# The Identifier Concept:

## Clinical Variables to Manage Costs for Surgical Patients

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### Executive Summary

Previous studies at Long Island Jewish Medical Center had shown that certain clinical variables (identifiers) would differentiate hospital charges within surgical diagnosis-related groups (DRGs). This current project demonstrated that the clinical variables of mode of admission (emergency versus nonemergency), blood transfusion, and surgical intensive care unit admission could stratify both differences in severity of illness and charges for patients in general surgical DRGs. These findings suggest that these three identifiers may be useful to physicians and hospital administrators in evaluating surgical patients for differences in resource consumption *during* their hospitalization, for better management of hospital-based inpatient costs.

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Due to the spiralling medical care costs of the past two decades, it is important to investigate the allocation of health care resources. Health care costs in 1983 amounted to $355 billion or 10.8 percent of the U.S. gross national product (GNP) [1]. This translates to $1,459 for every person in the United States. Medicare and Medicaid paid $91 billion, or 29 percent of all expenditures for personal health care in 1983, as public programs supported 40 percent of all personal health care spending [2]. Although growth in the health care market has begun to slow, medical care continues to expand its portion of the GNP. Federal projections estimate that health care expenditures will reach $700 billion dollars a year and between 12 and 14 percent of the GNP by 1990 [3]. However, it appears that reimbursement will be limited. The challenges are to analyze the components of care and to improve efficiency, thus maximizing survival or outcome with a limited supply of dollars and resources.

The diagnosis-related group (DRG) reimbursement system is a product classification system that provides a framework to examine the hospital component of health care services. The 468 DRGs group together patients with similar resource consumption, disease processes, or operative procedures [4,5]. Some DRGs appear more homogeneous than others. For example, DRG 167 (appendectomy between 18 and 70 years without complications) consists of the *same* operation and similar patients and seems rather homogeneous, while DRG 149 (major anal and large bowel procedures under age 70) appears more heterogeneous with *similar* operations and similar patients. However, the current DRG reimbursement schedule does not allow for any flexibility within each DRG.

The reimbursement system has been criticized for not accurately reflecting differences in severity of illness and thus resource consumption within each DRG [6]. A growing body of evidence suggests that the DRG classifications may need to be refined or adjusted to reflect resource utilization more accurately [7]. Although there may be a wide range of procedures performed within a DRG, the hospital is reimbursed a set "rate" for each classification. A number of projects have been approved by the Health Care Financing Administration (HCFA) to study ways to refine the DRG payment system to reflect severity of illness more adequately and thus promote more equitable payment to hospitals. These projects have varying degrees of complexity and administrative cost. In addition, most of them assess individual variance in patient resource consumption by using variables obtainable at the time of discharge. An ideal system would be relatively simple while allowing a reasonable description of severity.

Previous studies at the Long Island Jewish Medical Center had shown that patients within a DRG could be stratified by clinical variables (that is, identifiers) to predict differences in charges within a DRG for a wide range of surgical DRGs [8,9]. In theory an identifier can be any patient condition or event occurring during the patient stay. The key to hospital-based clinical cost management is to predict differences in resource utilization *before* or *during* resource use, not after resources have been used, and thus allow hospital administrators and physicians opportunities to manage costs as they are incurred. The purpose of this project was to test the hypothesis that clinical variables could act as cost-severity stratifiers for surgical DRGs.

## Methods

The Long Island Jewish Medical Center is an 805-bed not-for-profit teaching hospital in suburban New York. Hospital charges exclusive of physician fees were examined as a proxy for costs for all patients ($N = 317$) in the following surgical DRGs: 110 (major vascular procedures, age over 70 years), 149 (major anal and large bowel procedures, age under 70 years), 154 (esophageal, gastric, and duodenal procedures), 197 (cholecystectomy, with complications), and 198 (cholecystectomy, without complications). Charges were examined for all hospital service categories and calculated as mean dollars plus or minus the standard error of the mean (SEM).

Hospital charges per patient for each DRG were disaggregated via each identifier. Thus, for DRG 110, patients were disaggregated by the ER identifier, (+ER) represented the presence of emergency room admission and (−ER) was the absence of emergency room admission, and the mean charge per patient was compared. Service categories were aggregated to include room and board; laboratory (urinalysis, hematology, coagulation, biochemistry, and microbiology); blood processing (type and hold, type and cross, blood products and red cells); diagnostic radiology; central supply and pharmacy; operating room and recovery room; and other (EKG, surgical pathology, respiratory therapy, and so on). Similarly, each DRG was then aggregated by the T identifier to include +T (patients who received transfusion, that is, red cells) and −T (patients who did not receive transfusion) and for the SICU identifier, +SICU (patients admitted to the surgical intensive care unit) and −SICU (patients not admitted to the surgical intensive care unit).

