Disease staging: Implications for hospital reimbursement and management

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The current patient classification schemes used in case-mix reimbursement are not fully sensitive to variations in resource consumption that are associated with differential disease severity. Disease staging is a clinically based measure of severity that uses objective medical criteria to assess the stage of disease progression. Its availability in automated form increases its ease of implementation in hospital reimbursement and management. Results of recent studies demonstrate that staging is a useful case-mix reimbursement and management tool that explains significant variation in cost per discharge within current diagnosis-related groups.

Introduction

This article analyzes the utility of disease staging as a hospital reimbursement and case-mix management tool. staging is a measure of disease severity based solely on predefined medical criteria. Computerized staging software makes it replicable, easy to audit, and applicable to conventional automated hospital discharge abstracts. In case-mix reimbursement, staging has the potential to be used as a classification system in its own right for hospital payment or as a refinement tool for increasing the case-mix precision of existing classification systems. In hospital case-mix management, it has clinical meaning and acceptability, and provides sensitive measurement of the resources required in treating patients of differential disease severities.

Background

Under case-mix reimbursement, hospitals are typically paid a fixed amount for a given patient type regardless of the actual treatment costs incurred. Patients who consume similar types and quantities of hospital resources are grouped together according to a classification scheme and assigned a single reimbursement rate. The payment amount for a specific group is based on the average treatment cost for all patients in that group over all hospitals. Within any group, severely ill patients who require intensive treatments are reimbursed at the same rate as moderately ill patients who require only routine care. However, hospitals treating more severely ill patients might be expected to have higher costs, reflective of the greater intensity of services required to treat sicker patients. Under current classification schemes such hospitals may suffer financial losses because their expenses exceed the payments they receive for each disease category. To minimize such losses, hospitals may cut back on essential services or refer the more severely ill patients to other institutions, thus increasing potential financial risks for tertiary care hospitals. To reduce such problems and to ensure equitable payment to hospitals, refinements to the current patient classification schemes for hospital reimbursement are required so that variations in disease severity are fully recognized.

In addition to their role in hospital reimbursement, case-mix measures have also become important inpatient management tools. When utilization profiles (length of stay, ancillary use, nursing costs) are examined within clinical categories, hospital administrators can better monitor operational efficiency, contain unnecessary costs, assess physician and service profitability and engage in accurate financial planning. Most current classification schemes are not sufficiently detailed in their definition of clinical categories to describe these categories as homogeneous hospital products or outputs (Ament *et al.*, 1982; Grimaldi and Micheletti, 1983; Wennberg, 1984). Thus, within an individual hospital, it is difficult to use these schemes to explain any differences in physician profitability that derive from treating patients at different levels of disease severity. Existing patient classification systems, therefore, need to be more sensitive to severity of illness if they are to maximize their utility in case-mix management and profitability assessment.

Measures of disease severity

Several alternative measures have been developed to operationalize disease severity. Young *et al.* (1982) have designed a case-mix classification scheme consisting of clinically meaningful patient management categories (PMC's) that use reason for admission, discharge diagnosis, and elective procedures to predict resource use and the treatment path to be adopted during the course of a patient stay. The services comprising a given path are assigned a total dollar cost which is then interpreted as a costliness weight for the particular patient group. PMC's have the advantage of objective definition, but their designation of "appropriate" treatment paths for each patient category may do little to encourage alternative and more effective treatment practices. More importantly, though, the method cannot be currently applied to computerized discharge data, and may, therefore, have only limited potential for use in hospital reimbursement.

Horn *et al.* (1983) have developed the Severity of Illness Index in which each patients' total medical record is extensively reviewed and the patient is rated

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on a four-point scale for each of seven factors: stage of disease, severity of complication, interacting conditions, level of nursing care required, nonoperative procedures, rate of response to treatment, and completeness of response to treatment. The rating process is judgmental, with raters assigning scores based on their own impressions after reviewing the medical record. As a result there is no assurance that severity values have consistent meaning across raters, patients, or hospitals. Application of method is also limited to manual evaluation of medical records and may, therefore, be costly to apply on a large scale.

Wagner *et al.* (1983) have developed a two-part severity of illness classification exclusively for patients in intensive care called the acute physiology and chronic health evaluation (APACHE). The first component, the acute physiology score (APS), is designed to be a measure of the acute severity of illness of patients. It consists of a weighted sum of each of 33 physiologic measurements obtained from the patient's clinical record. The second component is a subjective measure of preadmission health status based on review of a patient's medical record. Because "APACHE predictions are not precise enough for individual clinical predictions" (Wagner *et al.*, 1983), and because it focuses exclusively on intensive care patients, the approach may have limited potential in large-scale refinements of case-mix reimbursement.

Most recently, researchers at Mediqual Systems, Inc. (1984) have developed the medical illness severity grouping system (MEDISGRPS). MEDISGRPS uses data derived from pertinent abnormal clinical findings, then processes those data by computerized clinical algorithms, and classifies patients based on their clinical findings into admission severity groups. Because no assessment of diagnosis is made, patients with similar clinical findings are assigned to the same severity value regardless of the nature or progression of their disease. MEDISGRPS is primarily useful for concurrent review and utilization management within the hospital setting. Because it relies on data that are rarely coded on computerized discharge files, its large-scale application for case-mix refinement and hospital reimbursement may be limited.

