > 1.3 ▪ ICa <0.80 Enteral Nutrition: □ New enteral start □ Patient receiving < 80% of	**Moderate Malnutrition** □ Severe weight loss: ▪ >5 % weight loss/ month ▪ >10% weight loss/ 6 months □ Albumin 21-27 nutritionally related (e.g. not valid indicator in critically ill or liver failure patients because dilution/ synthesis related). □ 75 – 84 % usual weight □ 70 - 79 % of ideal body weight □ Intake < 50 % of estimated requirements for > 7 days plus evidence of mild malnutrition (see level 2) □ Pregnant and weight gain less than 0.25 kg/week in women after 1st trimester □ Pre-pregnant weight < 90% of ideal body weight **Nutrition Support** Parenteral Nutrition: □ Electrolytes at following levels: ▪ K 3.0 - 5.5	**Mild malnutrition** □ Significant weight loss: □ 5 % weight loss/ month □ Intake < 50 % of estimated requirements for > 7 days but well nourished (see level 1) □ Albumin 28-35- nutritionally related (e.g. not valid indicator in critically ill or liver failure patients because dilution/ synthesis related). □ 85-90 % usual weight □ 80-90 % ideal body weight **Nutrition Support** □ Long term stable EN □ Long term stable TPN **Low to Moderate Education Priority** □ Patient needs teaching and has a medical condition for which nutrition intervention has an impact AND □ Patient has received teaching	**Well nourished** □ > 90 % usual or ideal weight □ Albumin >35 **No Education Priority** □ Possible need for teaching, but patient is not receptive (i.e. Patient refuses treatment/ education) □ Food preference issues. **Other** □ Low risk pregnancy □ Burn < 10 % TBSA □ Palliative Care (focus on comfort of patient; food preferences; if aggressive treatment, classify as level 2-4) as appropriate

Level 4	Level 3	Level 2	Level 1
estimated requirements > 3 days due to complications (diarrhea/ aspiration/ increased residuals/ tube problems) □ Poor glycemic control (<3 or >13) □ Electrolyte abnormalities (see above) **Other** □ Renal Failure: K<3 mmol/L or > 6mmol/ L (nutritionally relevant) □ Burn >30% TBSA	▪ Phos > 0.60 or <2.0 ▪ Mg >0.55 or < 1.3 ▪ ICa > 0.80 □ Blood glucose (3-13 mmol/L) □ Transition to enteral nutrition Enteral Nutrition □ Patient receiving and tolerating > 80% of estimated requirements for > 3 days □ Stable electrolytes, blood glucose (see above) □ Stable fluid balance □ Transition to oral feeds **High Education Priority** □ Need for teaching because patient has a medical condition or new procedure (E.g. starting insulin, gastroplasty) for which nutrition intervention has an impact AND □ Patient has not received previous teaching AND □ Patient/ caregiver is ready to learn **Other** □ Serum Phos < 0.8 mmol/L or > 2.0 mmol/L	in the past but requires additional teaching □ AND □ Patient/ caregiver is ready to learn □ High risk pregnancy- antenatal teaching □ (e.g. teen, multi-para births, vegan) □ **Other** □ Burn 10-20 % TBSA	

Level 4	Level 3	Level 2	Level 1
	□ Renal Failure: Serum K 3-3.5 mmol/L or 5.5-5.9 mmol/L (nutritionally relevant) □ 2nd or 3rd degree burns 20 % TBSA		
Capital Health Pediatric Inpatient Nutrition Risk Classification			
Severe Malnutrition □ < 75% ideal body weight □ FTT- fallen off more than 2 growth curves □ Prealbumin < 0.1 □ Significant weight loss: □ >5 % weight loss/ month □ >10 % in 6 months □ NPO □ Age 1 or less and malnutrition- NPO >24 hours □ Age 1-5 and malnutrition- NPO >2 days □ Age 5-18 and malnutrition- NPO >3 days □ Intake <80% of estimated requirements for >3 days □ Refeeding syndrome **Nutrition Support** Unstable TPN: □ Poor glycemic control (<3 or >13)	**Moderate Malnutrition** □ 75-79 % ideal body weight □ Diet related Fe deficiency anemia □ Dysphagia □ Intake <50 % of estimated requirements for >5 days plus evidence of mild malnutrition (see level 2) □ NPO ▪ Age 1 or less- NPO >3 days ▪ Age 1-5- NPO >5 days ▪ Age 5-18- NPO >7 days **Nutrition Support** Stable TPN: □ Stable electrolytes: ▪ K age 0-28 days- 3.7-6.0 ▪ K age 29 days or greater- 3.5-5.0 ▪ Phos age 0-10 days- 1.4-2.9 ▪ Phos age 11 days to 2 years - 1.3 -2.2	**Mild malnutrition** □ Intake < 50 % of estimated requirements for >5 days but well nourished (see level 1) □ Albumin 28-35- nutritionally related (e.g. not valid indicator in critically ill or liver failure patients because dilution/ synthesis related). □ 80-89 % ideal body weight **Nutrition Support** □ Long term stable EN □ Long term stable TPN **Low to Moderate Education Priority** □ Patient needs teaching and has a medical condition for which nutrition intervention has an impact □ AND □ Patient has received teaching	**Well nourished** □ 90-100% ideal body weight **No Education Priority** □ Possible need for teaching, but patient is not receptive (i.e. Patient refuses treatment/ education) □ Food preference issues. **Other** □ Burn < 10 % TBSA □ Palliative Care (focus on comfort of patient; food preferences; if aggressive treatment, classify as level 2-4)