Severity of illness was assessed using a form of the staging methodology, that is, the number from *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) codes per patient [10]. These included disease codes for comorbidities (that is, diabetes mellitus, hypertension, and so on) and complications (that is, wound infection, subphrenic abscess, pulmonary embolus, and so on) and procedure codes (such as primary operations for complications or other procedures like insertion of a catheter or tracheostomy). This type of methodology rates the severity of illness by the number of diseases and procedures for each patient at the time of discharge. Although this is a crude severity methodology, this type of assessment provides some information on the degree of severity. Mean severity of illness per patient was computed for patients with both positive and negative identifiers. Mean charge per patient and mean severity of illness per patient were quantified as the number of identifiers accumulated to include (1) no identifiers present, (2) one identifier present, and (3) two or more identifiers present.

## Statistical Analysis

The purpose of the statistical analysis was threefold.

- To assess the ability of each clinical variable to describe both hospital charge and severity of illness differences within each DRG for patients with or without the clinical variable
- To assess the ability of the accumulated clinical variables to describe patient differences in charges and severity within each DRG
- To compare the ability of a system based on clinical variables such as identifiers to a system based on the staging method in describing per patient cost variance within each DRG

Statistical analyses were performed in the following fashion. Identifiers (± ER, ± T, ± SICU) were compared for statistically significant differences in both mean charges and mean severity of illness for positive and negative identifiers by the student's t test. The staging method's ability to explain cost variance ($R$, the correlation coefficient) was assessed using simple linear regression models of charges versus severity for each DRG. Multivariant regression analysis using multiple linear regression models was used to describe the cumulative effect of four variables

(± ER, ± SICU, ± T, and severity) to explain cost variance for each DRG. Regression formulas were (1) hospital charges = A (staging), (2) hospital charges = A (ER) + B (SICU) + C (T), and (3) hospital charges = A (ER) + B (SICU) + C (T) + D (staging). These regression analyses give comparative data on the predictive value of charge variance per DRG explained by the staging method, identifiers alone, or identifiers plus the staging method.

## Results

The clinical variables were predictive of hospital charge differences within each DRG; the differences in resource utilization (that is, charges) by identifier are shown in Table 1. Positive identifiers always had higher mean charges per patient than negative identifiers. For the ER identifier, the greatest difference in charges was in DRG 154 (129.7 percent), followed by DRG 197 (105.3 percent), DRG 110 (66.6 percent), DRG 198 (57.4 percent), and DRG 149 (15.5 percent). Three DRGs, 154, 197, and 198, showed statistically significant differences between positive and negative identifiers. For the T identifier, the greatest difference in charges was in DRG 197 (188.7 percent), followed by DRG 154 (113.9 percent), DRG 198 (80.6 percent), DRG 149 (59.6 percent), and DRG 110 (14.1 percent). Four DRGs, 149, 154, 197, and 198, were statistically significantly different at $p \leq .10$. For the SICU identifier, the greatest differences were in DRG 198 (167.8 percent), DRG 154 (164.5 percent), DRG 149 (129.3 percent), and DRG 110 (65.3 percent). There were no SICU admissions for DRG 198. Three DRGs, 110, 149, and 154, were statistically significantly different at $p \leq .10$.

The clinical variables also usually stratified severity of illness differences within each DRG; severity of illness is contrasted for the three identifiers in Table 2. For the ER identifier, two of five DRGs had significantly greater severity of illness for positive identifiers (DRGs 110 and 154). For the T identifier, four of five DRGs had a greater severity of illness for positive identifiers. For the SICU identifier, three of four DRGs had significantly greater severity of illness for positive identifiers. Only DRG 198 was nondiscriminatory for this identifier.

