UNIVERSITY OF ALBERTA

A STUDY OF THE RELATIONSHIP
BETWEEN NURSING RESOURCE CONSUMPTION
AND
RESOURCE INTENSITY WEIGHTED CASE MIX
GROUPINGS (CMGS)

by

SARA L. WRIGHT

A THESIS

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THE UNDERSIGNED CERTIFY THEY HAVE READ, AND RECOMMEND TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH FOR ACCEPTANCE, A THESIS ENTITLED **A STUDY OF THE RELATIONSHIP BETWEEN NURSING RESOURCE CONSUMPTION AND RESOURCE INTENSITY WEIGHTED CASE MIX GROUPINGS (CMGs).** SUBMITTED BY SARA L. WRIGHT IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF NURSING.

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ABSTRACT

The purpose of this study was to examine the relationship between nursing resource consumption and resource intensity weighted Case Mix Groupings (CMGs). The study was conducted at a 560 bed community teaching hospital using 1988-89 retrospective hospital data. A limited sample of ten CMGs were included in the study. A random sample of 60 cases per CMG was selected. Nursing patient classification workload data were used to identify hours of care per day and stay; actual staffing and mix of patients were included in the calculation.

Variability of nursing resource consumption was found within and between the ten CMGs studied. Strong positive relationships were found between average length of stay (ALOS) and nursing hours per stay ($r = .943$, $p = <.001$), and between resource intensity weights (RIWs) and nursing hours per stay ($r = .871$, $p = .001$) at a one-tail alpha of 0.05. Outliers were found to consume a disproportionately large amount of resources. One-way Analysis of Variance (ANOVA) was used to examine the fixed per diem that has been used to cost out nursing across all CMGs. Significant differences were found between two of the ten CMGs at a one-tail alpha of 0.05 which provides some support for the nursing concern that a fixed per diem across all CMGs does not predict nursing resource consumption well.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I: INTRODUCTION

A major challenge to the Canadian health care system is maintaining the principles of equitable and universal access to high quality services while containing costs. Provincial governments, the funding agencies for hospitals in Canada, are making concerted efforts to curb "spiralling" hospital costs by imposing budget restrictions and reductions. Pressure is being placed on Canadian hospitals to establish better accounting systems that relate hospital costs (inputs) to hospital products (outputs). Case Mix Groups (CMGs) are being viewed by governments and administrators as the means of identifying the total hospital product.

Statement of Problem

Because nursing labor costs constitute the largest portion of the hospital budget, the nursing budget is the first to be scrutinized in efforts to reduce costs. There is a concern amongst nurses that CMGs, a medical classification scheme, may not provide an adequate method of predicting nursing resource requirements and thereby deleteriously affect the quality of patient care. The relationship between Resource Intensity Weighted CMGs and nursing resource consumption is not well known.

Purpose and Objectives

The purpose of this study is to gain some understanding of the patterns of nursing resource consumption within CMGs and of the relationship between nursing resource consumption and Resource Intensity Weighted CMGs. The specific objectives of the study are to examine the relationship between resource intensity weighted CMGs and (1) average nursing hours per stay (Hrs/Stay), (2) average nursing hours per day (Hrs/Day), and (3) average length of stay (ALOS). Nursing patient classification data are used to generate nursing hours per patient.

Definition of Terms

Case Mix - refers to the variety of patient types treated as related to the total quantity of hospital resources required.

Case Mix Groups (CMGs) - a patient classification scheme that groups inpatients into mutually exclusive medically meaningful groups on the basis of LOS as a proxy for total hospital resource consumption.

Nursing Patient Classification - refers to the process of grouping patients into mutually exclusive groups based on their requirements for nursing care.

Resource Intensity Weights (RIWs) - refers to indices that reflect the average relative expected total resource consumption across CMGs. Detailed information on the development of these weights is provided in background information, page 5.

Assumptions and Limitations

It is assumed that the record abstracting system and case mix grouping system are reliable and valid. Every batch of 100 abstracts were monitored for completeness and accuracy at the study hospital. Also audits of abstracting for diagnostic and procedure codes were done on a random basis every two weeks and found to be 95 percent reliable.

It is assumed that the nursing patient classification data are reliable and valid. Interrater reliability for patient type was audited on a weekly basis at the study hospital and found to be 90 to 95 percent. For this study actual nursing hours available on the specific nursing unit and day of stay are allocated to the patient by type using the relative weights between types to distribute the hours amongst the mix of patients present on the unit. The relative weights were established by means of a work sampling study conducted at the hospital approximately fifteen years ago.

It is not within the scope of this study to determine whether the amount of care that the patient receives is adequate. Nursing patient classification data converted to hours provided are used as a proxy for the amount of care received. Nursing resource consumption is not a measure of quality of care.

Interpretation of results is limited to the target population within the study hospital. The target population is limited to the ten CMGs selected for study for the time period of August 1988 to March 1989. It is assumed that this time period is typical of fiscal year 1988-89 and reflects the mix of patients in each CMG selected for study.

CHAPTER II: BACKGROUND AND SIGNIFICANCE

The purpose of this chapter is to provide background information on classification and funding systems and some of the related issues.

Case Mix Groups

CMGs is a patient classification scheme whereby hospital inpatients are grouped into 467 mutually exclusive medically meaningful groups (Besner, 1985; Botz & Singh, 1985). CMGs were introduced by the Hospital Medical Records Institute (HMRI), a Canadian voluntary nonprofit organization, in 1983. CMGs are the Canadian equivalent to Diagnosis Related Groups (DRGs) first developed at Yale University in the United States (U.S.) in the early 1970s (Coburn & Harper, 1983). The patients assigned to each group are theoretically similar in total resource consumption based on a statistical analysis of U.S. hospital charge data that demonstrated a proven relationship between length of stay (LOS) and total hospital costs per patient stay (Young, Swinkola & Hutton, 1980).

An HMRI medical record abstract is completed on every patient at discharge by means of a review of the patient's medical record. The medical portion of the abstract is based on the International Classification of Diseases, 9th revision (ICD-9) coding system. CMGs provide a means of collapsing the 10,171 ICD codes into a more manageable number of categories for data analysis. At discharge each patient is assigned a specific CMG based on the combination of ICD codes abstracted from the patient's medical record. (The CMG is computer assigned at HMRI based on a matching methodology that includes taking into consideration other diagnoses and co-morbidities).

The CMG system consists of 23 major clinical categories (MCCs) which are identical to the 23 major diagnostic categories (MDCs), used with the current U.S. version of DRGs. MCCs are diseases grouped by major organ systems. CMGs and DRGs are very similar with a correlation of 0.96 between DRG and CMG average length of stay (ALOS) (Botz, 1985), but there are differences in the coding procedures. DRGs use principal diagnosis assigned at the time of admission while CMGs use "responsible diagnosis (the reason for the longest stay)" (Boadway & Brown, 1987, p.24). A second difference between DRGs and CMGs is that with CMGs managed and unmanaged conditions, for example, diabetes or hypertension, are distinguished at discharge as to whether or not they have an impact on the patient's stay, while with DRGs these underlying disease conditions are listed at discharge even if they have no impact on the patient's stay.

A third difference is that CMGs are based on the ICD-9 coding convention developed by the World Health Organization in 1977, while DRGs are based on the ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification), an extension of the ICD-9 developed in the U.S. in 1978 (Greenway-Coates, 1990). It is assumed that because of the differences in the items abstracted from the medical record at discharge, CMGs would more accurately capture resource consumption than do DRGs if Canadian cost data were available (HMRI Presentation On Resource Intensity Weights, November 1988).

Resource Intensity Weights

Over the past two years HMRI has introduced resource intensity weights (RIWs) into Canada as a mechanism for analyzing hospital performance through tracking changes in resource use and case mix over time. RIWs are indices that reflect the average relative expected total resource consumption across CMGs. RIWs are mathematically derived by: (1) dividing the expected LOS per CMG by the overall data base LOS (LOS relative weight); and (2) multiplying this number by the cost per day relative weight, also referred to as Service Intensity Weight (SIW), developed from New York cost data (HMRI Database Committee, 1988).

Hospitals can compare their actual ALOS per CMG with the data base LOS for all hospitals on the HMRI system, and also compare their performance with other hospitals for matched cases (Table 1). As an example Hospital C has 12,991 cases (patients admitted). However, once the Hospital C cases are adjusted for case mix by using the LOS relative weight and cost per day relative weight, Hospital C has 22,158 weight equivalent cases. The cost per case Relative Weights (column 5 of Table 1) can be used to compare hospitals on the basis of case mix. If 1.0 represents the average case mix across hospitals then Hospital D is below average while Hospital C is well above average for case mix. The methodology used for computing RIWs has been legitimately criticized; "... the calculation method is only valid if both American and Canadian ALOSs are constantly proportional for all paired CMGs and DRGs" (Botz, 1989, p.9). Botz also criticizes the HMRI decision to use New York Service Intensity Weights rather than the more widely used DRG weights developed by the Health Care Financing Administration (HCFA) of the Department of Health and Human Services in the U.S. federal government. However, because Canadian cost

Table 1

Sample Hospital Report

LOS, Cost Per Day, and Cost Per Case Relative Weights

April 1986 - March 1987

Hospital (1)	Total # of Cases (2)	LOS Relative Weight (3)	Cst/Day Relative Weight (4)	Cst/Case Relative Weight (5)	Total Wt Equivalent Cases (6)
Hospital A	20,659	0.9295	1.2085	1.1233	23,206
Hospital B	4,384	1.3840	0.9291	1.2858	5,635
Hospital C	12,991	1.4130	1.2072	1.7057	22,158
Hospital D	17,383	0.7911	0.9860	0.7800	13,558

Note: Col (3) = LOS/CMG ÷ overall data base LOS

Col (4) = SIW (Cost/Day/CMG) ÷ overall data base Cost/Day

Col (5) = Col (3) x Col (4)

Col (6) = Col (2) x Col (5)

H.M.R.I. Database Committee (1988).

based data are not yet available, it is argued for the purposes of this study that U.S. adjusted data are the best available at this time. The assumption made by the HMRI Data Base Committee, that N.Y. Service Intensity Weights are more similar than HCFA data to the Canadian scene (HMRI Presentation On Resource Intensity Weights, November 1988) seems reasonable. Inherent weaknesses of HCFA DRG weights include: (1) the data are charge based not cost based; and (2) the population is unique to those over age 65, Medicaide or Medicare patients, and the disabled. Carney, Burns & Brobst (1989) found that it took longer to break even, comparing costs and reimbursement, for Medicare recipients than for the total patient population.

Hospital Funding

The U.S. government passed legislation in 1983 that has revolutionized the concept of hospital funding: rates for Medicare patients would be set in advance by the DRG into which the discharge falls (prospective payment system - PPS). The hospital can only recover the set rate, regardless of the costs. Other major private and public health insurance plans in the U.S. are converting to the DRG system as well.

In Canada, provincial governments have displayed increasing interest in the use of CMGs as a means of describing the hospital product. In Alberta the Department of Hospitals and Medical Care (now Alberta Health) has made policy decisions in the direction of prospective payment based on case mix. Direction was given that all hospitals should be converted to HMRI, a Canadian wide clinical hospital information system based on CMGs. Alberta Health is also directing the implementation of the federal-provincial Management Information System (MIS) Project, to promote uniform, consistent, and comprehensive hospital reporting from a financial accounting perspective in relation to individual patient and patient group costs. The MIS reporting is integrated at the global dimension with resource consumption based on case mix (Alberta Hospitals and Medical Care, 1984, 1986 and 1988).

Funding policies have also been changing in the direction of nondeficit financing in combination with announcing the percentage of budget increase or decrease in advance of the fiscal year. This progression of changes has culminated in the Alberta Acute Care Hospitals Funding Project. A group of 35 acute care hospitals and Alberta Health are currently involved in a project exploring the concept of predicting total hospital resource needs on the basis of resource intensity weighted CMGs in conjunction with severity of illness measures. The intent is that this Acute Care Funding Project will result in the development of a new funding formula for hospitals based on case mix (Alberta Health, 1989).

Limitations Of Case Mix Funding

It is important that any limitations of the funding model be identified particularly in relation to patient requirements for nursing care. Inpatients are admitted to acute care hospitals primarily because of a requirement for skilled nursing care. The effect of funding by case mix in the United States has been a decreasing length of stay and an increasing requirement for resources per day. This same trend is evident in Canada as well (Evans et al., 1989). As length of stay decreases and patient complexity and intensity increases the formula must be sensitive enough to respond to changing patient requirements for nursing care.