Level 4	Level 3	Level 2	Level 1
□ Electrolyte abnormalities: ▪ K age 0-29 days- <3.7 or >6.0 ▪ K age >29 days - <3.5 or >5.0 ▪ Phos age 0-10 days- <1.4 or >2.9 ▪ Phos age 11 days to 2 years - <1.3 or >2.2 ▪ Phos age 2 years to 13 years- <1.1 or >1.8 ▪ Phos age >13 years- <0.8 or >1.45 ▪ Mg <0.7 or >1.0 ▪ ICa age ≤ 14 days <1.10 or >1.48 ▪ ICa age ≤ 14 days <1.09 or >1.25 Unstable EN: □ Patient receiving < 80% of estimated requirements > 3 days due to complications (diarrhea/ aspiration/ increased residuals/ tube problems) □ Poor glycemic control <3 or >13 □ Electrolyte abnormalities (see above) **Other** □ Renal Failure: K<3 mmol/L or > 6mmol/ L (nutritionally	▪ Phos age 2 years to 13 years- 1.1-1.8 ▪ Phos age 13 years and greater- 0.8-1.45 ▪ Mg 0.7-1.0 ▪ ICa age ≤ 14 days 1.10-1.48 ▪ ICa age ≤ 14 days 1.09-1.25 □ Blood glucose 3-13 mmol/L □ Transition to enteral nutrition Stable EN: □ Patient receiving and tolerating > 80% of estimated requirements for > 3 days □ Stable electrolytes, blood glucose (see above) □ Stable fluid balance □ Transition to oral feeds **High Education Priority** □ Need for teaching because patient has a medical condition or new procedure (E.g. starting insulin, gastroplasty) for which nutrition intervention has an impact AND □ Patient has not received previous teaching AND □ Patient/ caregiver is ready to learn	in the past but requires additional teaching □ AND □ Patient/ caregiver is ready to learn □ Other □ Burn < 10 % and intake <50 % of estimated requirements for >3days □ Inappropriate diet for age	