A fifth alternative measure of severity of illness, disease staging, was developed by Gonnella, Louis, and others (1975, 1984). Staging defines the progressive levels of severity for disease in terms of the events and pathophysiological observations that characterize each stage. Within a given body system, higher degrees of involvement or greater degrees of disruption are identified as more severe. In contrast to alternative measures of severity, the criteria for assigning stage of illness are predefined and involve no judgmental decisionmaking. Computerized staging software eliminates the need for costly and labor-intensive manual record reviews and uses data elements that are already collected by most hospitals on an automated basis. Staging is the only measure of severity that can be currently applied to computerized discharge files, and that can, therefore, be immediately utilized in large-scale refinements of case-mix classifications.

Development and methodology of disease staging

Development

Disease staging has been developed over a ten-year period. Most recently, refinement efforts were funded by the National Center for Health Services Research (NCHSR). The initial concept was borrowed from the system developed by the National Cancer Institute to classify oncology patients. During the course of neoplastic diseases, there are discrete "stages" that are manifested and can be defined and detected clinically, reflecting the severity of the disease. These stages have clinical significance for prognosis and therapeutic modality.

As is true for cancers, the clinical advancement of most diseases is characterized by a stage-like progression exhibiting increasingly greater complications, broader systemic involvement, and poorer prognosis. During the development of staging, these concepts were applied to a vast array of medical and surgical problems by clinicians to classify essentially all hospitalized patients. Physician panels, representing the major medical specialties, developed distinct medical criteria to define stages of illness for individual diseases. Stages of each disease were defined in terms of biological progression and complications of the disease, such as infection, perforation, obstruction, hemorrhage, paralysis, shock, etc., based on medical knowledge and well-documented references. Stages were defined so that they could be confirmed on the basis of clinical test results. Since its development, staging has been extensively field tested, validated, and applied to millions of hospital discharges.

In staging, diseases are generically divided into four mutually exclusive categories of increasing severity based on the systemic involvement of the disease and the presence of complications. These four stages of illness are described below. Within each stage, substages are typically defined for most diseases to reflect finer differentiations of severity.

Stage I: Conditions with no complications or problems of minimal severity.

Stage II: Problems limited to an organ or organ system; significantly increased risk of complications.

Stage III: Multiple site involvement; generalized systemic involvement; poor prognosis.

Stage IV: Death

An example of the medical staging criteria for one disease, cirrhosis of the liver, is provided in Table 1. Here, stage I is characterized by patients with cirrhosis who have no evidence of complications. Patients in stages II and III exhibit complications of greater severity and broader physiological impact. Stage IV consists of patients who have died, and who have cirrhosis as their underlying diagnosis. While it is true that a disease actually terminates upon the death of the patient, it is useful, for both heuristic and analytic purposes, to include death as the endpoint of

Table 1

Clinical staging criteria for cirrhosis of the liver

Stage	Common description or name of the condition	Alternate description or synonym	Supporting evidence or clues
1.0	Cirrhosis	Cirrhosis: Portal (alcoholic, Laennec's); post-necrotic; biliary; cardiac; posthepatic cirrhosis; toxic cirrhosis	Liver biopsy or laparoscopy or documentation by physical signs and laboratory data consistent with the diagnosis
2.0	Cirrhosis plus:		
2.1	Ascites or peripheral edema		Abdominal paracentesis (aspiration) or shifting dullness or fluid wave, or pitting edema
2.2	Portal hypertension		Portal venous pressure measurement or radiologic exam of portal system or physical signs of abdominal collaterals, splenomegaly, cirrhosis, altered consciousness or mentation, neuromuscular signs (tremor, asterixis), abdominal EEG, elevated serum ammonia, factor hepaticus.
3.1	Hypersplenism		Splenomegaly, cytopenia
3.2	Variceal hemorrhage or bacterial peritonitis		Endoscopy or arteriography, diagnostic peritoneal tap
3.3	Coagulopathy	Coagulation defects	Physical signs of bleeding and coagulation studies consistent with this finding.
3.4	Hepatic encephalopathy	Hepatic coma	Altered consciousness or mentation, neuromuscular signs (tremors, asterixis), elevated serum ammonia
3.5	Hepatorenal syndrome		Oliguria, azotemia in patient with clinically severe liver failure
4.0	Death		

NOTE: EEG = electroencephalogram.
SOURCE: Gonnella (1983), pg. 334.

the severity scale. This provides explicit consideration of patients who died during any episode of care as the final progression level of the underlying disease, whether related to therapeutic intervention or not.

Thus, the assignment of disease stage is not based on actual utilization patterns or expected responses to therapy. It is, rather, based on conceptual model of the disease process itself and physical evidence of disease severity. Stages relate to organic disease, and not directly to the intensity of treatment or level of therapeutic intervention. Therefore, the groups into which patients are classified are not affected by factors that can be easily controlled by hospitals.

