HOW DOES PATIENTS' ACUITY AFFECT A HOSPITAL'S EXPENSES?

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Abstract

This study disproves the popular belief that a hospital's Case Mix Index, commonly used as a proxy for inpatient acuity, is the main driver of hospital expense. Case Mix Index should not be granted the singular importance it has historically enjoyed as a scapegoat for high hospital costs. And, since there is a weak statistical correlation between Case Mix Index and inpatient expenses, CMI should never be used as an adjustment factor in comparative expense analysis.

Introduction

Everyone believes that more resources (expenses and length of stay) are required to treat very sick hospital patients than less-sick patients. This concept is logical and straightforward; we can all readily understand why a hospital's cost to perform a heart transplant is vastly greater than the cost to perform a child's tonsillectomy. However, a great error arises when we take our logic to the next level and assume that a hospital full of sicker patients translates into higher expenses per patient—that inpatient acuity dictates hospitals' costs. In truth, only a weak statistical correlation exists between hospitals' overall acuity and their inpatient expense per discharge.

Since 1993, the author has been studying the relationship between hospitals' overall Case Mix Index (CMI), commonly used as a proxy for inpatient acuity, and inpatient expense per discharge. We include only California hospitals in this study each year because we require a dataset of all-payer financial and discharge data that can be grouped and analyzed at very detailed levels. A majority of the state's hospitals (298 out of 526) met our highly conservative criteria for inclusion in the study. Excluded hospitals failed to maintain a consistent CMI over several years of trending.

Before detailing the outcomes of this study, we need to define the two variables being examined. Each hospital's overall acuity level is determined by the hospital's Case Mix Index (CMI). This index is a weighting system devised by the Centers for Medicare and Medicaid Services (formerly HCFA) to associate a relative weight—or "score"—to each hospital-patient discharge, based on the complexity of the patient's diagnosis related group (DRG). Each DRG has a weight established for it based primarily on Medicare billing and cost data; each weight reflects the relative cost, across all hospitals, of treating cases classified in that DRG. Even though the DRG system is intended to determine reimbursement for treating only Medicare patients, DRGs are routinely assigned to every hospital inpatient A child who has a tonsillectomy will have a relatively low weight of 0.21, while a heart-transplant patient has the highest weight on the scale at 19.01 (*2000 figures*). Hospitals' overall CMI is calculated from their cumulative volume of inpatient discharges and corresponding weighted discharges for each diagnosis group. So the "sicker" a hospital's collective group of patients, the higher a hospital's overall CMI. For this study, we have calculated each hospital's CMI for *all* patients, instead of following the common practice of using only Medicare patients. It is important to note that CMI applies only to hospitals' inpatients who are formally discharged from a nursing unit; CMI does not reflect in any manner the acuity of the many patients who use only outpatient services at hospitals.

Many will argue right from the beginning that CMI is not a patient-acuity index. The author wholeheartedly agrees with this argument. CMI is *not* a patient-acuity index! HCFA never intended CMI to be an acuity index; instead, HCFA implemented the DRG weights with the prospective payment system in 1983 solely for reimbursement purposes. Nevertheless, CMI is widely used throughout the healthcare world as a proxy for patient acuity—especially as an adjustment in comparative analysis to normalize data between hospitals. Due to our professional interests in hospital benchmarking, we initially undertook this study solely to determine the validity of using CMI as an adjustment factor in comparative analysis.

The second examined variable, hospital inpatient expense per discharge, requires explanation of both

the numerator (expense) and denominator (discharge). Hospital expenses include the following categories of direct expense: salaries and wages, employee benefits, nonphysician professional fees, purchased services, supplies, depreciation and amortization, leases and rentals, physician expenses supported by the hospital for activities that do not involve direct patient care (i.e., research, medical education, supervision, and administration), and other direct expenses. To normalize the cost of labor in various California metropolitan areas, we adjusted all salaries and wages, nonphysician professional fees, and purchased service expenses to a common standard using the hospital wage index values from *The Federal Register*. Inpatient expenses were separated from outpatient expenses using patient revenue percentages for each department. We included only the inpatient portion of hospitals' total expenses for two very important reasons. First, the CMI variable reflects only inpatient acuity, so it is *never* appropriate to compare CMI to outpatient data. Second, the denominator, patient discharges, is a statistic that reflects only inpatient activity, so we can appropriately compare only inpatient expenses to inpatient discharges. The denominator is simply a count of all patients discharged from the hospital. Newborn discharges are included in this total because their data are included in the hospitals' overall CMI.