As hospitals respond to prospective payment by case mix and to scarcer resources by reducing LOS, it can be anticipated that the average requirements for nursing care per day will likely be increasing over time while the average requirements for nursing care per stay may be decreasing over time. As an example, a patient with a LOS of ten days, receiving four hours of nursing care per day, would receive a total of 40 hours per stay. The <u>same</u> patient with a LOS of eight days, receiving 4.4 hours of nursing care per day, would receive a total of 35.2 hours per stay. In this example the hours per day increased ten percent while the hours per stay decreased 12 percent.

In the absence of cost data the New York Service Intensity Weight (SIW), or cost per day relative weight per CMG, multiplied by the patient LOS and in conjunction with severity of illness measures, is proposed as the method of capturing the impact of differences in case mix amongst Alberta hospitals (Alberta Health, 1990). This index of case mix becomes one of the variables included in an equity least squares regression equation proposed for use by the Alberta Acute Care Hospitals Funding Project as a means of predicting hospital operating costs and appropriate levels of funding. Examples of other variables thought to be functions of hospital operating costs, based on previous research, and therefore included in the formula are number of beds and ratio of interns plus residents per beds (Alberta Health, 1990).

The point to emphasize is that all of these measures are based on averages, large samples of data and some error. The use of the New York SIW has a certain amount of bias built into it unless New York and Canadian LOSs are identical. There is a need for continuing research and development of the classification systems and funding formulas. Costing out patient care and assigning responsibility for those costs is extremely complex (Broyles & Rosko, 1987). As patient characteristics relating to medical classification and severity of illness become better addressed, a renewed interest in characteristics that separate hospitals can be anticipated. A study conducted by Weil and Hoyer (1987) suggests that hospitals of the same size and product mix may have justifiable differences in costs that relate to range of programs and services.

Costing Out Nursing

The HCFA calculation of the DRG weights included an average per diem rate for nursing across all DRGs. The assumption made was that variations in nursing intensity over the stay were driven by LOS and therefore reflected in the DRG weights (Cromwell & Price, 1988). Nonetheless, the costing methodology has been of concern to nurses and remains controversial in the literature.

The cost finding methodology used for the development of the New York Service Intensity Weights, a component of the RIW for CMGs, included step down allocations and development of costs (at a department or hospital wide basis) to charge (patient bills) ratios. Nursing weights were then developed on the basis of a panel of nurses estimating daily nursing time required by DRGs for three categories: preoperative days, ICU days, and recuperative days, to then be applied to an inpatient average per diem charge. The average nursing times were converted into an average relative weight between 1.0 and 5.0 with the intent of applying them to a patient's bill (HMRI Database Committee, 1988).

Nursing Patient Classification Systems

Although nursing patient classification systems were designed to predict staffing requirements they are viewed by some nurses as a readily available means of costing out nursing that would be preferable to the average per diem rate across DRGs (Edwardson & Giovannetti, 1987; Barhyte & Glandon, 1988). Although the term patient classification is generic, nurses have used it almost exclusively over the last 30 years to refer to "grouping patients according to their requirements for nursing care" for the purpose of determining the need for and allocation of staff resources (Giovannetti, 1985). Giovannetti identified three types of systems. The first was prototype evaluation which is a system where the patient is classified into a category on the basis of a descriptive paragraph. The second was factor evaluation where the patient is classified into a particular group on the basis of weighted critical indicators of care requirements. The third was referred to as nursing task documents and determines total staffing requirements on the basis of a listing of nursing tasks with standard times as required by each individual patient. This third type has also been referred to as a "relative value unit system" (Lewis & Carini, 1984, p.59).

Reliability And Validity of Patient Classification Systems.

Although nursing classification systems have been in use for some time there are limitations noted with these systems. There is the question of reliability: are different users of the classification instrument consistent in their interpretation and application of the indicators? With consistent inter-rater reliability established, the question of validity follows: does the instrument measure what it is supposed to measure? The question of validity is more complex. Nursing classification systems are designed to predict staffing requirements. The hours required are not necessarily equal to the actual hours provided. When hours required match actual hours provided another question remains: is the care provided both necessary and sufficient? The question of the relationship between resource consumption and quality of care has to date not been adequately addressed. As well there are a number of different nursing patient classification systems available and the question of which if any system is best has not been answered conclusively.

There are similar concerns raised regarding the reliability and validity of the CMG medical classification scheme. There is the concern of establishing inter-rater reliability in the coding of abstracts based on information taken from the medical record for the purposes of grouping the patients. There is also the question of the validity of generalizing to the total population from the original population used for establishing the separations between groups. As well there is the concern that the systems lack homogeneity within groups; that there is variation in the intensity or severity of illness within groups (heterogeneity) that may not be picked up. A number of severity of illness methodologies have been developed that address heterogeneity within groups, such as, Generic Algorithms, Disease Staging, Patient Management Paths/Categories, MEDISGRPS, APACHE II, and Severity of Illness (Benthey & Butler, 1982; Besner, 1985; Boadway & Brown, 1987; Horn, 1986; Horn, 1983; Mendenhall, 1984). As with nursing no one system has been established as being the best predictor of resource requirements.

Conclusions

The incorporation of the concept of case mix into hospital funding is a positive step. CMGs provide administrators, financial analysts, and clinicians with a common language. Decision making can then be centred on better as well as more cost effective ways of treating and caring for patients. The ethical conflict of focusing on cost per patient day to the exclusion of professional patient centered goals would be somewhat diminished by focusing on the episode of illness rather than a single day. However, there are legitimate concerns regarding the implementation of prospective payment by case mix. These concerns relate to both the limitations of the statistical methods used to derive the funding formulas and the ethics of the strategies and tactics hospitals might employ to respond to a new set of incentives.

At the aggregate level for global funding a formula such as the one proposed for Alberta has merit providing the limitations are recognized and some mechanism for appeal is provided. The implementation of a case specific fixed price per discharge could be premature until such time as consistent cost data across hospitals are available. As discussed earlier even the New York "cost" data, on which the CMG resource intensity weights are based, are in large part the result of estimates of costs in combination with charges as opposed to specific costing by DRG or CMG.

CHAPTER III: LITERATURE REVIEW

The literature review is focused primarily on research related to nursing resource consumption and DRGs. The discussion of the research findings is divided into seven sections: (1) nursing resource consumption and case mix, (2) defining and allocating costs, (3) mode of nursing and staff mix, (4) severity of illness measures and nursing resource consumption, (5) impact of PPS, (6) future directions, and (7) conclusions. A total of 42 research studies related to nursing resource consumption and case mix were found in the literature. Of the 42 studies reviewed, all were conducted in the U.S. with the exception of four Canadian studies (Bardswich, Davenport, Hundert & Stewart, 1989; Besner, 1985; Fryer, 1990; O'Brien-Pallas, 1987). The literature reviewed reflects a strong consensus amongst nurses that: (1) the actual cost of nursing care should be identified; and (2) nursing patient classification systems provide a readily available means of unravelling these costs for the purpose of DRG cost accounting.

Nursing Resource Consumption and Case Mix

A consistent finding for most of the studies was large variability of nursing resource consumption within and between DRGs (Arndt & Skydell, 1985; Atwood, Hinshaw & Chance, 1986; Besner, 1985; McKibbin, Brimmer, Galliher, Hartley & Clinton, 1985; Mitchell, Miller, Welches & Walker, 1984; O'Brien-Pallas, 1987; Sovie, Tarcinale, Vanputee & Stunden, 1985; Trofino, 1986). The conclusion generally drawn from these studies was that DRGs do not provide an adequate method of identifying nursing costs. The findings of major studies are reported in this section.

Arndt and Skydell (1985) conducted a study comparing across five hospitals the 15 DRGs with the highest volumes (approximately 45,000 patients). Their findings were that patients' nursing care requirements differed by day of stay, by DRG, within DRG, by age (reduced when adjusted for ALOS), by diagnosis, within DRG and across hospitals. Another major study was conducted by Medicus. Data were collected from 22 client hospitals over a six month period (McCormick, 1986). Variations of nursing costs within the 20 highest volume DRGs, with more variability within medical than surgical DRGs, were reported.

A third major study by Sovie, Tarcinale, Vanputee and Stunden (1985) revealed similar variability in nursing resource consumption between and among DRGs. In the Sovie et al. study there was a large sample of 22,000 patients. They found that "nursing patient classification data coupled with DRGs enabled a budget prediction that reflected 87 percent of the actual adjusted expenditures" (Sovie et al., 1985, p.39). However, even with these large sample size studies, there were variations in the findings between studies for the same DRGs.

Trofino (1986) conducted a correlation study comparing two hospitals with a large sample size of 30 DRGs and 3,277 patients, and a range of 18 to 109 cases per DRG. A correlation of 0.86 to 0.87 for nursing care hours between the hospitals for the same DRGs was found while a correlation of 0.95 to 0.97 for ALOS between the hospitals for the same DRGs was found. More recently Trofino (1989) reported the results of a study across six hospitals and found that fifty percent of the 48 DRGs studied had no significant difference in mean nursing care hours per DRG. With some of the DRGs with significant differences in mean care hours across hospitals, it was found that there was also a significant difference in the LOS across hospitals. For the nine DRGs that showed significant differences in nursing care hours exclusive of LOS, a large variability of nursing care hours was found within the DRG.

The American Nurses Association (ANA) funded a research project (McKibbin et al., 1985) that studied the 21 highest volume DRGs in two 400-bed Wisconsin hospitals. A total of 1600 patients, with a range of 25 to 116 cases per DRG, were included. This study examined daily nursing resource patterns and found a high correlation between DRG relative weights and nursing hours. These findings are <u>in keeping</u> with recent work reported by Cromwell and Price (1988). Cromwell and Price examined whether the nursing "per-diem amount which is constant across DRGs, accurately reflected the average daily intensity in each DRG" (p.19) by analyzing the data from studies done by Fetter and Thompson at Yale University in 1987 and by Sovie et al. (1984) at Strong Memorial, New York.

Cromwell and Price (1988) demonstrated that adjusting DRG cost weights for nursing intensity only resulted in a change of one to two percent in the funding rate and that any increases were offset by decreases. Because most researchers focused on the entire stay and not just a typical day and found variability within DRGs, it may have been falsely concluded by many that there was a problem with the allocation method used for calculating nursing costs and therefore with the PPS. The Medicare Algorithm was actually developed such that "variations in nursing intensity over the stay are driven by LOS, the DRG weights already account for differences in length of stay" (Cromwell & Price, 1988, p.22).

If the variability of nursing resource consumption within and between CMGs were not a problem with respect to the resource allocation method used for the PPS, then a question that follows is: why are there large variations in the findings between studies, for the same DRGs? The answer to this question may possibly be found in part in the methods used for defining costs and for allocating costs.

Defining And Allocating Costs

There is an inconsistency amongst the studies in the reporting of nursing time which results in an inconsistency in the calculation of nursing costs. This inconsistency makes comparisons between studies difficult. Nursing time was reported as a range of minutes per DRG per ICU stay (Adams & Johnson, 1986), to total hours per DRG and average hours per patient day (Mitchell et al., 1984; Mowry & Korpman, 1985; Reschak, Biordi, Holm & Santucci, 1985; Riley & Shaefers, 1983) to mean hours per category of care (Giovannetti, Edwardson & Busch, 1984) to mean hours of care per day (Grohar, Myers & McSweeney, 1986). In some instances there were no explanations given as to the content of the hours reported (Grimaldi & Micheletti, 1982; Mitchell et al., 1984).

Some of the variations in the findings related to costs may also be attributed to differences in the items being compared: for example, differences in the classification of nursing staff included in direct care giving staff (often referred to as variable direct care costs) versus administrative, management and support staff (often referred to as fixed costs); differences in the hours costed (paid versus worked hours); and whether or not the cost of benefits, both used and accrued, were included or excluded. This problem is compounded by variations in salary rates for different regions and different years.

The nursing patient classification systems used for allocating costs in the studies are representative of all three different types of nursing patient classification or workload information systems: prototype, factor evaluation, or nursing tasks documents. The differences in systems is not necessarily a problem in and of itself, but there was a fairly consistent lack of reporting of the reliability and validity of the instruments being used in the studies reviewed. Sometimes reliability was referred to, but whether it was current was not clarified with the exception of Trofino (1986, 1989). Levels of reliability were reported by some authors (Atwood et al., 1986; Bailie, 1986; Halloran, 1985; Harrell, 1986; Seitz & Edwardson, 1987; Sovie et al., 1985) but these levels were inter-rater reliability only, with the exception of Sovie et al. (1985) who also reported parallel testing with another instrument. Validation of the instruments used was not consistently reported.