The descriptive ability of the clinical variables also appeared to be cumulative; both charge (Table 3)and severity of illness (Table 4) per patient usually increased as the number of identifiers accumulated. Mean charge per patient was higher in most DRGs for patients with one positive

Table 1
**Hospital Charges in Selected Surgical DRGS by Identifiers (Mean per Patient)**

| DRG (N) | | Mean per Patient | +ER Mean | +ER (N) | −ER Mean | −ER (N) | +T Mean | +T (N) | −T Mean | −T (N) | +SICU Mean | +SICU (N) | −SICU Mean | −SICU (N) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 110 | (68) | $17,835 | $24,843 | (20) | $14,915 | (48) | $19,009 | (34) | $16,661 | (34) | $23,236 | (28) | $14,055 | (40) |
| | | | | (N.S.)* | | | | (N.S.)* | | | | ($p < .07$)* | | |
| 149 | (71) | 9,488 | 10,346 | (27) | 8,961 | (44) | 13,060 | (19) | 8,182 | (52) | 19,609 | (6) | 8,553 | (65) |
| | | | | (N.S.) | | | | ($p < .03$) | | | | ($p < .07$) | | |
| 154 | (45) | 22,202 | 23,688 | (40) | 10,311 | (5) | 26,610 | (31) | 12,442 | (14) | 34,725 | (20) | 12,183 | (25) |
| | | | | ($p < .01$) | | | | ($p < .01$) | | | | ($p < .006$) | | |
| 197 | (46) | 11,477 | 14,332 | (29) | 6,606 | (17) | 24,597 | (9) | 8,286 | (37) | 25,216 | (6) | 9,416 | (40) |
| | | | | ($p < .02$) | | | | ($p < .08$) | | | | (N.S.) | | |
| 198 | (87) | 5,059 | 6,954 | (22) | 4,417 | (65) | 8,733 | (5) | 4,835 | (82) | | | | |
| | | | | ($p < .001$) | | | | ($p < .07$) | | | | | | |
| | (317) | $12,156† | $16,611 | (138) | $ 8,722 | (179) | $20,249 | (98) | $ 8,535 | (219) | $26,901 | (60) | $10,585 | (170) |
| | | | | ($p < .0001$) | | | | ($p < .0001$) | | | | ($p < .0001$) | | |

* Level of statistical significance, N.S. = $p > .09$.
† Dollar figures in this row are the mean per patient for all patients.

Table 2
**Severity of Illness (Staging) for Identifiers in Selected Surgical DRGs (Mean per Patient)**

| DRG | Mean per Patient | +ER | −ER | +T | −T | +SICU | −SICU |
|---|---|---|---|---|---|---|---|
| 110 | 5.81 | 6.95 | 5.33 | 6.38 | 5.24 | 6.71 | 5.18 |
| | | ($p < .05$)* | | (N.S.) | | ($p < .05$)* | |
| 149 | 4.23 | 4.48 | 1.95 | 4.84 | 4.00 | 5.33 | 4.12 |
| | | (N.S.) | | ($p < .07$) | | (N.S.) | |
| 154 | 7.24 | 7.53 | 5.00 | 7.48 | 6.71 | 8.25 | 6.44 |
| | | ($p < .03$) | | (N.S.) | | ($p < .05$) | |
| 197 | 5.11 | 5.10 | 5.12 | 6.78 | 4.70 | 6.33 | 4.93 |
| | | (N.S.) | | ($p < .002$) | | ($p < .01$) | |
| 198 | 3.28 | 3.27 | 3.28 | 3.20 | 3.28 | — | — |
| | | (N.S.) | | (N.S.) | | | |
| | 4.86† | 5.66 | 4.25 | 6.31 | 4.21 | 7.05 | 4.90 |
| | | ($p < .0001$) | | ($p < .0001$) | | ($p < .0001$) | |

* Level of statistical significance, N.S. = $p > .09$.
† Figures in this row are the mean per patient for all patients.

identifier versus patients with no positive identifier (only DRG 154 was not discriminatory by this parameter) and in all DRGs for patients with two or more positive identifiers versus patients with one identifier. Mean severity of illness usually was higher for patients with one positive identifier versus no positive identifier. DRG 154 was nondiscriminatory by

Table 3
**Mean Charge per Patient As Identifiers Accumulate**

| | No Positive Identifiers | | | One Positive Identifier | | | Two or More Positive Identifiers | |
|---|---|---|---|---|---|---|---|---|
| DRG | Mean | (N) | | Mean | (N) | | Mean | (N) |
| 110 | $11,415 | (18)* | (N.S.)† | $15,106 | (23)* | ($p < .10$)‡ | $24,440 | (27)* |
| 149 | 7,755 | (30) | (N.S.)† | 8,499 | (32) | ($p < .01$)‡ | 18,778 | (9) |
| 154 | — | | | 9,862 | (14) | ($p < .001$)‡ | 27,775 | (31) |
| 197 | 5,771 | (14) | ($p < .0002$)† | 9,552 | (23) | (N.S.)‡ | 25,273 | (9) |
| 198 | 4,396 | (63) | ($p < .003$)† | 6,175 | (21) | ($p < .02$)‡ | 11,163 | (3) |
| | $ 6,367§ | (125) | ($p < .0001$)† | $ 9,795 | (113) | ($p < .0001$)‡ | $24,694 | (79) |

* Sample size.
† Significance between no positive identifier and one positive identifier.
‡ Significance between one positive identifier and two or more positive identifiers.
§ Dollar figures in this row are the mean per patient for all patients.