Study Outcomes

Total Expense Analysis

Now we can examine the outcomes of the study. Using simple linear regression analysis, hospitals' inpatient expenses per discharge were compared to hospitals' CMI to determine whether hospitals with higher expenses could attribute the high costs to CMI. **Table 1** shows the results.

Table 1: Total Expense Analysis

Year	*Independent Variable*	*Dependent Variable*	*R-Square (R^2)*
1993	CMI	Total Inpatient Expense per Discharge	.53
1994	CMI	Total Inpatient Expense per Discharge	.57
1995	CMI	Total Inpatient Expense per Discharge	.50
1996	CMI	Total Inpatient Expense per Discharge	.39
1997	CMI	Total Inpatient Expense per Discharge	.43
1998	CMI	Total Inpatient Expense per Discharge	.53
1999	CMI	Total Inpatient Expense per Discharge	.47

In regression analysis, a perfect correlation between two variables is expressed by an R^2 value of 1. Thus, the closer the R^2 value is to 1, the greater the correlation between the independent and dependent variables. **Table 1** shows that, in 1993, only 53 percent of the variability in inpatient expense per discharge could be explained by inpatient acuity (CMI) for the 298 hospitals examined. In 1996, the correlation had declined so that only 39 percent of the variability in inpatient expense per discharge could be explained by acuity. In 1999 the figure rests at 47 percent. These midrange values present a dilemma: since they are not strongly high *or* weakly low, some will conclude at first glance that they are high enough to establish a significant correlation—while others will conclude they are not high enough. Solving this dilemma requires that we delve deeper by conducting additional detailed analyses. Through these analyses, the author will disprove the popular belief that a hospital's Case Mix Index, commonly used as a proxy for inpatient acuity, is the main driver of hospital expense.

At first glance, one would logically expect the R^2 values in **Table 1** to be higher. Why are these results not higher? The most obvious reason why patient acuity does not dictate hospital expenses is found in the cost structure found in most hospitals. Inpatients incur expense from both patient-care and support

departments throughout the hospital. Patient-care areas include nursing units, ambulatory areas (e.g., clinics and emergency services), and ancillary departments (e.g., lab and radiology); support areas include education programs, general services (e.g., laundry, dietary, plant maintenance), fiscal services, and administrative services. Additionally, hospitals generally carry high expenses related to capital, such as interest on debt and depreciation on buildings and fixed equipment.

For the 298 California hospitals in this study, total inpatient departmental expenses fell into the groups shown in **Table 2**. The specific departments that roll up into these groups are defined in **Appendices A** and **B**.

Table 2: Hospital Inpatient Expenses by Department Area

	1993	*1996*	*1999*
Area	*Percent of Total*	*Percent of Total*	*Percent of Total*
Nursing Units	24.1 %	23.9 %	24.4 %
Ambulatory Care	1.4	1.8	2.1
Ancillary Care	31.7	32.2	31.5
Support Areas	33.7	34.0	34.7
Unassigned	9.0	8.1	7.3
	100.0 %	100.0 %	100.0 %

The percentages in **Table 2** tell us why a significant amount of hospitals' inpatient expenses have a small correlation to patient acuity. In 1999, support areas contributed 34.7 percent of inpatients' expenses, and unassigned expenses contributed another 7.3 percent. So 42 percent of inpatients' expenses is made up of costs from departments like dietary, laundry, patient accounting, medical records, interest on debt, etc. Support departments are critical to the operational viability of a hospital, yet the manner in which hospitals choose to run their support services probably has little to do with the severity of each inpatient's illness. Also, new and old hospitals may have the same inpatient CMI, but the new hospitals will have much higher expenses from depreciation and interest on debt than old hospitals with lower depreciation and debt interest.

Patient Care Expense Analysis

Considering the high percentage of total inpatient expenses that are incurred by support departments, we hypothesized that a stronger statistical correlation would exist if we excluded support-department expenses and examined the inpatient expenses from *only* patient-care departments (see **Appendix A** for the specific departments included in this group). **Table 3** shows the results of this analysis.