Once the reliability and validity of the particular patient classification instrument in use has been established and maintained, clear definitions of what constitutes hours and costs would assist in offsetting the realities of not having one universal nursing patient classification or workload measurement system. A clear delineation of what constituted direct, indirect and total costs was provided in only a few of the study reports (Arndt & Skydell, 1985; Besner, 1985; Fosbinder, 1986; Schaefers, 1985). A related area that requires clarification is whether the reported findings reflect actual hours and costs or recommended hours and costs. Bailie (1986) and McKibbin et al. (1985) reported the use of actual hours. Fetter & Thompson (1987) made reference to doing a reconciliation between nursing reported hours and financial reports.

Mode Of Nursing And Staff Mix

The mode of nursing (method of delivering nursing care) was described in some of the studies: Bailie (1986) - total patient care; Cheatwood and Martin (1986) - primary nursing; Dahlen and Gregor (1985) - primary nursing; Halloran (1985) - case method; Sovie et al. (1985) - primary nursing; and Walker (1983) - primary and team. It is possible that mode of nursing would impact on staff utilization and therefore should be reported (Bennett & Hylton, 1990; Glandon, Colbert & Thomasma, 1990). The exclusion of descriptions of staff mix also contributes to problems with interpretation of study data as the ratio of professional to nonprofessional staff may impact on utilization of resources as well. Adams (1986), Bailie (1986), Dahlen (1985), Fosbinder (1986), Harrell (1986), Lagona & Stritzel (1984), and Sovie et al. (1985) did describe the staff mix.

Severity Of Illness Measures And Nursing Resource Consumption

Lucke and Lucke (1986) reported a high correlation between a severity of illness measure for ICU patients (APACHE II) and nursing hours per day. Marks (1987) found a positive, but weak, correlation between Horn's Severity Index and nursing patient classification data (mean hours per patient day). In another study Wilson, Prescott and Aleksandrowicz (1988) found no significant relationship between nursing intensity and severity of illness in two of the three DRGs studied and only a weak relationship between nursing intensity and severity of illness for the third DRG. In this study Wilson et al. calculated nursing care hours by means of the Relative Intensity Measure (RIM) and the MacLeod patient classification instrument and then correlated the results with the AS-SCORE severity of illness instrument.

Bardswich, Davenport, Hundert and Stewart (1989) provided quite compelling preliminary information related to a Canadian project. Discharge nursing workload, that is six categories developed from total nursing workload data collected over the course of an inpatient stay, performed as well as discharge severity of illness systems (MEDISGRPS, Patient Management Categories, Disease Staging) for predicting total recommended hours for 6 of 19 major subspecialties. For the remaining subspecialties included in the study discharge nursing workload based models performed better. Bardswich et al. also reported that recommended nursing hours correlated better with discharge severity of illness measures than LOS did.

Impact Of PPS

Pointer and Ross (1984) suggested strategies that U.S. hospitals should use to respond to prospective fixed case reimbursement. Those strategies, primarily related to reducing LOS as a means of reducing resource consumption, included: determining the cost of different products to establish profit margins and what to do with losers; providing as many services as possible before admission; and diverting as many inpatient services as possible to alternative services such as outpatient, daycare and home health care. In addition to the strategies for managing patient mix and service volume, Pointer and Ross also noted the need for strategies to safeguard quality because of the change in incentives.

Within one year of implementing the PPS in 1983, the LOS in U.S. hospitals dropped from 9.5 to 7.5 days (Balinsky & Starkman, 1987). As a result of changes in the way hospitals are funded there have been major changes in the ways hospitals do things. These changes are quite consistent with Pointer and Ross's suggestions outlined above. Physicians have been increasingly integrated into hospital administrative structures because they do determine patient mix and flow as well as service intensity and therefore must embrace the new incentives to make PPS effective. With increasing competition for scarce resources, the need to develop adequate cost data and reporting systems that include patient factors, institutional factors (labor and material productivity), and physician practice patterns has intensified (Barnard, 1988; Overfelt, 1988).

The changes in funding and service delivery have affected nursing practice as well. Kramer and Schmalenberg (1987) conducted a follow-up study after the implementation of PPS. They interviewed over 1,000 hospital nurses from a subset of 16 of the original "magnet" hospitals studied to determine the impact of the PPS and funding by DRGs on patients, nurses and nursing departments. They found that while hospital occupancy rates and number of operating beds had decreased substantially, there were an increased number of patients admitted. Nurses indicated that with the shorter LOS there were higher levels of intensity; their largest single concern was discharging fragile patients to an uncertain environment.

The reported changes in nursing departments included: a shift from primary nursing to total patient care and modified team, increasing decentralization of decision making with reduction in administrative layers, and a movement toward all RN staffing. Other perceived changes that Kramer and Schmalenberg found in clinical nursing practice included: an increased requirement for patient teaching and discharge planning, increased cost consciousness in collaboration with physicians, and less job satisfaction. At the same time, an increased nursing specialization resulting in increased pride and esteem was reported.

Future Directions

There has also been reported in the literature a perceived shift in the hospital administrative view of nursing that is attributed to the PPS. Nursing departments are becoming less often viewed as overhead cost generating departments and more often viewed as major revenue generating departments (Jones, 1989; Overfelt, 1988). The need for reliable and valid nursing patient classification systems that can be used to predict resource needs and to account for nursing resource consumption is becoming well established (Bost & Lawler, 1989; Giovannetti & Johnson, 1990; Green, McLure, Winfeld, Birdsall & Rieder, 1988; O'Brien-Pallas, Leatt, Deber & Till, 1989; Williams, 1988). Nursing reimbursement systems are being proposed that acknowledge the variation in patient intensity within

DRGs and that capture the higher acuity resulting from shorter LOS and diversion of patients to daycare and outpatients services (Barhyte & Glandon, 1988; Trofino, 1989). The idea of integrating nursing intensity data within the DRG system has also been proposed (Green et al., 1988).

The view of nursing departments as revenue generating centres is also resulting in nurses assuming a role as case managers (DeZell, Comeau & Zander, 1988; Ethridge & Lamb, 1989; Jones, 1989; Kramer, 1990; Wake, 1990). Case management refers to the concept of managing a product or CMG from admission to discharge in relation to cost effectiveness, quality, LOS management, and discharge planning. The professional role of the nurse manager in collaboration with the physician is also expanding and includes assuming the role as an integrator of other disciplines and resources to meet patient needs at the unit level (Omachanu & Nanda, 1989; Cronin & Maklebust, 1989).

Prospective payment by case mix is offering nurses an opportunity to establish the economic worth of the nursing profession (Jones, 1989). Part of establishing this worth includes not only documenting the relationship between increasing severity of illness and increasing nursing intensity or resource consumption but also documenting the patient attributes and related nursing skills that have contributed to the reduction of LOS over time (Flood & Diers, 1988). As Wilson, Prescott and Aleksandrowicz (1988) noted, intensity and severity of illness although related are not interchangeable concepts. Nursing intensity measures also include the impact of the individual, human response to illness which is central to determining patients' nursing care requirements. With a perceived shortage of nurses and scarce resources there is the risk of focusing on the cost of staffing, without considering the unique contributions that nursing makes to enhanced patient outcomes and quality of care.

Conclusions

Although variability of nursing resource consumption between CMGs is theoretically addressed in the weighting of the CMGs, the patterns of nursing resource consumption are not well known. Continuation of comparisons such as Trofinos', with clear definition of terms and reliable and valid instruments, would provide useful information for problem solving to enhance the effective use of scarce resources. Even with the proliferation of U.S. studies including major ones such as the American Nurses' Association Study (McKibbin et al., 1985) only a small percentage of the

467 DRGs have been examined. In Canada there is limited cost information available. The assumption that U.S. patterns of resource consumption are transferable to the Canadian health care scene should be challenged.

CHAPTER IV: METHODS

The study was conducted at a 560 bed community teaching hospital with 440 beds in operation during the study period. Retrospective 1988-89 hospital data were used by accessing HMRI reports and the associated nursing patient classification workload data.

Study Sample

A total of 10 CMGs were selected for retrospective study on the basis of volume treated at the study hospital and their having been included in previous large sample studies (Table 2). Sixty cases per CMG were randomly selected from the HMRI hospital index listed by CMG and patient identification number for a total of six hundred cases. The decision to establish a minimum randomly selected sample size of 60 cases per CMG was based on a previous study (Besner, 1985) where 60 was identified as the minimum number required to allow meaningful statistical analysis. As well the amount of data collection time required was taken into consideration. The total of 600 cases and 8,000 days represented 3% of the total cases, and 6.8% of the total days at the study hospital in that year.

Conceptual Framework

The conceptual framework, a nursing resource model, is a representation of the traditional staffing

Table 2

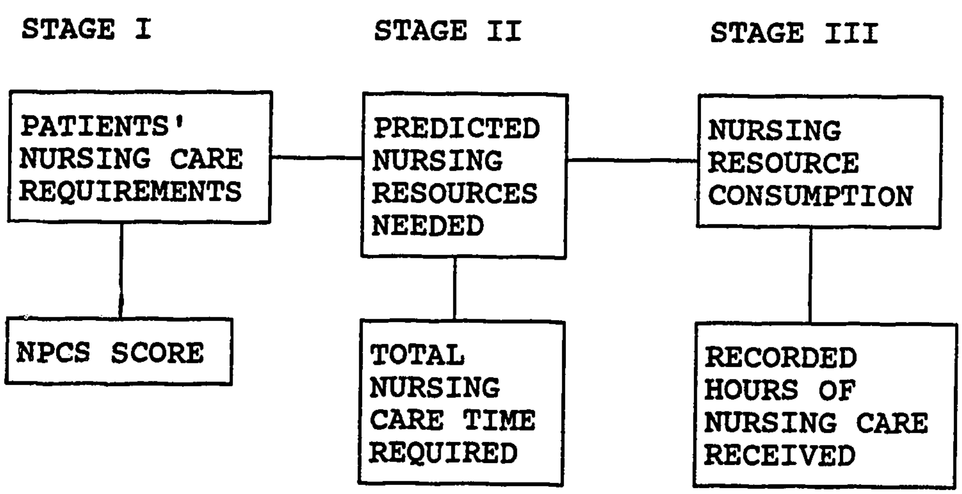
CMGs Studied: Target Population

CMG Number	Title	No. Of Separations	ALOS	RIW
595	Psychoses	315	26.5	2.5570
253	Cholecystectomy/ NOCDE, Age <70, NO CC	262	5.5	1.0251
280	Back/Neck Proc, Age <70 NO CC	277	6.1	1.7477
049	Lens Procedures	192	3.0	.6973
274	Major Joint Procedures	199	17.0	2.9435
156	AMI With CVS Complications	174	10.8	2.6664
014	Special Cerebrovasc. Dis, Not TIA	114	24.0	2.7427
446	TURP, Age >70/CC	127	7.5	1.3969
113	Chr Obstr Pulm Disease	122	14.6	1.3897
193	Major Bowel Proc, Age >70/CC	81	19.7	2.8070

Source: HMRI Report (1988-89)

methodology (see Figure 1). Stage I consists of the identification of patients' nursing care requirements as measured by the nursing patient classification system (Atwood, Hinshaw & Chance, 1986). Stage II consists of the prediction of the nursing resources (tire) required. Stage III consists of the actual resources (time) used. This framework does not address productivity or quality of care.

Figure 1. <u>Nursing Resource Model Based On Patient Care Requirements</u>



Adapted From: Atwood, J.R., Hinshaw, A.S. & Chance, H.C. (1986). Relationships among nursing care requirements, nursing resources, and charges. In F.A. Shaffer (Ed.), <u>Patients and Pursestrings</u>. New York, N.Y.: NLN Pub. No. 20-2155

Nursing resource consumption is the dependent variable in this study. Other variables that impact on nursing resource consumption include: patient characteristics (CMG); medical practice (LOS); nursing practice (percentage of RN staffing, nursing resources available, care delivery method); hospital characteristics (size of inpatient unit, range of programs and services available, referral or trauma centre, bed allocation policy, hospital ownership, philosophy and mission); and environmental characteristics (wage rates, availability of staff) (Petit, Kavois & Glandon, 1988).

The Setting

The size of the medical and surgical units at the study hospital was 32 to 36 beds. The nursing structure was decentralized with a participatory management philosophy. Responsibility for budgeting, staffing and quality of care was established at the unit level. The staffing mix on those units included in the study was predominantly all RN with a ten percent ratio of RNAs on orthopedics, urology and some of the medical units. The nursing delivery model in place at the time of the study was total patient care, but in conjunction with modified team nursing on some of the units. At the time of data collection nursing staff on the units were responsible for the initiation and administration of intravenous therapy including most of the add-mixtures. There was a traditional stock medication delivery system in place and limited materials distribution support.