Table 4
**Mean Severity per Patient (ICD-9-CM Codes) As Identifiers Accumulate**

| DRG | No Positive Identifiers | | One Positive Identifier | | Two or More Positive Identifiers |
|---|---|---|---|---|---|
| 110 | 4.22 | ($p < .09$)* | 5.22 | ($p < .05$)† | 7.11 |
| 149 | 3.73 | (N.S.)* | 4.41 | (N.S.)† | 5.22 |
| 154 | — | | 6.14 | ($p < .06$)† | 7.74 |
| 197 | 4.71 | (N.S.)* | 4.83 | ($p < .01$)† | 6.44 |
| 198 | 3.30 | (N.S.)* | 3.14 | (N.S.)† | 3.67 |
| | 3.70‡ | ($p < .0001$)* | 4.70 | ($p < .0001$)† | 6.94 |

* Significance between no identifiers and one identifier.
† Significance between one identifier and two or more identifiers.
‡ Figures in this row are the mean per patient for all patients.

this parameter, and DRG 198 had a slightly higher severity for patients with no identifiers versus one identifier (5.1 percent). Mean severity of illness was higher for all five DRGs for patients with two or more positive identifiers versus one positive identifier. Mean charge and severity of illness were always higher for patients with two or more positive identifiers versus no positive identifiers.

## Clinical Variables As Severity Measures (Regression Analysis)

Regression data demonstrated that these clinical variables could predict charge variances within a DRG as well as severity. Regression analysis data are shown in Table 5. The data demonstrate that clinical variables can act as cost-severity indicators for surgical DRGs. Regression compares the "goodness of fit" in the relation between a dependent variable, that is, charges, versus independent variables, that is, severity, identifiers, or both severity and identifiers. $R$ quantifies a value for the ability of the independent variable or variables to reflect a change in the dependent variable (charges). $R$ ranges from 0.00 to 1.00; a value of 0 represents no goodness of fit between dependent and independent variables, and a value of 1.00 represents perfect goodness of fit.

The $R$ values for formulas (a) and (b) yield a comparison between either severity alone or identifiers alone to describe cost variance. In all

Table 5
**Regression Analysis**

| DRG | ER* | ICU* | TT* | Severity (Staging)* | *R* |
|---|---|---|---|---|---|
| 110 (a) | — | — | — | .2452 | .2452 |
| (b) | .2437 | .2421 | .0141 | — | .3426 |
| (c) | .1786 | .2086 | .0224 | .0933 | .3551 |
| 149 (a) | — | — | — | .3017 | .3017 |
| (b) | .0095 | .1181 | .0295 | — | .4936 |
| (c) | .0046 | .0975 | .0202 | .0211 | .5145 |
| 154 (a) | — | — | — | .5110 | .5110 |
| (b) | .0313 | .1512 | .0135 | — | .5135 |
| (c) | .0163 | .1037 | .0000 | .1276 | .6255 |
| 197 (a) | — | — | — | .3829 | .3829 |
| (b) | .0500 | .0453 | .0957 | — | .5816 |
| (c) | 0404 | .0418 | .0584 | .0075 | .5880 |
| 198 (a) | — | — | — | .4307 | .4307 |
| (b) | .1913 | — | .1068 | — | .6072 |
| (c) | .1031 | — | .0977 | .0566 | .6522 |

Note: Regression formulas (simple and multiple linear models) are (a) hospital charges = A (severity), (b) hospital charges = A (ER) + B (ICU) + C (T), and (c) hospital charges = A (ER) + B (ICU) + C (T) + D (severity).
* Contribution to *R* values.

DRGs, identifiers alone were better at describing cost variance than a form of the staging method. A comparison between formulas (b) and (c) gives a determination of the additional predictive value of adding the severity of illness to the three identifiers (ER, SICU, and T). This yields the following improvement in *R*: DRG 110 (3.6 percent), DRG 149 (4.2 percent), DRG 154 (21.8 percent), DRG 197 (1.1 percent), and DRG 198 (7.4 percent). Thus, three DRGs (110, 149, and 197) showed less than 5 percent improvement in *R* with the addition of the severity measure; DRG 198 demonstrated a 7.4 percent improvement, and DRG 154 demonstrated a 22 percent improvement. The data suggest that clinical variables can act as cost-severity stratifiers for surgical DRGs.