Table 3: Patient Care Expense Analysis

Year	*Independent Variable*	*Dependent Variable*	*R-Square (R^2)*
1993	CMI	Patient Care Depts. Inpatient Expense per Discharge	.66
1994	CMI	Patient Care Depts. Inpatient Expense per Discharge	.63
1995	CMI	Patient Care Depts. Inpatient Expense per Discharge	.56
1996	CMI	Patient Care Depts. Inpatient Expense per Discharge	.29
1997	CMI	Patient Care Depts. Inpatient Expense per Discharge	.52
1998	CMI	Patient Care Depts. Inpatient Expense per Discharge	.62
1999	CMI	Patient Care Depts. Inpatient Expense per Discharge	.58

As we would expect, the correlation between CMI and inpatient expenses per discharge for only patient-care departments was higher from 1993 through 1995 than the R^2 values for all hospital departments in **Table 1** for the same years—yet only slightly higher. In 1996 only 29 percent of the variability in patient-care department inpatient expense per discharge could be explained by acuity. At present, we have not been able to determine a reason for this dramatic decline. The R^2 values in recent years have returned to a level similar to the values from the early years of this study.

Nursing Unit Expense Analysis

Since we did not see a high statistical correlation looking at inpatient expenses from all patient-care departments, we hypothesized that a strong correlation must surely exist by eliminating the ambulatory and ancillary areas and looking only at the nursing units. We know that nearly all expenses in nursing units relate to only inpatients—just as the discharges in our denominator and CMI relate only to inpatients in nursing units—so this analysis would be "cleaner" because it would not require the removal of outpatient expenses from the department groups examined. **Table 4** shows the surprising results of this analysis: nursing unit total expenses per inpatient discharge show a low—and declining—correlation with CMI so that by 1996 the correlation is essentially nonexistent. Even recent figures are far lower than the highest value from 1993.

Table 4: Nursing Unit Expense Analysis

Year	*Independent Variable*	*Dependent Variable*	*R-Square (R^2)*
1993	CMI	Nursing Units Expense per Discharge	.35
1994	CMI	Nursing Units Expense per Discharge	.24
1995	CMI	Nursing Units Expense per Discharge	.15
1996	CMI	Nursing Units Expense per Discharge	.01
1997	CMI	Nursing Units Expense per Discharge	.13
1998	CMI	Nursing Units Expense per Discharge	.22
1999	CMI	Nursing Units Expense per Discharge	.16

Nursing Unit Labor Expense Analysis

We were concerned by the dismal correlation results in **Table 4**, so we performed a further refinement to the nursing-unit expense analysis above. We examined only the labor expenses within the nursing units: salaries & wages, nonphysician professional fees, and purchased services. Remember that all labor expenses were wage-adjusted in every analysis to normalize the cost of labor in various California metropolitan areas. Logically, a near-perfect relationship should exist between a hospital's nursing labor expenses and the collective CMI of the patients under the nurses' care. We hypothesized that this analysis would be the most revealing in looking for statistical correlation between extremely "clean" variables, and therefore the most critical. **Table 5** shows the bizarre results.

Table 5: Nursing Unit Labor Expense Analysis

Year	*Independent Variable*	*Dependent Variable*	*R-Square (R^2)*
1993	CMI	Nursing Units Labor Expense per Discharge	.32
1994	CMI	Nursing Units Labor Expense per Discharge	.21

1995	CMI	Nursing Units Labor Expense per Discharge	.18
1996	CMI	Nursing Units Labor Expense per Discharge	.01
1997	CMI	Nursing Units Labor Expense per Discharge	.10
1998	CMI	Nursing Units Labor Expense per Discharge	.18
1999	CMI	Nursing Units Labor Expense per Discharge	.14

The values in **Table 5** show that very little correlation exists between nursing labor costs and CMI. Quite a surprise! Since a high correlation does not exist at such an important detailed level (where a high correlation would be most logical), the author is not willing to accept any significance in the higher R^2 values from the higher-level analyses. We'll take our results from this telling analysis one step further and hypothesize that higher values found in **Table 1** and **Table 2** are merely coincidental.