Although beds were allocated by medical service and subspecialties were consolidated on specific inpatient units, there was some overflow of services to other areas depending on the sporadic nature of emergency admissions. Occupancy levels were maintained at 85 to 95 percent. Nurse staffing was adjusted to increased workload demands and workload was limited by screening admissions or closing beds if necessary. Staffing was quite stable with limited vacancy and turnover rates.

In the 1988-89 study year 4,822 of the 12,874 surgical suite visits were channeled through surgical daycare. Of a total of 56,368 emergency department visits 6,385 patients were admitted through emergency. The nursing human resource budget was 45 percent of the total labor budget at the study hospital. The nursing human resource budget constituted 33.3 percent of the total hospital operating budget.

<u>Data Collection Procedures</u>

Lists of 60 randomly selected patients were generated for each of the 10 CMGs. A patient identification number, admission date, discharge date, and LOS were recorded for each randomly selected patient. The location of the patient on date of admission and date of discharge and the patient name were then obtained from on-line computer access by patient number. This step was required because of the many in-hospital transfers that can occur after admission. As well, the patient is identified on the nursing patient classification sheet by name not number.

Nursing patient classification sheets, stored chronologically by inpatient unit, were then accessed on the correct date and inpatient unit to determine the patient classification type for the selected patient. The type was then converted to total worked nursing hours (direct and indirect patient and unit related) by distributing actual nursing hours worked on the particular unit in 24 hours amongst the mix of patients based on coefficient weights per type. Fixed hours for nursing unit managers, unit secretaries and service aides were not included at this stage. (Details of computations and coefficient weights are provided with the discussion of instrumentation.)

This process for allocating hours was repeated for each subsequent day of stay until the day of discharge for each selected patient. For instances of missing data, ICU data were checked for dates in question in case the patient had been transferred there. If the patient was not transferred to ICU then the patient with missing data was excluded from the sample and another patient was randomly selected for replacement. Outliers were included initially and then later excluded as part of the data analysis. The HMRI outlier formula (trimpoint) was used: total number of separations reported under each CMG, excluding deaths, sign outs, long stay cases (greater than 3 times the standard deviation). The trimpoint (or point at which all outliers are excluded) is the third quartile plus the third inter quartile range (HMRI, 1988).

Instrumentation

A factor evaluation type of nursing patient classification and workload measurement system was in place at the study hospital at the time the data were collected. Patients were classified into one of five types or levels on the basis of checking critical indicators of a patient's demand for nursing service for each day of stay. The inter-rater reliability for type was found to be 90 to 95 percent in previous audits conducted at the study hospital. Although the instrument had not been tested for validity through work sampling since 1973-74, the method used in this study of allocating actual hours on the basis of patient mix was considered to have strengthened the validity of the study data. As well the coefficient weights used at the study hospital to determine patient mix were similar to the current weights used at other Alberta hospitals (Fryer, 1990). At the study hospital the coefficient weights for each patient type were as follows: Type I patient, 0.5; Type II patient, 1.0; Type III patient, 2.0; Type IV patient, 4.0; and Type V patient, automatically assigned 24 hours of care.

The "hours provided" per type were determined by taking the following steps: (1) having the total actual nursing hours of care available per inpatient unit per day and the numbers of patients by type for the same unit in the same time frame; (2) allocating 24 hours of care per day to any type V patients on the unit that day (working with the knowledge that any Type V patient requires constant care, 24 hours of care per day, at the study hospital); and then (3) distributing the remaining actual hours amongst the remaining patients on the unit on the basis of the coefficient weight per type (Appendix I, page 106). There were no Type I patients found in the data. Most patients were classified as Type III, less as Type II or IV, and very few as Type V.

The hours of care provided for each day of stay for an individual patient were then added together to compute the total hours per stay for each individual patient, and the average hours per day (based on the patient's LOS). Average hours of care per day and average hours of care per stay were then computed for each CMG specific group of patients. A major assumption being made is that the coefficient weights, or the relationship between types of patients in terms of amount of resources consumed, will hold regardless of the total amount of resources available on the unit. O'Brien-Pallas (1987) found this to be the case when acuity data from three different nursing classification systems were correlated with CMGs.

The hours of care allocated per day per type included worked nursing hours only (direct and indirect productive nursing hours) and excluded nonproductive paid hours such as vacation, statutory holiday and sick hours. For the purposes of costing (presented with findings), nonproductive hours were computed as an average amount per patient day, based on actual experience at the study hospital, to identify total paid nursing hours. Fixed hours for nursing management, clerical and support staff at the unit level were computed and added as a constant average hour per patient day. Fixed hours for nursing administration and nurse clinicians (educators) were allocated as a constant average per patient day as well.

Data Analysis

Data analysis were performed using the SPSS-X Release 3.0 statistical software package. Data analyses included the use of descriptive statistics, correlational statistics, and inferential statistics including significance testing and analysis of variance. Each of the statistical methods will be briefly discussed below using Pagano (1981) as the primary reference.

Descriptive statistics are concerned mainly with describing the sets of data in a meaningful way. Hours per day, hours per stay, and weighted hours per stay were computed for each patient. The total hours per stay were divided by the RIW of the particular CMG to compute weighted hours per stay. The data were then summarized for each of the ten CMGs by measures of central tendency and dispersion.

Measures of central tendency used included the mean and the median. The mean, the sum of the scores divided by the number of scores, was used because as a measure of central tendency it is least subject to sampling variation. Overall the mean varies less than other measures of central tendency and is most often used in inferential statistics. However, the mean is very sensitive to extreme scores when they are not balanced. The median, also a measure of central tendency, is the value below which 50 percent of the scores fall. The median, the midpoint score, is less sensitive than the mean to unbalanced extreme scores and is therefore useful if the data is strongly skewed.

The measures of dispersion or variability used included the range, standard deviation (S.D.), and coefficient of variation (C.V.). The range is simply the difference between the lowest and highest score. The standard deviation gives a measure of dispersion relative to the mean. The standard deviation like the mean is sensitive to each score in the distribution and is stable with regard to sampling variance. The coefficient of variation is the standard deviation divided by the mean. It provides a unitless measure of the relative degree of homogeneity between groups and is expressed as a percentage.

Correlational Statistics. The Pearson r correlation coefficient measures the magnitude and direction of the relationship between two variables. It was used to measure the relationship between the dependent variable, nursing resource consumption, and each of the independent variables. The Pearson r is the slope of the least squares regression line. The scores are plotted as transformed standardized Z scores. By using Z scores the measurement of the relationship between the two variables is independent of differences in scaling and units used in measuring the variables.

The Pearson r coefficient can be interpreted as the variability of Y (the dependent variable) explained by X (the independent variable). To use the Pearson r correlation coefficient the shape of the relationship between variables should be linear and the measurement scale of the data should be interval or ratio. The data were plotted to confirm that they were linear. The magnitude and direction of the correlation between the two variables does not establish causality per se.

Inferential Statistics. Random sampling and probability are central to inferential statistics. With inferential statistics the sample scores are used to make generalizations about the target population from which the sample was drawn. For this study the sample was randomly selected by means of a random numbers table. The table was entered randomly and the direction for moving through the table was established in advance. As noted earlier a sample size of 60 randomly selected cases per group had been planned. A minimum sample size of thirty cases is required for inferential statistics.

Significance testing relates to the probability of rejecting the Null hypothesis when the Null is true (Type I error). The student's t test and F statistic are the inference tests used in this study. Both these tests depend on sampling distributions that are normal. A critical probability level called the alpha level is set in advance: if the obtained probability is equal to or less than the alpha level set then the Null hypothesis can be rejected. When the Null hypothesis is rejected the results are said to be significant.

With the Pearson r correlation statistic, the student's t test was used for significance testing. A one-tailed test of significance with an alpha level of 0.05 was used. The t test is used for making comparisons between groups and is based on a set of t distributions of means of randomly selected samples from a normally distributed population. All t distributions have a normal distribution and a mean equal to the population mean. The shape of the t distributions vary based on the sample size and degrees of freedom.

One-way analysis of variance (ANOVA) was used to examine the mean differences among the ten CMGs to determine whether group means differed from one another for each of the dependent variables. The test of significance used is the F test which is the ratio of two independent variance estimates of the same population variance. The analysis of variance like the t test assumes that only the mean of the scores is affected by the independent variable, not the variance. The alpha level for the F statistic was set at 0.05.

The analysis of variance, the squared deviation of scores from the group mean, partitions the total variability of the data into two sources: the variability that exists within each group, called the within groups sum of squares (SS_W), and the variability that exists between the groups called the between groups sum of squares (SS_B). If groups differ substantially the SS_B is large. If there is no difference between groups the SS_B and SS_W should be about the same. If the F statistic, the ratio of the two variance estimates, is large then the Null hypothesis is rejected (Besner, 1985). An alpha level of 0.05 was set.

When a significant F is obtained the Null hypothesis, that there are no mean differences between groups, can be rejected. However, when there are more than two groups compared a test for multiple comparisons to determine which groups differ from which is indicated. For this study the Newman-Keuls procedure was used to look for multiple comparisons. The Newman-Keuls test is a posteriori test that maintains the Type I error rate at alpha for each comparison. This test controls the probability of making a Type I error by using sampling distributions based on comparing the means of many samples. "These distributions, called the Q or studentized range distributions, were developed by randomly taking k samples of equal n from the same population (rather than just 2 as with the t test) and determining the difference between the highest and lowest sample means" (Pagano, p.384). "Newman-Keuls has a higher experiment-wise Type I error rate but a lower Type II error rate" (Pagano, p.392). Type II error is failing to reject the Null when the Null is false.

Ethics

Administrative approval to conduct this research was obtained from the study hospital. The researcher agreed that the name of the study hospital would not be identified without prior approval. The obligations regarding maintaining confidentiality of patient information were met. The data were summarized such that there is no way of linking the data to individual patients.

Ethical clearance was obtained from the Ethics Review Committee, Faculty of Nursing, University of Alberta (Appendix II, page 107).

CHAPTER V: FINDINGS

The purpose of this study was to gain some understanding of nursing resource consumption patterns within and between selected CMGs. The objectives were related to examining the relationship between resource intensity weighted CMGs (the independent variable) and measures of nursing resource consumption (the dependent variables). Data analyses were performed using the SPSS-X Release 3.0 statistical software package. Data analyses included the use of descriptive statistics, correlational statistics, and inferential statistics including significance testing and analysis of variance.

First a description of the study sample as a subset of the hospital target population will be provided along with a summary of the variables studied. The discussion of the study findings will then be presented in six parts: (1) nursing resource consumption by CMG; (2) variability within CMGs; (3) impact of excluding outliers; (4) relationships between nursing resource consumption and resource intensity weighted CMGs; (5) variability between CMGs; and (6) costing out nursing.

The Sample And Variables

A random sample of 582 cases was selected for the ten CMGs included in the study. Nine of the ten CMGs were selected from amongst the twenty highest volume medical and surgical CMGs at the study hospital. The remaining CMG, Psychoses (595), was overall the third highest volume CMG at the study hospital. The target population of the ten CMGs included in the study represented 9.3 percent of the total inpatients admitted to the study hospital in 1988-89. A random sample size of sixty cases per group had been planned but because of missing data the sample size was reduced in some instances (Table 3). The analyses of data were performed both with and without outliers included. A summary of the trim points and sample size with outliers excluded per CMG is provided in Table 4.

The variables recorded for each individual case, or patient, included:

(1) <u>length of stay</u>; total days stay for patient (24 hours of stay per day from midnight to midnight);

(2) <u>total hours per stay</u>; total hours of nursing care provided for the stay (hours of care on date of admission included, hours of care on date of discharge excluded);

(3) <u>average hours per day</u>; total hours per stay divided by length of stay.