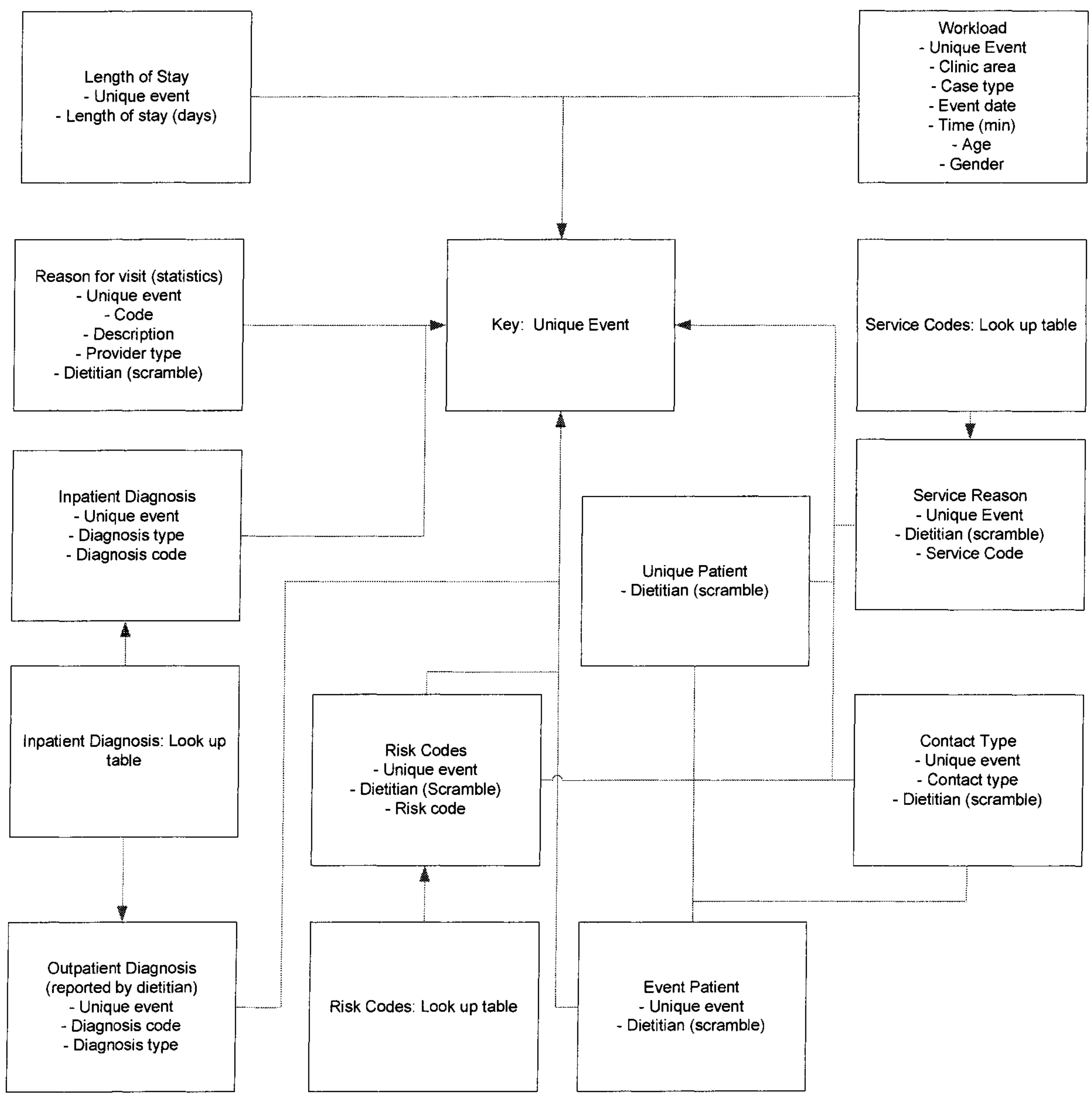
Level 4	Level 3	Level 2	Level 1
relevant) □ Burn >10% TBSA with surgery	**Other** □ Serum Phos < 0.8 mmol/L or < 2.0 mmol/L □ Renal Failure:Serum K 3-3.5 mmol/L or 5.5-5.9 mmol/L (nutritionally relevant) □ Burn >10% TBSA without surgery		
Capital Health Pediatric Inpatient Nutrition Risk Classification: Neonatal			
Malnutrition □ Infant < 1 week: ▪ >15 % weight loss from birth ▪ < 1 Kg birth weight □ Infant 1-2 weeks: ▪ Daily intake <60 Kcal/ Kg ▪ Any continued weight loss □ Infant > 2 weeks: ▪ <10 g/Kg/day (< 38 weeks GA) ▪ <1/2 expected g/day weight gain (>38 weeks GA) ▪ Prealbumin <7.0 mg/dL ▪ Albumin <2.5 g/dL	**Malnutrition** □ Weight gain persistently lower than expected for more than 2 weeks **Nutrition Support** TPN or Enteral: □ Preterm infant on or advancing to Enteral Nutrition □ Preterm infant on or advancing to TPN	□ Pre-term or term infant starting feeds within the first 2 to 3 days with no problems □ Preterm infant medically and nutritionally stable: feeding, growing at anticipated level	□ Term babies, no medical condition affecting nutrition; nipple feeding without problem