Methods of application

Staging criteria are currently available for over 400 conditions. These include the major diseases in each etiology and body system class, and represent the vast majority of admissions to a typical short-term general hospital. Some catchall coded criteria have been developed for particular organs or body systems to handle residual cases when processing discharge abstracts. The medical criteria and staging methodology can easily be applied on a manual basis to medical records to analyze patients within an institution or a selected disease category. More relevant to large-scale case-mix reimbursement schemes, the method can also be applied on an automated basis using a computer software package that has been developed to read and stage large volumes of automated discharge abstract data. Staging is the only existing comprehensive case-mix system other than diagnosis-related groups (DRG's) that can be implemented on a large scale with computerized discharge data. While its manual application to medical records avoids the potential problems of errors in diagnostic coding, in computerized form it is the only measure of severity that can be immediately applied in hospital reimbursement and management.

Table 2 uses diabetes mellitus to provide an example of the complexity of the task that was undertaken to define the clinical staging criteria in terms of diagnostic codes [1] during the development of the automated version of staging (Louis *et al.*, 1983). All data elements necessary to apply the staging algorithm to a set of records are already typically collected by hospitals on an automated basis. No additional data need be collected to apply the staging software.

The staging algorithm compares the list of diagnoses on the abstract with the list of diagnostic codes that comprise each stage definition. It scans principal and secondary diagnosis codes and uses the relationships among those codes to identify the underlying condition of highest severity. The software contains logic which imposes an ordering on the diagnostic codes listed on the abstract. Thus, a case with appendicitis and retroperitoneal abscess would be staged on the assumption that the abscess was caused by the appendicitis regardless of the order in which they are listed on the abstract. The highest stage match (typically stage I, stage II, or stage III) is then assigned to the patient; the patient is assigned to stage IV in the case of death. To assign a stage IV, there must be some presumptive evidence on the discharge abstract that the underlying diagnosis was the likely cause of death (Louis *et al.*, 1983).

[1] Coded staging criteria have been developed in three coding rubrics: *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM), *International Classification of Diseases, adapted for use in the United States* (ICDA), Eighth Revision (ICDA-8), and Second Revision of Hospital ICDA (H-2).

Table 2

Coded staging criteria for diabetes mellitus using *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM)

Stage	Common description or name of the condition	ICD-9-CM codes that define each stage and substage
1.0	Diabetes mellitus	775.10, 790.20, 250.00-250.01, 250.80-250.91;
2.1	Diabetes mellitus with an infection in one or more systems (skin, genital tract, urinary tract infection, etc.)	S1.0 + 320.00-324.90, 245.00-245.10, 254.10, 289.20-289.30, 420.00-422.99, 424.91, 429.89, 447.60, 480.00-486.00, 510.00-510.90, 511.10, 513.00-513.10, 526.40, 566.00-567.90, 569.50, 572.00, 577.00, 580.81, 590.00-590.30, 595.00-595.40, 595.89-595.90, 597.00-597.80, 598.00-598.01, 599.00, 601.00-601.90, 603.10, 604.00-604.99, 607.10-607.20, 590.90, 608.00, 608.40-608.81, 611.00, 614.00-616.11, 616.30-617.90, 680.00-686.90, 711.00-711.99, 728.00, 730.00-730.39, 730.80-730.99;
2.2	Diabetes mellitus with septicemia	S1.0 + 038.00-038.90;
2.3	Diabetes mellitus with acidosis	S1.0 + 588.80, 791.60, 276.20-276.40; 250.10-250.11;
2.4	Diabetes mellitus with: retinopathy but without loss of vision or glomerulosclerosis (without azotemia) or neuropathy (peripheral or autonomic) or gangrene (tissue breakdown)	S1.0-S2.3 + 337.10, 362.18, 443.81, 443.90, 446.60, 447.10, 581.81, 785.40, 354.00-356.90; 357.20, 362.01, 250.40-250.71;
3.1	Diabetes mellitus with: acidosis and coma or retinopathy and loss of vision or necrotizing papillitis or azotemia	S2.4 + 276.20, 369.00-369.90; S1.0-S2.4 + 583.70, 780.00, 790.60, 584.50-586.00, 590.80-590.81; 362.02, 250.30-250.31;
3.2	Diabetes mellitus with hyperosmolar coma	250.20-250.21;
3.3	Shock	S1.0-S3.2 + ZSHOCK9;
4.0	Death	S2.2-S3.3 + Death:

Complications and comorbidities

The identification of complications and comorbidities is an important consideration in categorizing illness. Under the DRG system, complications and comorbidities are defined as conditions other than the principal diagnosis that are likely to increase the length of hospital stay by at least one day in about 75 percent of patients. A list of such conditions has been designated for use in defining DRG's. While, in theory, comorbidities are preexisting prior to hospitalization and complications occur during hospitalization, no such distinctions are made during DRG assignment. Secondary diagnoses need only to appear on the list to qualify as complications and comorbidities. Furthermore, neither severity of illness nor the relationship to the underlying disease are assessed in defining such conditions.