The variables computed for each CMG, or group of

Table 3

Study Sample: Outliers Included

CMG Number	Title	No. Separations	Random Sample
595	Psychoses	315	60
253	Cholecystectomy/ NOCDE, Age <70, NO CC	262	60
280	Back/Neck Proc, Age <70 NO CC	277	60
049	Lens Procedures	192	60
274	Major Joint Procedures	199	59
156	AMI With CVS Complications	174	60
014	Special Cerebrovasc. Dis, Not TIA	114	60
446	TURP, Age >70/CC	127	57
113	Chr Obstr Pulm Disease	122	60
193	Major Bowel Proc, Age >70/CC	81	46
	Total	1863	582

Note. Institutional Year Total 19,975

Table 4

Study Sample: Outliers Excluded

CMG Number	Title	N Before Exclusions	Outliers Excluded For LOS	N After Exclusions
595	Psychoses	60	(>98)	59
253	Cholecystectomy/ NOCDE, Age <70, NO CC	60	(>16)	59
280	Back/Neck Proc, Age <70 NO CC	60	(>25)	59
049	Lens Procedures	60	(>5)	55
274	Major Joint Procedures	59	(>51)	58
156	AMI With CVS Complications	60	(>36)	59
014	Special Cerebrovasc. Dis, Not TIA	60	(>98)	56
446	TURP, Age >70/CC	57	(>25)	55
113	Chr Obstr Pulm Disease	60	(>36)	57
193	Major Bowel Proc, Age >70/CC	46	(>66)	45
	Total	582		562

Note. Exclusions also include deaths, patients who sign out against medical advice and transfers to and from other acute care facilities with LOS <3 days.

patients, included:

(1) average, mean, hours per stay (Hrs/Stay); total nursing hours divided by total number of patients in group;

(2) average, mean, hours per day (Hrs/Day); total nursing hours divided by total number of patient days per group;

(3) average length of stay (ALOS); total patient days divided by total number of patients in group;

(4) average, mean, weighted hours per stay (WHrs/Stay); average hours per stay divided by the RIW of the particular CMG.

Nursing Resource Consumption

The nursing resource use by patients in each CMG studied is provided in this section. (Hours reported include nursing direct and indirect patient and unit related worked hours only.) Tables 5 and 6 provide a summary of the average hours per day (Hrs/Day), average hours per stay (Hrs/Stay), and average length of stay (ALOS) for each CMG. The Hrs/Day per CMG range from 3.19 to 7.78. The Hrs/Stay range from 11.79 to 118.10.

The rank orders of Hrs/Stay and ALOS from lowest to highest (Table 5) are fairly well matched with the exception of Psychoses (595), and Special Cerebrovascular Disease, not TIA (014). This finding

Table 5

Average (Mean) Nursing Hours Used By Patient Stay (Hrs/Stay) And ALOS Per CMG Rank Ordered

CMG Number	Title	N	Hrs/Stay	ALOS
595	Psychoses	60	105.93(8)	22.3(10)
253	Cholecystectomy/ NOCDE, Age <70, NO CC	60	22.16(2)	5.5(2)
280	Back/Neck Proc, Age <70 NO CC	60	24.95(3)	6.7(3)
049	Lens Procedures	60	11.79(1)	3.3(1)
274	Major Joint Procedures	59	77.62(7)	19.0(8)
156	AMI With CVS Complications	60	69.31(6)	9.7(5)
014	Special Cerebrovasc. Dis, Not TIA	60	118.10(10)	18.8(7)
446	TURP, Age >70/CC	57	33.68(4)	7.8(4)
113	Chr Obstr Pulm Disease	60	40.47(5)	11.4(6)
193	Major Bowel Proc, Age >70/CC	46	113.14(9)	21.7(9)

Note. Outliers included. Rank order from lowest to highest in brackets ( ) with poor matches of rank orders underlined.

lends some support to the theoretical design of the CMG model; LOS is a proxy for resource consumption and there is a positive linear relationship between LOS and resource consumption.

The rank orders of Hrs/Day and ALOS are not well matched in six of the 10 cases (Table 6). This finding is not consistent with the findings reported by Fetter et al. (1987) and suggested by McKibbin et al. (1985); that patients with longer stays used higher Hrs/Day than patients with shorter stays. This finding is however, of interest to nurses because of the concern that the intensity per day will continue to increase as the length of stay continues to decrease in response to prospective payment by case mix and scarcer resources.

Variability Within CMGs

Some variation of nursing resource consumption within CMGs is to be expected. Some patients will require more resources and others less but overall the mean or average is considered to be the appropriate measure. Those cases that use less than or more than the mean resources are expected to balance one another off. Variation within CMGs is only a problem if systematic bias is present.

The mean, standard deviation (S.D.), and coefficient of variation (C.V.) of Hours/Stay and

Table 5

Average (Mean) Nursing Hours Used By Patient Day (Hrs/Day) And ALOS Per CMG Rank Ordered

CMG Number	Title	N	Hrs/Day	ALOS
595	Psychoses	60	4.72(7)	22.3(10)
253	Cholecystectomy/ NOCDE, Age <70, NO CC	60	4.05(6)	5.5(2)
280	Back/Neck Proc, Age <70 NO CC	60	3.76(3)	6.7(3)
049	Lens Procedures	60	3.53(2)	3.3(1)
274	Major Joint Procedures	59	3.96(5)	19.0(8)
156	AMI With CVS Complications	60	7.78(10)	9.7(5)
014	Special Cerebrovasc. Dis, Not TIA	60	6.49(9)	18.8(7)
446	TURP, Age >70/CC	57	3.90(4)	7.8(4)
113	Chr Obstr Pulm Disease	60	3.19(1)	11.4(6)
193	Major Bowel Proc, Age >70/CC	46	5.49(8)	21.7(9)

Note. Outliers included. Rank order from lowest to highest in brackets ( ) with poor matches of rank orders underlined.

Hours/Day for each CMG are presented in Tables 7 and 8. The C.V. is computed by dividing the S.D. by the mean. The C.V. is used to assess the level of homogeneity within CMGs: the lower the C.V. the greater the homogeneity of the group. Because the C.V. is a unitless measure of relative variability expressed as a percentage it can be used to compare groups with different units of measurement.

The C.V.s for hours per stay per CMG (Table 7) are all quite high with a range of 0.5 to 1.87. Six of the ten C.V.s for hours per stay per CMG are at 0.93 or greater. Psychoses (595), Major Joint Procedures (274), Special Cerebrovascular Dis, not TIA (014), TURP, Age >70/CC (446), COPD (113), and Maj Bowel Proc (193) are all highly heterogeneous.

The C.V.s for hours per day per CMG (Table 8) are lower than those for hours per stay. The C.V.s for hours per day per CMG range from 0.2 to 1.15. Seven of the ten C.V.s for hours per day are below 0.5 suggesting more homogeneity in hours per day than hours per stay within CMGs. Ranges and medians for hours per stay and hours per day are provided in Appendices III and IV, pages 108 and 109.

The HMRI exclusions and outliers have been

Table 7

Within CMG Variability: Nursing Hours/Stay

CMG Number	Title	N	Mean	S.D.	C.V.
395	Psychoses	60	105.93	98.38	0.93*
253	Cholecystectomy/ NOCDE, Age <70, NO CC	60	22.16	11.03	0.50
280	Back/Neck Proc, Age <70 NO CC	60	24.95	17.80	0.71
049	Lens Procedures	60	11.79	8.26	0.70
274	Major Joint Procedures	59	77.62	77.24	0.99*
156	AMI With CVS Complications	60	69.31	50.23	0.72
014	Special Cerebrovasc. Dis, Not TIA	60	178.10	234.60	1.32*
446	TURP, Age >70/CC	57	33.68	42.49	1.26*
113	Chr Obstr Pulm Disease	60	40.47	75.71	1.87*
193	Major Bowel Proc, Age >70/CC	46	113.14	105.88	0.93*

Note. Outliers included.
* Highly Heterogeneous: C.V. >0.9.

Table 8

<u>Within CMG Variability: Nursing Hours/Day</u>

CMG Number	Title	N	Mean	S.D.	C.V.
595	Psychoses	60	4.72	2.02	0.43*
253	Cholecystectomy/ NOCDE, Age <70, NO CC	60	4.05	0.82	0.21*
280	Back/Neck Proc, Age <70 NO CC	60	3.76	0.98	0.26*
049	Lens Procedures	60	3.53	0.98	0.28*
274	Major Joint Procedures	59	3.96	1.29	0.34*
156	AMI With CVS Complications	60	7.78	4.76	0.61
014	Special Cerebrovasc. Dis, Not TIA	60	6.49	7.49	1.15
446	TURP, Age >70/CC	57	3.90	1.05	0.27*
113	Chr Obstr Pulm Disease	60	3.19	0.99	0.31*
193	Major Bowel Proc, Age >70/CC	46	5.49	3.52	0.64

<u>Note.</u> Outliers included.
* More Homogeneous: C.V. <0.5.

included in the data analysis to this point because these are often the atypically expensive cases; the longest stays, emergency admissions transferred to other acute care facilities within three days of admission, and deaths. As well, the exclusions and outliers are often the cases that are most unpredictable in occurrence and therefore most difficult to plan for.

Impact Of Excluding Outliers On Nursing Resource Consumption

The data presented in this section were analyzed with outliers excluded to determine whether or not homogeneity within groups would improve. In the cases where heterogeneity persisted some interpretive comments are made. The magnitude of the impact of excluding outliers on the overstatement or understatement of resource consumption is also described.

Nursing resource consumption. A summary of ALOS and nursing hours per day and per stay are provided for each CMG with outliers excluded in Tables 9 and 10. The range between CMGs for hours per day per CMG is 3.18 to 7.49, with outliers excluded, as compared to 3.19 to 7.78 with outliers included. The range between CMGs for hours per stay per CMG is 10.1 to 124.7, with outliers excluded, as compared to 11.79 to 118.10 with outliers included.

The match between rank orders of Hrs/Stay and ALOS has improved (Table 9). Removal of the outliers from the data has increased support for the theoretical underpinning of the CMG model, that there is a positive linear relationship between ALOS and resource consumption. However, the discrepancy between rank orders of Hrs/Day and ALOS has only improved marginally with the exclusion of outliers (Table 10).

Variability within CMGs. A comparison of the coefficients of variation (C.V.) for hours per stay and hours per day per CMG with outliers included and excluded are presented in Tables 11 and 12. The variability for the hours per stay per CMG has decreased for the most part after the exclusion of outliers (Table 11). The major exception is Special Cerebrovascular Disease, Not TIA (014), where heterogeneity of hours per stay actually increased after the exclusion of outliers from 1.32 to 1.94.

The variability for the hours per day has changed very little if any per CMG after the exclusion of outliers (Table 12). The one exception again is Special Cerebrovascular Disease, Not TIA (014). In this case the C.V. has decreased quite substantially

Table 9

Nursing Hours Per STAY And ALOS Rank Ordered

CMG Number	Title	N	Hrs/Stay	ALOS
595	Psychoses	59	107.63(9)	22.68(10)
253	Cholecystectomy/ NOCDE, Age <70, NO CC	59	21.2(2)	5.25(2)
280	Back/Neck Proc, Age <70 NO CC	59	23.35(3)	6.22(3)
049	Lens Procedures	55	10.1(1)	2.87(1)
274	Major Joint Procedures	58	68.69(6)	17.69(7)
156	AMI With CVS Complications	59	70.04(7)	9.88(6)
014	Special Cerebrovasc. Dis, Not TIA	56	124.7(10)	20.03(9)
446	TURP, Age >70/CC	55	27.79(4)	7.0(4)
113	Chr Obstr Pulm Disease	57	29.07(5)	9.03(5)
193	Major Bowel Proc, Age >70/CC	45	105.53(8)	19.64(8)

Note. Outliers excluded. Rank orders from lowest to highest in brackets ( ).

Table 10

Nursing Hours Per DAY And ALOS Rank Ordered

CMG Number	Title	N	Hrs/Day	ALOS
595	Psychoses	59	4.7(7)	22.68(10)
253	Cholecystectomy/ NOCDE, Age <70, NO CC	59	4.05(6)	5.25(2)
280	Back/Neck Proc, Age <70 NO CC	59	3.76(3)	6.22(3)
049	Lens Procedures	55	3.5(2)	2.87(1)
274	Major Joint Procedures	58	3.9(5)	17.69(7)
156	AMI With CVS Complications	59	7.47(10)	9.88(6)
014	Special Cerebrovasc. Dis, Not TIA	56	5.11(8)	20.03(9)
446	TURP, Age >70/CC	55	3.84(4)	7.0(4)
113	Chr Obstr Pulm Disease	57	3.18(1)	9.03(5)
193	Major Bowel Proc, Age >70/CC	45	5.5(9)	19.64(8)

Note. Outliers excluded. Rank orders from lowest to highest in brackets ( ). Poor matches of rank orders underlined.