The results in **Table 5** prompted the author to examine the nursing staffing patterns from institution to institution. Looking only at the medical/surgical acute department of the 298 hospitals in this study, staffing varied tremendously: from 6.5 to 11 productive hours per patient day (excluding outliers). The skill mix of those hours also fluctuated greatly: RNs comprised anywhere from 38 to 68 percent of the staff in the same medical/surgical department (excluding outliers). (The staffing figures are from 1996, a randomly selected sample year.) One hospital may staff a unit with fewer FTEs while leveraging more lower-skilled and -compensated labor, while another hospital may staff the same type of unit with more FTEs who are highly skilled and compensated. At each hospital, the CMI of the patients in this unit may be quite similar, while the nursing unit labor expense per patient is very different.

Please note that it is not our intention to single out nurses or place any blame on nursing units in this study. The medical/surgical unit statistics are used anecdotally to point out that a variety of complex variables—staffing patterns, care models, tenure, unionization, etc.—in *any* hospital department may contribute more to the department's cost structure than patient acuity does.

Other Considerations

A major contributor to expenses that transcends specific departments is the concept of economies of scale. Departments such as Emergency Services or Surgery & Recovery must maintain certain staffing patterns to handle emergencies, regardless of patient volume. Some hospitals do not have enough volume to justify their staffing, yet the staffing must remain to comply with safety and legal protocols. Hospitals that maintain minimum fixed staffing but lack patient volume add expense to departments without adding patients. Once again, the higher costs do not correlate with CMI.

The author examined other variables—such as hospital occupancy rate, length of stay, number of staffed beds, and gross square footage—in search of something that would show a strong correlation to inpatient expense per discharge. **Table 6** shows the correlation results. At present time, we have not found a single variable that shows a high R^2 value when compared to expenses. Interestingly, the comparison of total (inpatient and outpatient) expenses to gross square footage offers the highest R^2 value of any analysis in this study. We would logically expect a strong correlation between total hospital expenses and the physical size of the hospital; indeed, we would expect a much stronger correlation than .68! This R^2 value would probably be much higher if hospitals had greater consistency in their occupancy rates. In the search for higher R^2 values, perhaps examining a combination of independent variables in conjunction with the CMI variable will produce a higher statistical correlation.

Table 6: Correlation of Other Variables

Year	*Independent Variable*	*Dependent Variable*	*R-Square (R^2)*
1999	Occupancy	Total Inpatient Expense per Discharge	.00
1999	Length of Stay	Total Inpatient Expense per Discharge	.09
1999	Staffed Beds	Total Inpatient Expense per Discharge	.17
1999	Gross Sq. Footage	Total Inpatient + Outpatient Expense	.68

Two other points to consider. First, the calculation of a hospital's overall Case Mix Index is dependent on the Centers for Medicare and Medicaid Services' published DRG weights. Perhaps the DRG weights simply do not accurately reflect the resources (expenses and length of stay) required to care for the patients classed into the DRGs, especially when extrapolating Medicare data results to all patients. Also, we know that the Medicare weights are derived from patient charges and length of stay data averaged across all hospitals, even though care practices (that highly affect hospital expenses) vary greatly from region to region.

The second point to consider is yet another problem with using CMI as an adjustment in comparative analysis. In this study, we have calculated each hospital's CMI for *all* inpatients so we could accurately compare this all-payer CMI to various hospital expenses for all inpatients. Traditionally, however, the CMI that is used in analysis is Medicare CMI, which is derived primarily from Medicare patient data and is annually published in *The Federal Register*. The common practice of applying Medicare CMI to all-payer data (expenses, hours, length of stay, etc.) seems like an even worse idea than applying all-payer CMI.

What does all this mean? First, hospitals need to be careful when they want to attribute high inpatient expenses per discharge solely to patients' acuity. The author has no reason to doubt that acuity is one piece of the expense puzzle, but this study shows that Case Mix Index does not adequately explain variation in inpatient expense per discharge—especially at important, detailed nursing-expense levels where strong statistical correlations would be most logical. So CMI should not be granted the singular importance it has historically enjoyed. Second, since there is a weak statistical correlation between Case Mix Index and inpatient expenses, CMI should *never* be used as an adjustment factor in comparative expense analysis (or any comparative analysis). Again, CMI is not an acuity index! Third, the examination of several diverse single variables did not produce any that showed a high R^2 value when compared to expenses. There are likely many variables that should be considered in combination. Fourth, and most important, the author believes little correlation exists between CMI and inpatient expenses simply because some hospitals manage their expenses well, while others do not. This belief is subjective, yet it stems from the author's personal observation during hospitalwide benchmarking studies performed at 80 facilities nationwide. Those who manage their costs well achieve a competitive expense per discharge ratio—regardless of their CMI. All hospitals can improve their day-to-day operations in some way, and many hospitals can improve dramatically in many ways.