In contrast, Staging explicitly assesses relationships among diseases and examines disease severity in defining complicating and comorbid conditions. No constraints are imposed on the timing of disease occurrence (e.g., prior to versus during hospitalization). Complications are defined as conditions related to the underlying disease that represent steps in the disease progression. The potential list of complications is unique to each disease and is implicit in the assignment of a stage value. Comorbidity is defined as any condition secondary, yet unrelated, to the underlying disease which is of sufficient severity to require greater resource consumption. The criteria for "sufficient severity" have been established and reviewed by clinicians for each potential comorbidity. An unrelated condition does not qualify as comorbid unless it meets or exceeds its own severity criterion.

Staging as a hospital reimbursement tool

The most widely implemented case-mix reimbursement scheme is the prospective payment system (PPS) initially developed by the Health Care Financing Administration (HCFA) for Medicare inpatient reimbursement, and currently being considered by a number of State and private payers. At the heart of PPS, diagnosis-related groups (DRG's) have been implemented as the primary measure of hospital case mix and as the basis upon which HCFA reimburses hospitals for their treatment of Medicare patients. Under PPS, reimbursement rates are set for each of 467 different DRG's and hospitals are paid based on the DRG of each patient. Except for adjustments for local wage rates and teaching status, all general acute-care hospitals are reimbursed on the same basis according to the classifications into which their patients fall.

DRG's were originally developed to reduce variance in length-of-stay patterns based on diagnoses, surgery, and patient age/sex. No consideration was given to variations in disease severity. As a result, the relationship between disease severity and treatment cost is ignored, and the within-DRG variance in resource consumption is significant. Several studies have demonstrated the lack of homogeneity within DRG's (e.g., Ament *et al.*, 1982; Grimaldi and Micheletti, 1982; Wennberg, 1984; Young *et al.*, 1982). This lack of homogeneity threatens the validity of PPS as an equitable case-mix reimbursement system, and it may lead to cross-subsidization (Grimaldi and Micheletti, 1980).

To ensure the equitable payment of hospitals under PPS, patients must be classified into groups that are homogeneous with respect to the specific resources used in caring for them. However, group definitions should not be based directly on measures of resource utilization. If groups were defined in such a manner, patients with greater resource use and treatment

intensity would automatically be reimbursed at higher levels than patients using fewer resources. Hospitals would thus have the capability of increasing payments by increasing treatment intensities. Clearly, systems that pay hospitals directly on the basis of resource use are little different from fee-for-service systems. Both indirectly provide incentives for greater resource consumption.

Disease staging stands as a viable patient classification scheme that is objective, reliable, and defined solely on the basis of clinical factors. In contrast to other measures of disease severity, a significant characteristic of the staging approach is its emphasis on the medical meaningfulness of the criteria. While numerous analyses have demonstrated the strong relationship between staging and resource consumption (Garg *et al.*, 1978; Gonnella *et al.*, 1984), it is noteworthy that no utilization data were used to develop the staging criteria. The measure has an underlying *a priori* structure in which only the clinically pertinent attributes of the patient are employed in the classification system.

DRG refinement study

Recognizing the limitations of the DRG system and the implications for hospital reimbursement, HCFA recently joined with the Office of the Assistant Secretary of Planning and Evaluation (OASPE) to contract a pilot study investigating the feasibility of combining disease staging with the DRG method so as to more accurately predict the total resource costs incurred by an individual patient (Conklin *et al.*, 1984). A hospital reimbursement system resulting from a merging of DRG's and staging could have the potential to be more sensitive to variation in resource consumption and treatment cost, and thereby lead to more equitable hospital reimbursement.

The study was based on over 32,000 Medicare patient discharges in the selected DRG's from the states of Maryland (1981) and New Jersey (1979). The data contained information on patient characteristics (e.g., diagnoses, procedures, age, sex and discharge status) and length of stay. Total cost per discharge was estimated by converting charges using ratios of cost-to-charge within ancillary centers and aggregating to the total discharge level. These estimates of total cost were used throughout the study as the principal measures of resource consumption and acted as the dependent variables in the majority of the statistical analyses.

For analysis purposes, the DRG's in the study were aggregated into adjacent DRG (ADRG) categories. Adjacent DRG's which represented splits on the basis of age and/or the presence of complications or comorbidity were combined to form a single ADRG. For example, the ADRG representing kidney and urinary tract infections (UTI) consisted of DRG 320 (Kidney and UTI for ages = > 70 and/or with complications or comorbidities), DRG 321 (Kidney and UTI for ages < = 70 without complications or comorbidities), and DRG 322 (Kidney and UTI for ages 0-17). This allowed for the direct comparison of alternative splits within each ADRG based on stage of illness, age, and unrelated comorbidity.