Table 11

Comparison Of C.V.s With And Without Outliers For Hours/Stay

CMG Number	Title	Hrs/Stay With	Hrs/Stay Without
595	Psychoses	0.93	0.13
253	Cholecystectomy/ NOCDE, Age <70, NO CC	0.50	0.39
280	Back/Neck Proc, Age <70 NO CC	0.71	0.55
049	Lens Procedures	0.70	0.38
274	Major Joint Procedures	0.99	0.52
156	AMI With CVS Complications	0.72	0.72
014	Special Cerebrovasc. Dis, Not TIA	1.32	1.94
446	TURP, Age >70/CC	1.26	0.78
113	Chr Obstr Pulm Disease	1.87	0.79
193	Major Bowel Proc, Age >70/CC	0.93	0.89

Table 12

Comparison Of C.V.s With And Without Outliers For Hours/Day

CMG Number	Title	Hrs/Day With	Hrs/Day Without
595	Psychoses	0.43	0.43
253	Cholecystectomy/ NOCDE, Age <70, NO CC	0.20	0.20
280	Back/Neck Proc, Age <70 NO CC	0.26	0.26
049	Lens Procedures	0.28	0.28
274	Major Joint Procedures	0.34	0.32
156	AMI With CVS Complications	0.61	0.54
014	Special Cerebrovasc. Dis, Not TIA	1.15	0.73
446	TURP, Age >70/CC	0.27	0.20
113	Chr Obstr Pulm Disease	0.31	0.30
193	Major Bowel Proc, Age >70/CC	0.64	0.64

from 1.15 to 0.73. Overall it is of interest to note that the deletion of outliers had a greater impact on reducing the internal variability of hours per stay per CMG than hours per day per CMG. Hours per day per CMG are more homogeneous with a range of 0.20 to 0.73 than are hours per stay with a range of 0.13 to 1.94 after the deletion of outliers. Appendices V and VI, pages 110 and 111, provide means and standard deviations for hours per stay and hours per day after the exclusion of outliers.

Because the data for the CMG Special Cerebrovascular Disease, Not TIA (014), seemed to be so out of line in comparison with the other selected CMGs a closer look was taken at the raw data. An examination of ALOS indicated that the ALOS for CMG 014 was in line with the other CMGs for mean, S.D. and C.V. Therefore ALOS was not contributing to the atypical total hours per stay resource consumption pattern. The C.V. for ALOS for CMG 014 decreased from 0.81 to 0.74 with the exclusion of outliers (Appendices VII and VIII, pages 112 and 113). The main feature that distinguished the CMG Special Cerebrovascular Disease, Not TIAs (014) from the other selected CMGs was its large standard deviation for hours per stay.

The other CMG that seemed to stand out from the ten CMGs included in the study was AMI with CVS Complications (156). Although CMG 156 ranked sixth in ALOS after excluding outliers it ranked highest in hours per day per CMG. The distinguishing feature for this CMG was that 48 of the 60 cases spent a substantial portion of their days stay in the Intensive Care Unit. As well CMG 156 was 4 days below the HMRI database mean for ALOS (Appendix IX, page 114).

Impact Of Outliers On Statement Of Resource Consumption

From the total of 582 cases in the study sample there were twenty outliers identified representing 3.4 percent of the sample. Eight of the outliers were one day stays with the remaining 12 being long stays exceeding the HMRI trim points. The outliers used 7.4 percent of the patient days and 7.9 percent of the hours (Table 13).

The outliers used on average 140 hours per case while the average for the total sample was 60 hours per case. It can be concluded that outliers could contribute substantially to hospital costs if they represent 3.4 percent of cases but 7.9 percent of costs. A compensating factor might be the efficient and effective management of the remaining cases. However, because the study hospital is already below the HMRI data base mean for LOS for matched cases

Table 13

Impact Of Outliers On Resource Consumption

CMG Number	Title	No Outliers	% Of Cases	Days Stay	Hours Consumed	% Of Hours	
595	Psychoses	1	1.7%	1	5.6	<1%	Discharged self
253	Cholecystectomy/ NOCDE, Age <70, NO CC	1	1.7%	18	79	5.9%	
280	Back/Neck Proc, Age <70 NO CC	1	1.7%	33	119	7.8%	
049	Lens Procedures	5	8.3%	42	217	30%	1 death
274	Major Joint Procedures	1	1.7%	96	595	13%	
156	AMI With CVS Complications	1	1.6%	1	9.8	<1%	1 death
014	Special Cerebrovasc. Dis, Not TIA	4	6.6%	4	160	2.25%	3 deaths 1 transfer
446	TURP, Age >70/CC	2	3.5%	58	391	20.4%	
113	Chr Obstr Pulm Disease	3	5%	170	771	32%	1 Discharged self
193	Major Bowel Proc, Age >70/CC	1	2.6%	115	455	8.7%	
	Total	20	3.4%	538	2802		
	For All Cases	582		7226	35267		
				7.4%	7.9%		

(outliers removed) in many instances, it might prove difficult to financially compensate for the more costly outliers by shortening the ALOS (Appendix IX, page 114).

Relationship Between Nursing Resource Consumption And Resource Intensity Weighted CMGs

Data were analyzed at the CMG level using Pearson r correlation coefficients to examine the relationship between the variables Hrs/Day, Hrs/Stay, ALOS, and RIW (Table 14). The correlation coefficient for Hrs/Stay and ALOS per CMG ($r = .943$) supports a strong relationship between nursing resource consumption and ALOS and is significant at $p = <.001$. The correlation coefficient for Hrs/Stay and RIW per CMG ($r = .871$) is not quite as strong as with ALOS but is significant at $p = .001$. ALOS would be a stronger predictor of nursing resource consumption, ($r^2 = .89$) than would be the RIW ($r^2 = 0.76$). The t value for the difference between the correlation coefficients for Hrs/Stay and ALOS ($r = .9428$) and Hrs/Stay and RIW ($r = .8709$) was computed. There was no significant difference found between the correlation coefficients of .9428 and .8709 for seven degrees of freedom and a one-tail alpha of 0.05. The relationship between ALOS and Hrs/Day is low ($r = .349$) and not significant which again challenges

Table 14

Pearson Correlation Coefficients For Data Grouped By CMG

	Hrs/Day	Hrs/Stay	ALOS	RIW
Hrs/Day	1.000			
Hrs/Stay	.5736	1.000		
ALOS	.3493	.9428*	1.000	
RIW	.6209	.8709*	.8604*	1.000

Note. Outliers Excluded.
One-tailed test of significance (Alpha .05)
* Significant - p = .001.

the opposite findings reported in previous studies referred to earlier.

Variability Between CMGs

The question of whether the mean differences between the CMGs truly reflect differences in nursing resource consumption or whether they are merely a result of sampling error is addressed by the use of One-Way Analysis of Variance (ANOVA). One-way ANOVA was carried out on the ALOS, Total Hours per Stay, and Weighted Hours per Stay across the ten selected CMGs. In each case the F statistic was found to be significant at p = <.001 suggesting a significant difference between groups for each of the variables (Appendix X, XI, XII, pp. 116 - 118). The critical value of F at 9 and 552 degrees of freedom at the .01 level of significance is 2.43 (Table 15).

The Newman-Keuls procedure was used to do post hoc multiple group comparisons to determine which groups differed from which. For ALOS, groups 274, 193, 14 and 595 were found to be significantly different from groups 49, 253, 280, 446, 113 and 156 at an alpha level of 0.05. For Hours per Stay, groups 274, 156, 193, 595 and 14, the groups with the highest hours/stay (Table 9, page 64), were found to be significantly different than groups 49, 253, 280, 446 and 113, the five groups

Table 15

One-Way ANOVA Across 10 CMGs

Variable	F Ratio	F Prob
ALOS	35.27	<.001
Hrs/Stay	12.23	<.001
WHrs/Stay	6.34	<.001

Note. Alpha = 0.05, df = 9 and 552
Critical value of F = 2.43

with the lowest hours/stay, at an alpha level of 0.05. For Weighted Hours per Stay (Hours per Stay divided by RIW), groups 595 and 14 were found to be significantly different from groups 280, 49, 446, 253, 113, 274, and 156, at an alpha level of 0.05.

Because the CMG system is designed on the basis of the groups being mutually exclusive with respect to resource consumption as well as medical classification, mean differences between the groups are expected. ALOS, as a proxy for and predictor of total resource consumption, showed the most paired significant differences between groups across the ten selected CMGs with a total of 28 paired differences. Total hours per stay showed only one less paired difference between groups than did ALOS. Weighted hours per stay showed sixteen paired differences which were essentially CMGs 595 and 14 differing from the seven groups as listed above. For WHrs/Stay group 193 was significantly different from 280 and 49 as well. In comparing significant differences between groups for ALOS and Hrs/Stay groups 156 and 274 exchanged positions in mean ordering as did groups 14 and 595 which is consistent with the rank orders in Table 9, page 64. The main differences in the pairs of group comparisons for ALOS and Hrs/Stay are: CMG 49 was found to be significantly different from CMG 113 for mean ALOS but not Hours/Stay; CMG 14 was found to be significantly different from CMG 274 for mean Hrs/Stay but not for ALOS.

Through examining the variable weighted nursing hours per stay across the ten CMGs, the concern that a fixed per diem had been used across all DRGs to cost out nursing is being addressed. Weighted nursing hours per stay was computed by dividing total hours per stay by the RIW for the particular CMG thereby adjusting the Hours/Stay to control for differences in LOS and daily service intensity. If the variability in nursing resource consumption were addressed through the LOS and weighting of the CMGs, then there should be no significant difference between any of the CMGs for weighted nursing hours per stay and this is not the case. However, as noted earlier there are other parameters that separate CMGs 014 and 595 from the ten selected CMGs. First it was noted that CMG 014, Special Cerebro. Vasc. Dis, Not TIA, was highly heterogeneous for hours per stay with a C.V. of 1.94 with outliers excluded. A distinguishing feature of CMG 595, Psychoses, was that its ALOS exceeded the database for matched cases by 3.3 days. By dropping the ALOS by 3.3 days the rank order for 595, Psychoses, would drop from ninth to seventh position for Hours per Stay (see Table 9, page 64), even if hours per day were to increase somewhat.

Because CMGs were theoretically separated on the basis of <u>total</u> resource consumption, and nursing inpatient unit ts constitute only one portion of total costs, sions should not be drawn about the CMG scheme on the basis of significant mean differences between paired groups for total hours per stay. However, the finding of the fewest significant mean differences between paired groups for weighted hours per stay lends some support to the argument that heterogeneity of nursing resource consumption between CMGs is accommodated by the RIW.

<u>Costing Out Nursing</u>

The hours per day and stay used in this study were direct and indirect patient specific and unit related worked nursing hours. The staff mix at the study hospital is predominantly all RN (less than 5 percent nursing assistant hours on the inpatient units included in the study). To calculate nursing salary costs per patient or patient day requires additional information (see Appendix XIII, page 118). Table 16 provides the inpatient unit nursing labor costs for the ten selected CMGs using 1988-89 salary and benefit costs and rank

Table 16

Nursing Salary Cost Per Stay: Inpatient Units

CMG Number	Title	Inpatient Unit Salaries	RIW
595	Psychoses	$2318(9)	2.5570(6)
253	Cholecystectomy/ NOCDE, Age <70, NO CC	462(2)	1.0251(2)
280	Back/Neck Proc, Age <70 NO CC	511(3)	1.[illegible]
043	Lens Procedures	223(1)	.6973(1)
274	Major Joint Procedures	1502(6)	2.9435(10)
156	AMI With CVS Complications	1474(7)	2.6664(7)
014	Special Cerebrovasc. Dis, Not TIA	2641(10)	2.7427(8)
446	TURP, Age >70/CC	607(4)	1.3969(4)
113	Chr Obstr Pulm Disease	647(5)	1.3897(3)
193	Major Bowel Proc, Age >70/CC	$2256(8)	2.8070(9)

Note. Outliers excluded. Rank orders from lowest to highest in brackets ( ) with poor matches of rank orders underlined. Salary costs include nonproductive hours, fixed staffing and premiums; accrued benefits excluded. (See Appendix XIII, page 118).

orders them in comparison to RIWs. There is poor matching of five of the rank orders.

Table 17 provides total nursing salary costs including surgical suite salary costs for surgical cases and a fixed per diem for nursing administration costs of 0.27 hours per patient day. Also included are medical/surgical supply costs. (See Appendix XIV, page 119 for details of costs.) The matching of rank orders between costs and RIW has improved substantially with the inclusion of supply costs in the total.

Nursing salaries and medical/surgical supplies together constitute 43 percent of the study hospital's total operating budget. It is possible that with the allocation of laboratory and diagnostic imaging costs the relationship between the RIW and resource consumption might improve even more.

Summary

Descriptive statistics for hours per stay and hours per day are provided for each of the ten CMGs studied both with and without outliers included (using HMRI trim points and exclusions). Most of the CMGs are found to be heterogeneous for hours per stay. Nursing hours per day are found to be relatively homogeneous across the ten CMGs. Overall variability within CMGs is evident.