Level 4	Level 3	Level 2	Level 1
Nutrition Support TPN or Enteral: □ Infant 1-2 weeks: □ < 60 Kcal/Kg □ Infant 2 weeks: ▪ <60 Kcal/Kg (IV only) ▪ <70 Kcal/Kg (IV and enteral) ▪ <80 Kcal/Kg (all enteral) **Other** □ Direct Biliruben >2.0 mg/dL □ Serum phosphorus <4.0 mg/dL □ Alkaline phosphatase >600 U/L			

Appendix 2. International Disease Classification Chapter Groups

I. Certain infectious and parasitic diseases
II. Neoplasms
III. Diseases of the blood and blood forming organs and certain disorders involving the immune mechanism
IV. Endocrine, nutritional and metabolic diseases
V. Mental and behavioral disorders
VI. Diseases of the nervous system
VII. Diseases of the eye and adnexa
VIII. Diseases of the ear and mastoid process
IX. Diseases of the circulatory system
X. Diseases of the respiratory system
XI. Diseases of the digestive system
XII. Diseases of skin and subcutaneous tissue
XIII. Diseases of the musculoskeletal system and connective tissue
XIV. Diseases of the genitourinary system
XV. Pregnancy, childbirth and the puerperium
XVI. Certain conditions originating in the perinatal period
XVII. Congenital malformations, deformations and chromosomal abnormalities
XVIII. Symptoms, signs and abnormal clinical and laboratory findings not elsewhere classified
XIX. Injury, poisonings and certain other consequences of external causes
XX. External causes of morbidity and mortality
XXI. Factors influencing health status and contact with health services

Appendix 3. Database Schema for Creation of Database using Structure Query Language (SQL Server)



Appendix 4. Summary of Data Obtained and Modifications to the Database

Variable Type	**Variable**	**Data source**	**Used for Analysis**	**Description of changes made to database and how tables were combined**
Hospital	Hospital key	Regional Costing		
Patient	Diagnosis	Health Records (inpatients) Regional Costing (outpatients)		Excluded cases that did not have a matching ICD-10 diagnosis on the diagnosis look-up table (1644 events) Created a grouping for diagnosis based on the code ranges for each chapter of ICD-10.
	Age	Health Records		Excluded cases with a missing age (9 events)
	Gender	Health Records		
	Length of Stay (LOS)	Health Records		Excluded cases with a LOS <0 (63 events)
Dietitian	Dietitian key	Regional Costing	Not used	Some cases had more than 1 provider per event. Dietetic interns did not have a key identified.
	Type of Provider	Regional Costing	Not used	Some cases had more than 1 provider type per event.
Activity	Service Area	Regional Costing		Some cases had more than 1 service area.
	Event	Regional Costing		Provision of patient care on a specific day during a patients hospital stay. Includes direct and indirect activities. Most cases had multiple events.
	Patient	Regional Costing		This variable is for discrete patients. Note that some patients may

Variable Type	Variable	Data source	Used for Analysis	Description of changes made to database and how tables were combined
				have had more than 1 hospital stay.
	Case	Regional Costing		One hospital stay with a defined length of stay. Patients with more than 1 hospital stay had multiple case numbers.
	Service Code	Regional Costing		Service code defines that type of service provided including assessment, therapeutic intervention, and consultation collaboration. There was more than 1 service code per event. Only useful for outpatient analysis.
	Mode of service	Regional Costing		Mode of service defines if the service was individual (direct or indirect), group, home or telephone. For many patients there was more than 1 mode of service per event. Indirect time was combined with direct time to obtain total time. For inpatients, any patients coded as home or other were deleted. These services must have been done after a patient was discharged, but the inpatient case identifier was used. In addition, there were 234 events which where telephone contacts. These services were

Variable Type	Variable	Data source	Used for Analysis	Description of changes made to database and how tables were combined
				included in the inpatient analysis because these are considered part of the service provided per case.
	Reason for Service	Regional Costing		Reason for service was coded per event by the dietitian. Excluded 10 cases that did not have a reason for service identified. For those with that had more than 1 reason for service per event, the highest priority (higher number) event was selected. 4 = Parenteral Nutrition 3 = Enteral Nutrition 2 = Risk of Malnutrition 1 = Education
Acuity	Nutrition Risk Classification	Regional Costing		Nutrition Risk Classification was coded per event by the dietitian. For those with more than 1 nutrition risk classification per event, the high acuity event was selected. 4= High Malnutrition Risk/ High Acuity 3 = Moderate Malnutrition Risk/ Moderate Acuity 2= Low Malnutrition Risk/ Low Acuity 1= Not at Risk of Malnutrition