A total of 10 ADRG's were examined in the OASPE/HCFA study. A subset of these ADRG's based on Maryland (1981) discharges has been selected for review in this article. The subset includes diabetes mellitus, cirrhosis and alcoholic hepatitis, biliary tract procedures, and benign prostatic hypertrophy (BPH). These ADRG's are among the most common in the Medicare population. In addition, they are characterized by a high degree of variability in cost per stay, making them likely candidates for classification refinement.

The analyses assessed the clinical validity of group definitions and the reduction of variation in resource consumption attributable to stage of illness, age, and unrelated comorbidity within specific ADRG's. General linear models were used to assess variance explained (R^2) by DRG splits and splits based on stage of illness, age, and unrelated comorbidity. Dummy variables were used to define the different values of the predictors. No main effect for stage was included in the modeling process, since staging is an ordinal measure of disease progression and aggregations of stages across conditions lack uniform meaning. Instead, an interaction term of stage by condition (principal diagnosis) was specified as a class variable and was used to separate the effects of severity for each condition. Unrelated comorbidity was represented by a dummy indicator and age was divided into six categories: 0-64, 65-69, 70-74, 75-79, 80-84, and 85 and over. For analysis purposes, cost and length-of-stay outliers were defined using HCFA's criteria as published in the *Federal Register* (October 1, 1983), and were excluded from the data base. Parallel analyses were conducted of untrimmed data and New Jersey data for cross-validation purposes.

Table 3 illustrates the relationship between average total cost per stay and stage of illness. The most striking characteristic presented is that treatment costs almost always increase with severity. In the adjacent DRG of biliary tract procedures, the principal diagnosis of cholecystitis exhibits an average cost of $3,444.14, in stage I, and the highest average cost, $5,730.23, in stage III. The slightly lower average cost for stage IV ($3,194.37) is not surprising, since patients who die during the course of their treatment often tend to have relatively short stays in the hospital. Though not presented, per diem costs are dramatically higher for stage IV cases than for other stages. Cirrhosis and alcoholic hepatitis also demonstrates a high correlation between stage of illness and cost. Here, the lowest average cost occurs in stage I, with the highest occurring in stage IV. For diabetes mellitus, average total cost increases throughout stages I, II, and III, but is slightly lower for stage IV as in biliary tract procedures. Patients with BPH also incur higher average cost with increases in stage of illness. The lowest average total cost in this adjacent DRG occurs in stage I while the highest occurs in stage III. No stage IV's are present for this group in the analysis sample.

Table 4 illustrates the relationships of cost to unrelated staged comorbidity and age. For each disease, patients with unrelated comorbidities have higher aggregate costs than patients without comorbidities. The average cost for biliary tract procedures is $3,401 when unrelated comorbidities are not present, but increases to $4,441 for cases with comorbidities. For cirrhosis and alcoholic hepatitis, the average cost is equal to $2,690 for cases without unrelated comorbidities, and $2,784 otherwise. This is the only condition in which the relationship between unrelated comorbidity and cost is not statistically significant. In diabetes mellitus, the average cost for cases without unrelated comorbidities, $1,816, is significantly lower than for cases with comorbidities, $2,329. The most dramatic differences in cost by unrelated comorbidity occur in BPH, where the average cost for cases without comorbidities is equal to $1,204, while the average cost for cases with comorbidities is $1,930, a difference of over 60 percent.

Age was the least important of all variables analyzed in this study. As can be seen in Table 4, no consistent differences are apparent between age groups. This suggests that within the Medicare population, age may not be as important in patient classification as stage of illness and unrelated comorbidity. However, further statistical analyses are required to gain more insight into each variable's significance in formulating a patient classification scheme.

Based on the tabulations above and further examination of relationships among the variables, alternative splits within each ADRG were formed on the basis of stage, age, and unrelated comorbidity. Table 5 presents these splits along with the current DRG splits within each ADRG. The severity groups were designed to be similar in number to the DRG splits in order to avoid any spurious increases in explanatory power associated with subcategorization. They were specifically defined to be clinically meaningful.

DRG's often group together patients who are clinically dissimilar and who, therefore, have different treatment requirements. Alternative groups based on stage of illness and unrelated comorbidity can better account for clinical differences between such patients. For example, diabetes mellitus patients with uncontrolled blood sugar alone (stage 1), if hospitalized, will most likely be treated by regulation of insulin

Table 3

Average cost, by stage and principal condition within adjacent diagnosis-related group

Principal conditions	Frequency				Average cost (in dollars)			
Stage of disease	1	2	3	4	1	2	3	4
Total biliary tract procedures	1,119	84	57	5	$3,495.47	$4,317.61	$5,674.28	$ 4,835.50
Cholecystitis	1,075	80	55	4	3,444.14	4,252.21	5,730.23	3,194.37
Other conditions	44	4	2	1	4,749.48	5,625.66	4,135.82	11,400.00
Total cirrhosis and alcoholic hepatitis	137	54	67	41	2,343.06	2,552.66	2,719.90	4,510.56
Cirrhosis of the liver	106	54	66	41	2,396.11	2,552.66	2,718.83	4,510.56
Other conditions	31	—	1	—	2,161.67	—	2,790.56	—
Total diabetes mellitus	1,385	689	155	45	1,802.30	2,247.04	2,758.91	2,503.86
Diabetes mellitus	1,385	689	155	45	1,802.30	2,247.04	2,758.91	2,503.86
Total benign prostatic hypertrophy	292	66	10	—	1,269.00	1,675.08	2,445.93	—
Benign prostatic hypertrophy	292	66	10	—	1,269.00	1,675.08	2,445.93	—