## Clinical Variables to Stratify Resource Consumption within a DRG

It appeared from the regression analyses that identifiers were as good at describing cost variance as a form of the staging method for the surgical DRGs studied. Other studies have demonstrated that these, in combination with other clinical variables, may be comparable to other severity methods such as the Horn index or APACHE II, as severity stratifiers [11]. Therefore, this study demonstrates that clinical variables can be "subproduct" stratifiers for resource consumption differences within each DRG.

There are many potential uses for this type of system in the field of hospital management. Since this type of cost stratification is useful for the practicing physician or surgeon, the identification of more or less costly subproducts within a DRG may aid physicians and hospital administrators in improving resource use. DRG 197 (cholecystectomy) as analyzed in this study demonstrates the practical application of this concept. Emergency admissions in this DRG had total charges that were more than double nonemergency admissions; this was due in part to long preoperative lengths of stay (about eight days). Since emergency DRG 197 patients were financial losers, there was an economic incentive to improve efficiency in this group. The utilization review coordinator and the administrative staff believed that the preoperative workup for these patients, who were usually admitted with the diagnosis of acute cholecystitis, could be done more quickly without changing the quality of care or outcome for the patient. A team effort with the physicians is being made to improve preoperative efficiency for this group of patients. The effort involves decreasing the lag time for the diagnostic testing (usually Tc = labeled immunodiacetic acid (HIDA) scans, ultrasound, or both) and facilitating operative bookings to avoid a delay in treatment.

*The identification of more or less costly subproducts within a DRG may aid physicians and hospital administrators in improving resource use.*

Laboratory charges in a number of surgical DRGs within the transfusion identifier have been studied [12]. Patients with the positive T identifier (that is, patients receiving blood) have much higher laboratory charges than nontransfused patients within each DRG. Although the marginal analysis on the utility of all of the laboratory tests on these patients has not been done, other work has suggested that laboratory tests may be decreased in this type of patient without a change in outcome [13]. The utilization coordinator is educating physicians regarding laboratory expenses for these patients to improve efficiency in laboratory testing.

Another study found that these identifiers may assist hospital management in reversing physician-related referral behavior that may result in higher hospital costs per DRG. An analysis of DRG 001 (craniotomy) at the Long Island Jewish Medical Center found that emergency admissions had a pattern of referral dynamics that tended to expand costs per DRG [14]. Emergency admissions in the craniotomy study were twice as expensive as nonemergency admissions, but not more severely ill; however, they had significantly different referral patterns. Many of these patients were admitted to the neurology service with subsequent referral to the neurosurgery service, then craniotomy. The study suggested that hospital administration could promote savings by encouraging admission directly to the neurosurgical service for certain patients with an admitting emergency diagnosis fitting the craniotomy DRG profile and thus shorten the preoperative length of stay for these patients. The researchers are working with physicians and administrators to develop a reasonable solution to this problem. It appears, then, that route of admission may be a powerful predictor of cost variance due to a variety of factors, some of which are reversible without altering the quality of medical care.

This study also confirmed initial findings regarding the dynamics of identifiers. One type (such as mode of admission) occurs at the *beginning* of the disease productive process. Thus, it may be used at time zero of the hospital stay to develop clinical management methodologies to improve efficiency. A second type (SICU or T) occurs sometime *during* the disease productive process, that is, at some point in the continuum of hospital treatment. The tendency of these identifiers to occur near the beginning or end of a hospital stay will make them more or less useful for clinical cost management. Further study will be needed to describe the temporal relationship of the occurrence of these clinical variables; other identifiers may be needed for other medical and surgical specialties. These types of identifiers, however, could be used by physicians and hospital administrators to stratify high and low cost patients within each DRG and then attempt to improve efficiency in a variety of ways.

## Conclusions

As the DRG payment system is fully implemented with federalized reimbursement rates in 1987, hospitals will face financial risk and uncertainty in their revenue streams. Hospitals will need to develop methodologies that will manage physician-generated hospital costs. The purpose of this project was to test the hypothesis that clinical variables (that is, mode of admission, blood transfusion, or SICU admission) could be used as identifiers to reflect differences in charges and severity of illness for patients in general surgical DRGs. The findings demonstrate that clinical variables can predict differences in hospital charges and severity within surgical DRGs better than a form of the staging method. This suggests that clinical variables may be useful to both hospital administrators and physicians to stratify resource consumption during a patient's hospitalization and provide a framework for better management of hospital inpatient costs.

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