Table 17

Total Nursing Salary And Medical/Surgical Supply Costs

CMG Number	Title	Costs	RIW
595	Psychoses	$2594(6)	2.5570(6)
253	Cholecystectomy/ NOCDE, Age <70, NO CC	779(2)	1.0251(2)
280	Back/Neck Proc, Age <70 NO CC	1076(5)	1.7477(5)
049	Lens Procedures	654(1)	.6973(1)
274	Major Joint Procedures	5163(10)	2.9435(10)
156	AMI With CVS Complications	2970(7)	2.6664(7)
014	Special Cerebrovasc. Dis, Not TIA	3050(8)	2.7427(8)
446	TURP, Age >70/CC	970(4)	1.3969(4)
113	Chr Obstr Pulm Disease	835(3)	1.3897(3)
193	Major Bowel Proc, Age >70/CC	$3197(9)	2.8070(9)

Note. 1988-89 dollars.
Rank ordered in brackets ( ) from lowest to highest.
Outliers excluded.
See Appendix XIV, page 119 for details of cost allocation.

The exclusion of outliers from the data results in less variability within CMGs. Of the 582 randomly selected cases, 20 are identified as outliers. This small number of outliers (3.4 percent of total cases) is found to consume 7.4 percent of the days stay for the total study sample and 7.9 percent of the total hours for the study sample.

Pearson r correlation coefficients were used to examine the relationship between the independent variables ALOS and RIW per CMG and the dependent variable(s) nursing resource consumption. There is a strong significant correlation found between nursing hours per stay and ALOS for the ten CMGs studied (r = .943, p = <.001). The correlation coefficient for nursing hours per stay and RIW per CMG is also found to be high and significant (r = .871, p = .001). There was no significant difference found between the two correlation coefficients of 0.943 and 0.871 at a one-tail alpha of 0.05.

One-way Analysis of Variance (ANOVA) was used to examine the variability between groups. Significant differences were found across the ten CMGs studied for ALOS, Hours per Stay and Weighted hours per stay (p = <.001) at an alpha of 0.05. The Newman-Keuls procedure was used to do post hoc multiple group comparisons to find which groups differed from which. For Weighted hours per stay (total hours per stay divided by RIW) two groups were found to be different from the remaining groups for mean comparisons: 595, Psychoses; and 014, Special Cerebrovasc. Dis, Not TIA.

Nursing salary costs per CMG were calculated and compared with the RIW per CMG. There was a poor match of rank orders between nursing salary costs and RIWs. However, once nursing salary costs were combined with operating room salary costs for surgical cases and medical/surgical supply costs for all cases the rank orders matched.

CHAPTER VI: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction And Background

Resource intensity weighted Case Mix Groupings (CMGs) are viewed by provincial governments and hospital administrators as the means to identifying the total hospital product for the purposes of more equitable funding and cost control.

Nurses are concerned that CMGs, a medical patient classification scheme, may not adequately represent nursing resource requirements thereby negatively affecting the quality of patient care. A major concern for nurses [illegible] the use of a fixed per diem across all CMGs to [illegible] nursing. The purpose of this study was to examine the relationship between nursing resource consumption and resource intensity weighted CMGs.

Background information was provided on the development of DRGs, CMGs and resource intensity weights (RIWs). Nursing literature was reviewed with a focus on nursing research related to nursing resource consumption and DRGs. A total of 42 research studies were located in the literature. Of the 42 studies found only four were Canadian studies. The literature reviewed reflected a consensus amongst nurses that the actual cost of nursing care should be identified and that nursing patient classification schemes provided a readily available means of accounting for these costs. However, the importance of reliable and valid instruments that captured actual costs as well as prospective estimates of staffing needs was identified.

A finding of many of the studies reviewed was large variability of nursing resource consumption within and between DRGs. It was concluded by many of the researchers that DRGs did not adequately reflect nursing resource requirements. However, some studies were focused on average daily nursing resource consumption in conjunction with the DRG weights and a strong relationship between the two was found (Cromwell & Price, 1988; McKibbin, et al., 1985). The use of DRGs or CMGs, the Canadian equivalent to DRGs, to predict nursing resource consumption remains controversial in the literature. A conceptual framework for the study was presented that included a discussion of the many variables other than case mix that impact on nurse staffing levels.

The study was conducted at a 560 bed community teaching hospital using 1988-89 retrospective hospital data. A limited sample of ten CMGs, with high volumes treated at the study hospital, were included in the study. Sixty cases were randomly selected for each

CMG. Nursing patient classification workload data were used as a proxy for nursing resource consumption. Actual nurse staffing and the mix of patients on the unit on the day of stay were included in the calculation of nursing hours per day for each selected patient.

Data Analysis And Findings

Data analyses were performed using the SPSS-X Release 3.0 statistical software package. Descriptive, correlational and inferential statistics were used. Data were analyzed both with and without outliers included.

Limitations. The findings of this study must be considered within the context of the assumptions and limitations identified:

1. Interpretation of results is limited to the target population within the study hospital. A limited sample of ten CMGs were studied. The findings cannot be generalized beyond this small sample of ten CMGs, for the year 1988-89, to all 467 CMGs, to other years, or to other hospitals.

2. The accuracy of abstracted medical record data and nursing patient classification data cannot be assured. The reported inter-rater reliability of 0.95 for each of the chart abstracted data and the nursing patient

classification data could be lower than 0.95 because of the combined effect of the two.

3. Nursing patient classification data, converted to hours of care, are a proxy for the amount of care received. The hours of care received are not a measure of the quality of care provided.

4. Nursing resource consumption is impacted by other variables including patient characteristics (CMG and severity of illness), medical practice (LOS, diagnostic and therapeutic procedures), nursing practice (percentage of RN staffing, nursing resources available, care delivery method), hospital characteristics (size of units, range of programs and services, philosophy, mix of patients), and environmental characteristics (wage rates, availability of staff).

Findings. Average nursing hours per day and stay were calculated for each of the ten CMGs included in the study. The findings from the analysis of data for this study include:

1. Variability of nursing resource consumption within the ten CMGs was found with more heterogeneity of hours per stay than hours per day. Means, standard deviations, ranges and coefficients of variation were examined.

2. Outliers constituted 3.4 percent of the study sample but were found to consume 7.9 percent of the nursing resources. With the exclusion of outliers from the data, heterogeneity of hours per stay per CMG decreased. Heterogeneity of hours per day per CMG was less and remained fairly consistent both with and without outliers included.

3. Rank orders of average nursing hours per stay and ALOS, with outliers excluded, matched for six of the ten CMGs. Rank orders of average nursing hours per day and ALOS matched for only two of the ten CMGs.

4. Pearson r correlation coefficients were used to examine the relationship between nursing resource consumption, ALOS and RIWs. Strong significant correlations were found between nursing hours per stay and ALOS ($r = .943$, $p = <.001$), and between nursing hours per stay and RIWs ($r = .871$, $p = .001$) at a one-tail alpha of 0.05.

5. One-way ANOVA was used to examine the mean differences between the ten CMGs for ALOS and nursing hours per stay. Significant mean differences were found between groups for ALOS and hours per stay ($p = <.001$) at an alpha level of 0.05. The Newman-Keuls procedure for multiple groups comparisons was used to determine which groups differed from which.

6. Weighted nursing hours per stay (total hours per stay divided by the specific RIW for each CMG to control for LOS and service intensity per day) were used to examine the fixed per diem for nursing across the ten CMGs. For weighted hours per stay, only 16 paired differences were found and these differences related to two specific CMGs: CMG 595, Psychoses, and CMG 014, Special Cerebro. Vasc. Dis., Not TIA. For CMG 014, Special Cerebro. Vasc. Dis, Not TIA, large heterogeneity of nursing care hours within the CMG was found which is consistent with Trofino's (1989) findings. For CMG 595, Psychoses, the significant difference cannot be attributed to large heterogeneity (variability) within the CMG. However the ALOS for CMG 595 was found to be greater than the data base LOS for matched cases. Although it cannot be assumed that the longer LOS is related to poor management of resources, other variables such as severity of illness, or physician and nursing practices could be explored.

7. Inpatient unit nursing resource consumption was costed out by CMG and poor matches between rank orders of nursing resource consumption and RIWs were found. However, once the surgical suite labor costs and medical/surgical supply costs were included, the rank orders matched consistently for comparisons of resource

consumption and RIWs.

Conclusions And Recommendations

The purpose of this study was to examine the relationship between nursing resource consumption and resource intensity weighted CMGs. Although the strong correlations between nursing resource consumption, ALOS and RIWs across the limited sample of ten CMGs would suggest some support for the overall design of the CMG scheme, definitive conclusions should not be drawn. Findings regarding mean differences between groups for ALOS and nursing hours per stay were not consistent. Matching of rank orders of nursing inpatient labor resource consumption with ALOS and RIWs for the ten CMGs were also not consistent. However, once the medical-surgical supply costs and surgical suite costs per CMG were included the rank orders matched.

The examination of differences between groups for weighted hours per stay, the variable which addressed the nursing concern regarding the allocation of a fixed per diem for nursing across all CMGs, did offer some support for the design of the CMG scheme. However, again because of the relatively small sample size and the small number of CMGs included in the study this support should be viewed conservatively. Overall it is concluded that although the CMG scheme may address total hospital resource consumption it is not a good predictor of nursing resource requirements.

Recommendations. The recommendations that follow are based on the findings and conclusions drawn from this study. It is recommended that:

1. Reliable and valid nursing patient classification systems be established in hospitals that account for actual nursing resource consumption at the patient specific level as well as projected staffing needs.

2. Nursing resource consumption data be stored electronically by patient and easily integrated with HMRI and financial reports for the purposes of hospital management and cost control.

3. Nursing research such as this with clear definition of terms and what constitutes the hours included be replicated as there is limited information available regarding patterns of nursing resource consumption within and between CMGs. Appendix XV, page 120, provides a comparison of data from this study with data from selected U.S. studies.

4. Nursing research be conducted that identifies the impact of nursing practice variables, such as, staff mix, method of care delivery, and support services, on nursing resource consumption.

5. Nursing research be conducted that relates nursing

care to changes in patient outcomes within CMGs including changes in LOS.

6. Research relating to hospital characteristics, such as range and mix of services and their impact on resource consumption by case mix be continued.

7. Nursing research be continued that examines patient characteristics and response to illness from a nursing perspective.

8. Canadian nurses continue to pursue the development of a minimum data set for nursing including the development of national standards related to the documentation of nursing resource consumption.

The overall conclusion based on the review of the literature and the findings of this study is that the introduction of case mix into hospital funding is a positive step. It provides a common language for clinicians, administrators and financial analysts that is focused on patients. Case Mix Groupings could be used as an interdisciplinary management tool for focusing on selected groups of patients for the purpose of improving quality as well as cost effectiveness of care. Nursing departments could review care delivery methods and consider the use of nurses as case managers for selected CMGs as is currently being discussed in the literature. However, CMG weights should not be used as a mechanism for allocating nursing resources.

The use of case mix information by government agencies for the purposes of global funding at the aggregate level and for regional planning may have merit. However, in the absence of consistent Canadian cost data across hospitals over time it would seem premature to implement prospective fixed case reimbursement. Canadian hospitals may already have responded quite substantially to the notion of prospective payment by case mix. Reductions in LOS and number of operating beds have been occurring over the last few years in Alberta. There has also been an increasing shift to alternative methods of delivering services; for example, early discharge programs, medical and surgical day care, and expanded home care services. The incentive to do things in better ways may be well established. Management by case mix will provide another mechanism to support these efforts.

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APPENDIX I

CONVERSION OF TYPE TO ACTUAL HOURS

Unit ____________ Date ____________

ACTUAL STAFFING		Head Count
Evenings	Staff Nurse	______
	RNA	______
	Reserve	______
Nights	Staff Nurse	______
	RNA	______
	Reserve	______
Days	Staff Nurse	______
	RNA	______
	Reserve	______

(1) TOTAL STAFF (______ x 7.75 hours) = ____________
Total Available Hours

PATIENTS

Type	No. Pats.		Coeff. Wt.			Revised Weight	
II	(______	X	1	)	=	______	*
III	(______	X	2	)	=	______	
IV	(______	X	4	)	=	______	
	TOTAL WEIGHT					______	**
V	(______	X	24	)	=	______	hours for Type V's.

(2) TOTAL AVAILABLE HOURS (______ - ______) hours for Type V

= ____________ Remaining Hours.