Table 4

Descriptive statistics of cost (rounded dollars), by comorbidity and age

ADRG [1]	Statistic	Unrelated comorbidity		Age					
		Yes	No	1-64	65-69	70-74	75-79	80-84	85+
Biliary tract procedures	Mean	$4,441	$3,401	$3,575	$3,207	$3,710	$3,808	$4,431	$4,726
	Standard deviation	2,137	1,684	1,742	1,716	1,842	1,804	2,191	1,735
	Frequency	307	958	125	431	311	228	111	59
Cirrhosis and alcoholic hepatitis	Mean	2,784	2,690	2,682	2,642	3,085	3,158	2,442	2,070
	Standard deviation	1,831	1,696	1,748	1,752	2,136	1,554	1,734	1,039
	Frequency	230	69	79	113	55	30	15	7
Diabetes mellitus	Mean	2,330	1,820	1,959	1,889	2,044	2,163	2,009	2,262
	Standard deviation	1,442	1,066	1,276	1,165	1,269	1,304	1,286	1,166
	Frequency	873	1,401	420	593	535	364	228	134
Benign prostatic hypertrophy	Mean	1,940	1,206	1,654	1,178	1,313	1,409	1,490	1,924
	Standard deviation	1,452	826	1,677	963	861	892	1,170	1,398
	Frequency	84	284	21	110	99	75	36	27

[1] ARDG = adjacent diagnosis-related groups.

only, while a diabetic patient with acidosis and coma (stage 3) may also require intensive care and continuous monitoring of the comatose stage. DRG's subclassify diabetic patients only on the basis of age (greater or less than 35 years) and generally ignore such differences in severity. The alternative severity groups presented in Table 5 separately classify stage 1 and stage 3 patients and, therefore, allow for differences in resource requirements. In a second example, a BPH patient with a simple abscess of the salivary gland would be classified into the same DRG as would a BPH patient with an acute myocardial infarction. Both sets of co-occuring conditions qualify as complications or comorbidities under the DRG definition, even though they differ dramatically in complexity and treatment intensity. The proposed severity groups, however, classify these patients differentially since the salivary gland abscess is not sufficient in severity to be identified as an unrelated comorbidity, while the acute myocardial infarction is.

Table 5

Comparison of existing DRG splits and alternative severity groups for selected adjacent diagnosis-related groups (DRG's)

Principal diagnosis	Stage	Age	Complications or comorbidity (DRG definition)	Unrelated comorbidity	N	Mean cost
			Adjacent DRG: Biliary tract procedures			
Total					1,265	$3,653.54
DRG-splits						
DRG 197: Total cholecystectomy w/o CDE [1]	—	70+ (or)	Yes	—	917	3,945.48
DRG 198: Total cholecystectomy w/o CDE [1]	—	0-69	No	—	348	2,884.25
Severity groups						
Total cholecystectomy w/o CDE [1] and all others	1	All	—	No	852	3,266.59
Total cholecystectomy w/o CDE [1] and all others	1, 2	All	—	1 (yes), 2 (all)	351	4,247.81
Total cholecystectomy w/o CDE [1] and all others	3, 4	All	—	All	62	5,606.64
			Adjacent DRG: Cirrhosis and alcoholic hepatitis			
Total					299	2,762.57
DRG splits						
DRG 202: Cirrhosis and alcoholic hepatitis (Only DRG in category)	—	All	All	—	299	2,762.57
Severity Groups						
Cirrhosis and all others	1	All	—	No	35	2,173.67
Cirrhosis and all others	1, 2	All	—	1 (yes), 2 (all)	156	2,453.62
Cirrhosis and all others	3, 4	All	—	All	108	3,399.69
			Adjacent DRG: Diabetes mellitus			
Total					2,274	2,016.14
DRG splits						
DRG 294: Diabetes mellitus	—	36+	All	—	2,247	2,014.11
DRG 295: Diabetes mellitus	—	0-35	All	—	27	2,185.30
Severity groups						
Diabetes mellitus	1	All	—	No	920	1,655.45
Diabetes mellitus	1, 2	All	—	1 (yes), 2 (no)	886	2,085.38
Diabetes mellitus	2, 3, 4	All	—	2 (yes), 3-4 (all)	468	2,594.12
			Adjacent DRG: Benign prostatic hypertrophy			
Total					368	1,373.81
DRG splits						
DRG 348: Benign prostatic hypertrophy	—	70+ (or)	Yes	—	275	1,465.29
DRG 349: Benign prostatic hypertrophy	—	0-69	No	—	93	1,103.33
Severity groups						
Benign prostatic hypertrophy	1	1 or 0-69	—	No	255	1,155.59
Benign prostatic hypertrophy	1, 2, 3, 4	1 or 0-69 and 70+	—	Yes All	113	1,866.27

[1]CDE = common bile duct exploration.