Biographical Sketch

Garrick Hyde has worked as a management consultant to the healthcare industry for the past 17 years. He founded Garrick Hyde Consulting in 1995, specializing in benchmarking services for hospitals. Through hospital departmental benchmarking, Garrick has identified cumulative cost savings of $2.18 billion for all client hospitals.

Prior to founding GHC, Garrick worked in the Performance Improvement consulting practices at both Ernst & Young and APM (now CSC Healthcare). He also led the Data Analytics practice at Performance Logic and designed educational software for IBM.
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Appendix A: Patient Care Departments

Departments Included in **Nursing Units** Group

Medical/Surgical ICU
Coronary Care ICU
Pediatric ICU
Neonatal ICU
Psychiatric ICU
Burn Care
Other ICU
Definitive Observation (stepdown/telemetry)
Medical/Surgical Acute
Pediatric Acute
Psychiatric Acute: Adult
Psychiatric Acute: Ped
OB Acute
Alternate Birthing Center
Chemical Dependency Srvs
Physical Rehabilitation
Hospice Inpatient Care
Other Acute Care
Nursery Acute
Subacute Care
Subacute Care: Pediatrics
Skilled Nursing
Psychiatric Long-term
Intermediate Care
Residential
Other Long-term Care
Other Daily Services

Departments Included in **Ambulatory Care** Group

Emergency Room
Medical Transport
Psychiatric ER
Clinics
Satellite Clinics
Satellite Ambulatory Surgery
Outpatient Chem Dep Srvs
Observation Care
Partial Hospitalization: Psych
Home Health Services
Hospice – Outpatient
Adult Day Health Care
Other Ambulatory Srvs

Departments Included in **Ancillary Care** Group

Labor and Delivery
Surgery and Recovery
Anesthesiology
Durable Medical Equipment
Clinical & Path Lab
Blood Bank
Echocardiology
Cardiac Cath Srvs
Cardiology Srvs
Electromyography
EEG
Med Supplies Sold to Patients
Radiology: Diagnostic
Radiology: Therapeutic
Nuclear Medicine
MRI
Ultrasonography
CT Scanner
Respiratory Therapy
Pulmonary Function Srvs
Renal Dialysis
Lithotripsy
Gastro-Intestinal Srvs
Drugs Sold to Patients
Physical Therapy
Speech-Lang Pathology
Occupational Therapy
Other Physical Medicine
Electroconvulsive Therapy
Psychiatric Testing
Psych Individ/Grp Therapy
Organ Acquisition
Other Ancillary Srvs

Appendix B: Nonpatient Care Departments

Departments Included in **Support Areas** Group

Research & Education Programs
Research Projects & Admin
Education Admin Office
School of Nursing
LVN Program
Med Postgraduate Education
Paramedical Education
Student Housing
Other Hlth Professional Educ

Fiscal Services
General Accounting
Patient Accounting
Credit & Collection
Admitting & Outpatient Regist.
Other Fiscal Svcs

General Services
Printing/Duplicating
Dietary & Food Srvs
Laundry & Linen
Social Work Srvs
Central Services & Supply
Pharmacy
Purchasing & Stores
Security
Parking
Housekeeping
Plant Ops/Maint. & Grounds
Communications
Data Processing
Other General Services

Administrative Services
Hospital Administration
Governing Board Expense
Public Relations
Mgmt Engineering
Personnel
Employee Health Srvs
Auxiliary Groups
Chaplaincy Services
Medical Library
Medical Records
Medical Staff Admin
Nursing Admin
Inservice Educ: Nursing
Utilization Management
Community Health Educ
Other Admin Services

Departments Included in **Unassigned** Group

Depreciation and Amortization
(on bldgs. and fixed equip.)
Bldg. Leases and Rentals
Insurance
Licenses and Taxes
Interest
Nonpayroll Employee Benefits
Other Unassigned Costs