(3) LEVEL II REVISED WEIGHT (______ * ÷ ______) ** Total Weight

= (______ X ______) Remaining Hours

= (______ ÷ ______) No. Level II Patients

= ______ Hours/Type II

X 2 = ______ Hours/Type III

X 2 = ______ Hours/Type IV

University of Alberta
Edmonton
Canada T6G 2G3

Faculty of Nursing
3-120 Clinical Sciences Building

Certification of Ethical Acceptability for Research Involving Human Subjects

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NAME OF APPLICANT: Sara Wright

TITLE OF PROJECT: A Study of the Relationship Between Nursing Resource Consumption and Resource Intensity Weighted Case Mix Groupings (CMGs)

The members of the review committee, having examined the application for the above-named project, consider the procedures, as outlined by the applicant, to be acceptable on ethical grounds for research involving human subjects.

May 7, 1990
Date

Terry Davis
T. Davis, RN, PhD
Chair
Ethics Review Committee
Faculty of Nursing

Appendix III

Average Hours/STAY, Standard Deviation, Range And Median

CMG Number	Title	Mean	S.D.	Range	Median
595	Psychoses	105.93	98.38	5.6-435	92.36
253	Cholecystectomy/ NOCDE, Age <70, NO CC	22.16	11.03	11.62-78.65	18.91
280	Back/Neck Proc, Age <70 NO CC	24.95	17.80	6.61-119.46	20.46
049	Lens Procedures	11.79	8.26	2.48-51.9	9.6
274	Major Joint Procedures	77.62	77.24	30.66-595.2	56.95
156	AMI With CVS Complications	69.31	50.23	9.34-301.07	55.17
014	Special Cerebrovasc. Dis, Not TIA	118.10	234.6	9.56-1788.5	62.42
446	TURP, Age >70/CC	33.68	42.49	12.58-299.52	20.55
113	Chr Obstr Pulm Disease	40.47	75.71	1.74-562.35	24.37
193	Major Bowel Proc, Age >70/CC	113.14	105.88	28.5-555.64	69.47

- Outliers included.

Appendix IV

Average Hours/DAY, Standard Deviation, Range And Median

CMG Number	Title	Mean	S.D.	Range	Median
595	Psychoses	4.72	2.02	3.04-13.82	3.97
253	Cholecystectomy/ NOCDE, Age <70, NO CC	4.05	0.82	2.61-6.75	3.93
280	Back/Neck Proc, Age <70 NO CC	3.76	0.98	2.30-6.32	3.59
049	Lens Procedures	3.53	0.98	1.86-8.23	3.31
274	Major Joint Procedures	3.96	1.29	2.49-8.88	3.71
156	AMI With CVS Complications	7.78	4.67	2.72-29.62	6.95
014	Special Cerebrovasc. Dis, Not TIA	6.49	7.49	2.01-49.60	4.6
446	TURP, Age >70/CC	3.90	1.05	2.52-9.36	3.62
113	Chr Obstr Pulm Disease	3.19	0.99	1.67-5.99	3.05
193	Major Bowel Proc, Age >70/CC	5.49	3.52	2.64-23.15	4.63

- Outliers included.

Appendix V

Within CMG Variability Hours/STAY

CMG Number	Title	N	Mean	S.D.	C.V.
595	Psychoses	59	98.33	12.80	0.13
253	Cholecystectomy/ NOCDE, Age <70, NO CC	59	21.20	8.24	0.39
280	Back/Neck Proc, Age <70 NO CC	59	23.35	12.87	0.55
049	Lens Procedures	55	10.10	3.82	0.38
274	Major Joint Procedures	58	68.69	35.92	0.52
156	AMI With CVS Complications	59	70.04	50.33	0.72
014	Special Cerebrovasc. Dis, Not TIA	56	124.69	241.57	1.94
446	TURP, Age >70/CC	55	27.79	21.58	0.78
113	Chr Obstr Pulm Disease	57	29.07	22.85	0.79
193	Major Bowel Proc, Age >70/CC	45	105.53	93.51	0.89

- Outliers excluded.

Appendix VI

Within CMG Variability Hours/DAY

CMG Number	Title	N	Mean	S.D.	C.V.
595	Psychoses	59	4.7	2.04	0.43
253	Cholecystectomy/ NOCDE, Age <70, NO CC	59	4.05	0.83	0.20
280	Back/Neck Proc, Age <70 NO CC	59	3.76	0.99	0.26
049	Lens Procedures	55	3.54	0.98	0.28
274	Major Joint Procedures	58	3.92	1.27	0.32
156	AMI With CVS Complications	59	7.47	4.03	0.54
014	Special Cerebrovasc. Dis, Not TIA	56	5.11	3.76	0.73
446	TURP, Age >70/CC	55	3.8	0.76	0.20
113	Chr Obstr Pulm Disease	57	3.18	0.97	0.30
193	Major Bowel Proc, Age >70/CC	45	5.52	3.55	0.64

- Outliers excluded.

Appendix VII

Within CMG Variability LOS

CMG Number	Title	N	Mean	S.D.	C.V.
595	Psychoses	60	22.32	17.31	.77
253	Cholecystectomy/ NOCDE, Age <70, NO CC	60	5.47	2.29	.42
280	Back/Neck Proc, Age <70 NO CC	60	6.67	4.65	.70
049	Lens Procedures	60	3.33	2.01	.60
274	Major Joint Procedures	59	19.02	12.43	.65
156	AMI With CVS Complications	60	9.7	5.56	.57
014	Special Cerebrovasc. Dis, Not TIA	60	18.77	15.18	.81
446	TURP, Age >70/CC	57	7.77	5.44	.70
113	Chr Obstr Pulm Disease	60	11.42	16.41	.69
193	Major Bowel Proc, Age >70/CC	46	21.72	18.84	.87

- Includes Outliers.

Appendix VIII

Within CMG Variability LOS

CMG Number	Title	N	Mean	S.D.	C.V.
595	Psychoses	59	22.68	17.23	.76
253	Cholecystectomy/ NOCDE, Age <70, NO CC	59	5.25	1.61	.31
280	Back/Neck Proc, Age <70 NO CC	59	6.22	3.13	.50
049	Lens Procedures	55	2.87	.75	.26
274	Major Joint Procedures	58	17.69	7.17	.40
156	AMI With CVS Complications	59	9.88	5.49	.55
014	Special Cerebrovasc. Dis, Not TIA	56	20.03	14.92	.74
446	TURP, Age >70/CC	55	7.0	3.6	.51
113	Chr Obstr Pulm Disease	57	9.03	7.21	.80
193	Major Bowel Proc, Age >70/CC	45	19.64	12.68	.64

- Excludes Outliers.

Appendix IX

ALOS For Matched Cases

CMG Number	Title	No. Of Separations	Matched Cases	HMRI Database
595	Psychoses	315	23.9	20.6
253	Cholecystectomy/ NOCDE, Age <70, NO CC	262	5.3	7.0
280	Back/Neck Proc, Age <70 NO CC	277	6.0	9.3
049	Lens Procedures	192	2.8	2.7
274	Major Joint Procedures	199	16.2	18.2
156	AMI With CVS Complications	174	10.1	14.2
014	Special Cerebrovasc. Dis, Not TIA	114	18.2	19.9
446	TURP, Age >70/CC	127	7.3	9.2
113	Chr Obstr Pulm Disease	122	10.5	9.5
193	Major Bowel Proc, Age >70/CC	81	17.4	19.8
	Total Institution	19,975	6.0	6.6

- Excludes Outliers

Appendix X

One-Way ANOVA - ALOS Across CMGs

Source	df	SS	MS	F Ratio	F Prob
Between Gps	9	26223.35	2913.71	35.2719	.0000
Within Gps	552	45599.06	82.61		
Total	561	71822.41			

Group	Mean	S.D.
49	2.87	.75
253	5.25	1.6
280	6.22	3.13
446	7.00	3.61
113	9.03	7.21
156	9.88	5.49
274	17.69	7.17
193	19.64	12.68
14	20.03	14.92
595	22.68	17.23

Appendix XI

One-Way ANOVA - Total Hours Per STAY Across CMGs

Source	df	SS	MS	F Ratio	F Prob
Between Gps	9	886100.39	98455.60	12.2281	.0000
Within Gps	552	4444491.39	8051.61		
Total	561	5330591.78			

Group	Mean	S.D.
49	10.10	3.82
253	21.20	8.24
280	23.35	12.87
446	27.79	21.58
113	29.07	22.85
274	68.69	35.92
156	70.04	50.33
193	105.53	93.51
595	107.63	98.33
14	124.69	241.60

Appendix XII

One-Way ANOVA - Weighted Hours Per Stay Across CMGs

Source	df	SS	MS	FRatio	FProb
Between Gps	9	64851.13	7205.68	6.3439	.0000
Within Gps	552	626981.99	1135.84		
Total	561	691833.12			

Group	Mean	S.D.
280	13.36	7.36
49	14.48	5.48
446	19.89	15.45
253	20.68	8.03
113	20.92	16.44
274	23.34	12.20
156	26.27	18.88
193	37.50	33.31
595	42.09	38.46
14	45.46	88.08

Appendix XIII

Costing Out Nursing: Inpatient Unit Salary Cost

1. Multiply total hours per case by an actual percentage to add nonproductive hours (vacation, statutory holidays, sick time, and paid leave: 1.13 percent for study hospital).
2. Add a constant to cover fixed staffing at unit level (unit managers, service aides, unit clerks: a constant of 0.4 hours per patient day at study hospital).
3. Multiply hours by average salary rate for RN staff (approximately $16.50 per hour at study hospital).
4. Add percentage for premiums (approximately 7.5 percent at study hospital).

Note. 1988-89 Dollars.
The percentage of nonproductive hours for full time staff was 15.7 percent in 1988-89. The rate of 13 percent used above is lower because it includes casual and part time staff hours.

Appendix XIV

Total Nursing Salary And Medical Surgical Supply Costs

CMG Number	Title	Total Nsg Salaries	Med/Surg Supplies	Total
595	Psychoses	$2453	$141	$2594(6)
253	Cholecystectomy/ NOCDE, Age <70, NO CC	568	211	779(2)
280	Back/Neck Proc, Age <70 NO CC	846	230	1076(5)
049	Lens Procedures	315	339	654(1)
274	Major Joint Procedures	1905	3258	5163(10)
156	AMI With CVS Complications	1533	1437	2970(7)
014	Special Cerebrovasc. Dis, Not TIA	2760	297	3050(8)
446	TURP, Age >70/CC	724	246	970(4)
113	Chr Obstr Pulm Disease	701	134	835(3)
193	Major Bowel Proc, Age >70/CC	$2701	$496	$3197(9)

Note. 1988-89 dollars.
Outliers excluded.
Total nursing salaries include unit inpatient salary costs, 0.27 hours per day fixed for nursing administration ($5.94) and OR salary costs for surgical cases.
Med/surg supply costs include: $14.84 per medical inpatient day, $178.40 per ICU day, $19.84 per surgical patient day, $6.23 per psychiatry patient day, $107.00 per OR case (excluding prosthetics), $150.00 for lens prosthesis, $2,800 for joint prosthesis.

Appendix XV

Comparison Of Nursing Hours Per Stay Across Studies

CMG Number	Title	Study 1990	Sovie 1984	McKibbin 1985	Fetter 1987** A	B	C	D	E
595	Psychoses	108	118	—	65	88	45	80	58
253	Cholecystectomy/ NOCDE, Age <70, NO CC	21	32	—	34	29	34	21	32
280	Back/Neck Proc, Age <70 NO CC	23	55	—	56	36	52	36	46
049	Lens Procedures	10	15	12	9	9	10	9	11
274	Major Joint Procedures	69	94	—	79	61	111	61	106
156	AMI With CVS Complications	70	70	—	75	81	119	72	91
014	Special Cerebrovasc. Dis, Not TIA	124	113	116	80	93	124	75	79
446	TURP, Age >70/CC	28	43*	—	29	30	29	59	22
113	Chr Obstr Pulm Disease	29	48	41	45	38	61	34	68
193	Major Bowel Proc, Age >70/CC	105	110	138	106	130	148	72	100
Staff Mix (% RN)		95%	92%		80%			92%	

Note. * N = <60
Study, 1988-89 data (Actual) 560 bed
Sovie, 1982-83 data (Predicted) 741 bed teaching
McKibbin, 1984 data (Actual)
** All Discharges
A, 1979-83 data (Actual) 430 bed (nonprofit tertiary community)
B, 1983-85 data (Actual) 473 bed (nonprofit teaching)
C, 1983-84 data (Predicted) (5 hospitals, pooled data)
D, 1982-83 data (Actual) 700 bed (nonprofit teaching, tertiary)
E, 1984-85 data (Predicted) 600 bed (nonprofit teaching, tertiary)