In addition to their greater clinical validity, the severity groups exhibit greater homogeneity in resource consumption than do the DRG splits. The frequencies and mean costs for the various groups (presented in Table 5) demonstrate that the staging splits have more even distributions of cases and greater differentiation in mean cost than do the DRG splits within each ADRG. These findings are supported by cross validation analyses of untrimmed data and data from another state, New Jersey (Conklin *et al.*, 1984).

Table 6 presents the proportion of variance in cost per discharge explained by the DRG splits, the staging splits, and a linear model of principal condition, stage, unrelated comorbidity, and age. The multiple correlation coefficient (R^2) is presented as a measure of variance reduction for each model. F-values are displayed for the independent variables in the linear model as tests of their incremental significance (the F-tests are sequential, in the variable order from left to right). As mentioned above, stage of illness was represented in the linear model with a stage by condition interaction since stage cannot be meaningfully aggregated across conditions within an ADRG. In two of the ADRG's presented, diabetes mellitus and benign prostatic hypertrophy, only one condition is represented, thus reducing the stage by condition interaction to a staging main effect.

The results in Table 6 reveal that the complete staging model accounts for greater variance reduction in total cost than do the DRG splits within ADRG. The effect of staging on cost is significant in all four ADRG's as indicated by the significant F-values for the stage by condition interaction. Unrelated comorbidity has a significant impact on costs in all ADRG's except cirrhosis and alcoholic hepatitis. As suggested in the previous tabulations, age has a nonsignificant effect on cost in all four ADRG's.

The staging splits within each ADRG that are defined in Table 5 classify patients into a small number of groups and, therefore, provide more valid comparisons to the DRG splits than do the complete staging models which tend to maximize variance reduction due to the large number of cells they define. The figures in Table 6 reveal that the staging splits significantly improve on the variance reduction in total cost explained by the DRG splits without imposing excessive new categories within ADRG. The variance explained by the staging splits ranges from 8 percent to 16 percent, and exceeds the variance explained by DRG's by large margins in all cases. These results confirm the earlier interpretations of differential subcategory means in Table 5, and are supported by cross validation analyses of untrimmed and New Jersey data bases (Conklin *et al.*, 1984).

In summary, the study of potential DRG refinement has shown that subgroups defined on the basis of staging explain a larger proportion of variance within ADRG's than do the DRG groups themselves. In terms of patient classification, then, staging may be used to form groups that are more homogeneous on resource consumption than are DRG's. Its availability in computerized form makes it immediately applicable to large-scale data bases. Staging can be used as a classification system in its own right or as a tool for refining the current DRG system. In either case, its use in patient classification can increase the sensitivity to case-mix variation and thereby ensure a more equitable and cost-effective hospital reimbursement system.

Staging as a case-mix management tool

The introduction of the DRG-based prospective payment system into the Medicare program, and its possible adoption by other third party payers, may augur a new era of constrained growth for the hospital sector. The resulting climate of austerity compels hospital administrators to maintain cost controls through effective case-mix management. Hospitals must classify their patients into clinically meaningful and statistically homogeneous groups to better estimate revenues and expenses by patient type, to forecast staffing needs, to assess physician profitability, and to monitor the provision of costly ancillary services. However, current patient classification systems (e.g., DRG's) do not define medically meaningful groups that are administratively accurate and fully differentiated with respect to clinical characteristics. Greater sensitivity to the determinants of

Table 6

Proportion of variance in total cost explained, by diagnosis-related group (DRG) splits, staging splits, and general linear model

Adjacent DRG	Number of cases	DRG splits R^2	Staging splits R^2	Analytical model R^2	Analytical model F-values and significance: Condition	Stage by condition	Unrelated comorbidity	Age
Biliary tract procedures	1265	.07	.11	.19	43.60*	16.27*	46.14*	14.89*
Cirrhosis and alcoholic hepatitis	299	[1]0	.16	.18	2.38	12.62*	0.03	1.27
Diabetes mellitus	2290	.0001	.08	.09	[1]0	45.44*	66.10*	2.15
Benign prostatic hypertrophy	370	.02	.11	.14	[1]0	10.85*	27.29*	1.78

[1]Insufficient degrees of freedom for this effect.
*Significant at the 5-percent level.

treatment intensity (e.g., stage of disease) is needed to increase their clinical validity for classifying hospital products, thereby facilitating cost-containment efforts.

As an example, the current DRG system is inadequate for measuring physician productivity and efficiency because it is insensitive to differences in the severity of a given disease. Physicians treating patients in the same DRG's may differ significantly in their apparent profitability because the patients they treat differ in disease severity and therefore require different treatment intensities. Using DRG's to classify patients, a hospital administrator may question the efficiency and productivity of seemingly unprofitable physicians, when in reality their higher treatment costs are fully justified due to the high disease severity of their patients. Such misinformation may constrain the evaluation of cost-efficient treatment alternatives and result in unnecessary changes in service delivery and referral patterns.

Staging provides an essential classification tool for hospital case-mix management because it is easily and reliably implemented and is fully sensitive to variations in disease severity. Staging is meaningful for physicians and administrators alike since it is based entirely on medical criteria. It explains variations in service intensity; it identifies patient groups that are relatively homogeneous on expenditures; and it possesses clinical significance for prognosis and choice of therapeutic modality. Staging is a useful tool for evaluating physician efficiency and profitability since it reduces the extraneous within-group variability that is due to variation in disease severity, thus providing meaningful comparisons among physicians.

A recent study (Gonnella *et al.*, 1984) demonstrated the utility of disease staging as a method for relating case mix and resource consumption. The study assesses the feasibility of using staging as an appropriate measure of patient epidemiology, hospital case mix, and utilization patterns, with length of stay analyzed as the measure of resource consumption.

The study showed that the characteristics of patients with higher stages of a particular disease can be examined to provide greater insight into the factors associated with higher treatment costs. Older persons had relatively higher stages of disease. Lengths of stay were found to be significantly greater for patients of higher stage of illness and for patients of greater age. Patients seen as emergency admissions were more likely to have higher severity levels and have higher mortality rates than those admitted routinely. In addition, surgical cases had considerably longer stays than nonsurgical cases.

Examining the stages of illness characterizing patients of different payers, the study revealed that Medicare and self-paying patients were significantly higher in assigned severity levels than other groups of patients. In the case of Medicare this is likely to be age related. For self-pay patients, the higher severity may be related to delay in seeking appropriate care. Such delay usually allows a disease to progress to a more advanced stage before care is initiated. Because hospitals incur high financial risks in treating self-pay patients, there are incentives to identify the diseases and severities associated with this group, and to develop preventive/awareness programs to educate the community so that low severity cases among the self-pay population can be detected and treated early.

Staging can also be applied as a comprehensive case-mix measure at the hospital level, and be used to compare the differential treatment efficiencies of different institutional types. The Gonnella study showed that proprietary hospitals tend to admit less severely ill patients than voluntary and governmental hospitals. Patients in larger hospitals tend to be more severely ill and require longer stays than patients in smaller hospitals. In addition, stage of illness and length of stay are associated with teaching status, with medical school affiliated hospitals admitting relatively more severely ill patients than nonaffiliated hospitals.

These analyses demonstrate the utility of staging as a research and management tool. Within hospitals, staging can be used to describe more accurately the types of patients covered by different payers, the relationships between ancillary utilization or cost and severity of illness, the diagnostic efficiency of the physician, and treatment outcomes in terms of quality of care. In analyses of hospital-level characteristics, staging can be used to accurately define differential case-mix by hospital type, to relate utilization patterns by disease to hospital characteristics, and to adjust for severity differences in analyses of average treatment costs.

Conclusions

This article has demonstrated the utility of disease staging as a hospital reimbursement and management tool. Staging has advantages over current classification schemes for reducing variance in resource consumption because it explicitly defines gradations of severity within a given disease. It is based on the clinical criteria of disease progression rather than on direct measures of resource utilization. Thus, it is meaningful to clinicians, administrators, and third-party payers. The availability of staging in an automated form allows for its immediate large-scale application as a reimbursement or management system. Since it is based on objective, predefined criteria, it is reliable, replicable, and easily audited.

Staging defines a patient classification scheme that can be used in its own right as the basis for case-mix reimbursement or one that can be used as a refinement tool to increase the case-mix sensitivity of current classification systems. Results of a recent study demonstrate that staging accounts for significant variance in cost per discharge within DRG's. Splits that are defined on the basis of staging and unrelated comorbidity explain greater proportions of variance in cost than do the current DRG splits that are based on complications/comorbidities and age. Applied in such a manner to the entire DRG system, staging would significantly increase the clinical relevance, statistical power, and equity of prospective reimbursement.

As a case-mix management tool, staging is both clinically meaningful and sensitive to the resources required in treating patients of differential severity levels. As hospital administrators begin to look at physician productivity under PPS, communication between the financial side and the healing side of the hospital is all-important. This process is facilitated by measuring case-mix with a methodology that has been shown to be objective and clinically rigorous.

Staging provides an accurate measure of case-mix that is well received by hospital professionals at all levels. It is capable of identifying services that are seemingly unprofitable under the DRG system, but are legitimately more costly because of the severity of the case-mix involved.

The key to hospital profitability under PPS is cost containment. Disease staging provides a useful tool for hospital management to accurately assess and monitor operational efficiency and thereby control increasing costs. Staging can help a hospital more accurately identify the patient groups that it treats most efficiently, so it can attempt to attract those patients. It can also be used to identify any services that the hospital might decide it can no longer afford to provide.

The feasibility of staging in DRG-refinement has been well established, and its utility as a management tool is apparent. Further research is required to allow full integration of staging into current reimbursement and management systems.

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