CASE MIX MEASURES

AND THEIR

REIMBURSEMENT APPLICATIONS:

A Preliminary Staff Report

September, 1979

James D. Bentley, Ph.D.
Peter W. Butler, M.H.S.A.

Department of Teaching Hospitals
Association of American Medical Colleges
One Dupont Circle, N.W.
Washington, D.C. 20036

TABLE OF CONTENTS

BACKGROUND

At the 1979 Spring Meeting of the Council of Teaching Hospitals (COTH), a workshop examining the definition of the term teaching hospital was conducted. Prior to the meeting, attendees were provided with a staff paper, "Toward a More Contemporary Public Understanding of the Teaching Hospital," which summarized the evolution of the teaching hospital, the characteristics which fundamentally distinguish teaching from non-teaching hospitals, and the diversity among those teaching hospitals. Following a brief oral summation of the paper, attendees were divided into four discussion groups to review the paper and discuss its implications for health planning, reimbursement, and national health insurance.

While the individual workshops were organized around these separate topics, the recommendations developed by three of the four workshops were very similar. Essentially each workshop concluded that the problems facing teaching hospitals in the future resulted from three factors: atypical service costs resulting from the complexity or intensity of care provided patients, atypical institutional costs resulting from educational program activities, and a wide variation in each of these costs among teaching hospitals. Because of the variation among teaching hospitals, each discussion group concluded methodologies were needed to quantify intensity and educational costs so that teaching hospitals could be classified into homogeneous groups or scaled into continuous distributions. Therefore, each discussion group recommended that the AAMC/COTH sponsor or conduct a study (or studies) to quantify the intensity of patient care and the costs of educational programs.

The recommendations from the COTH Spring Meeting were brought to the COTH Administrative Board at its June meeting. The Board took the position that the design of a case-mix study should be preceded by the development of a paper describing the state-of-the-art. In addition, the Board asked staff to prepare an annotated bibliography on educational costs in teaching hospitals. The Board proposed this approach to the AAMC Executive Council where it was adopted.

This paper is a preliminary report on the staff review of methodologies for calculating hospital case mix and their applications. The annotated bibliography is still being prepared. A preliminary report is being provided because the state-of-the-art assessment will take longer than originally planned. Based upon an initial literature review and a series of site visits with individuals active in case mix, this paper is organized in three sections. The first section describes the initial literature review and site visits, summarizes methods for measuring case mix, and briefly describes ongoing and planned applications. The second section outlines a proposed final report. The final section represents three recommendations for current AAMC policy.

INITIAL ACTIVITIES AND PRELIMINARY FINDINGS

While case mix is one of the more talked about hospital reimbursement concerns, case mix methodologies and applications are being actively pursued in a limited number of areas, primarily in the Northeast. In order to identify those currently involved in case mix efforts, relevant individuals at the Health Care Financing Administration, the National Center for Health Services Research, the

Blue Cross Association, and the Hospital Research and Education Trust of the American Hospital Association were contacted. In addition to their suggestions, three major health services publications (Health Services Research, Medical Care, and Inquiry) and the National Library of Medicine were searched for articles appropriate to the topic. Using these personal contacts and citations, a schedule of site visits, see Figure 1, was developed.[1] The list accents individuals in the Northeast because staff have found relatively little case mix activity in the Midwest, West, and South. Without exception, the individuals visited have been helpful and candid. They have been willing to objectively describe their activities; strategies for designing, implementing, or coping with case mix measures; and their personal observations and biases.

PRELIMINARY REVIEW OF CASE MIX MEASURES

In the 1960's, health service researchers trying to describe case mix differences focused their attention at the institutional level, and institutions were described in terms of the average length of patient stay; the presence of a medical school affiliation; the existence of residency training programs; the proportion of board-certified medical staff; and the provision of relatively rare, often expensive, clinical services. Within the past decade, there has been a major change in conceptualizing case mix. Contemporary researchers define case mix in patient-related variables: diagnosis, personal characteristics, and patterns of treatment. This change in focus from the institution to the patient has been stimulated and supported by utilization review and medical audit activities.

---

1. In addition, the COTH concern with case mix was discussed with Albert P. Williams, Ph.D., of the Rand Corporation during a recent visit to the AAMC.

FIGURE 1

CASE MIX SITE VISITS

Organization Visited	Persons Interviewed	Major Emphasis	Visit Status
Yale University	Robert Fetter, Ph.D. John Thompson Richard Averill	Case Mix Measures	Completed
Johns Hopkins University	Dale Schumacher, M.D. Susan Horn, Ph.D.	Case Mix Measures	Completed
Blue Cross-Blue Shield of Western Pennsylvania	Wanda Young, Sc.D.	Case Mix Measures Reimbursement Application	Completed
Systemetrics	To be identified	Case Mix Measures	Planned
Veterans Administration	Karl Eurenius, M.D.	Case Mix Measures	Completed
National Center for Health Services Research	Mark Hornbrook, Ph.D.	Case Mix Measures	Completed
University of Colorado	Roice Luke, Ph.D.	Case Mix Measures	Planned
Brandeis University	Stuart Altman, Ph.D.	Case Mix Measures	Planned
Health Care Financing Administration, HEW	Michael Fitzmaurice Julian Pittengill	Reimbursement Applications	Planned
New Jersey Health Department	Michael Kalison Leo Lichtig	Reimbursement Application	Completed
New York State -- Office of Health Systems Management	JoAnn Quan Shlomo Appel	Reimbursement Application	Completed

Figure 1 (cont.)

Organization Visited	Persons Interviewed	Major Emphasis	Visit Status
Maryland Health Services Cost Review Commission	Jack Cook, Sc.D.	Reimbursement Application	Completed
Jones Health Systems Management New York, New York	Tom Jones	Case Mix Data Processor	Completed
Georgia Department of Medical Assistance	Paul Bellows	Reimbursement Application	Planned
Wisconsin PSRO	To be determined	Case Mix Utilization Review	Planned
Illinois Hospital Association	Timothy Garton	Case Mix Management Information System	Completed
New Jersey Hospital Association	Dominick Camisi	Reimbursement Application	Planned
Hospital Association of New York State	John Bassett John Rossman	Reimbursement Application	Planned
Muhlenberg Hospital Plainfield, New Jersey	Edward Dailey	Reimbursement Application	Completed
Morristown Hospital Morristown, New Jersey	Donald Bradley James Carroll	Reimbursement Application	Planned
Cooper Medical Center Camden, New Jersey	Robert Evans, M.D. Gerald Moreland Dorothy Belding Angelo Angelides, M.D.	Reimbursement Application	Completed
New York Hospital	David D. Thompson, M.D.	Internal Management Reimbursement Application	Completed

Figure 1 (cont.)

Organization Visited	Persons Interviewed	Major Emphasis	Visit Status
Beth Israel Hospital Boston, Massachusetts	Mitchel Rabkin, M.D. David Dolins Howard Bleich, M.D. Warner Slack, M.D. John Melski, M.D. Dan Geer	Internal Management Information Reporting	Completed
Montefiore Hospital New York, New York	Irwin Birnbaum Alvin Goldberg	Reimbursement Application	Completed
Evanston Hospital	Martin Drebin	Hospital Information System	Completed

Staff have identified six major, patient-based approaches to measuring case mix:

- the diagnosis related groups (DRGs) developed several years ago at Yale University,
- the isocost groups presently being developed at Johns Hopkins University,
- the patient management algorithms being developed at Blue Cross-Blue Shield of Western Pennsylvania (Pittsburgh),
- the Disease Staging technique developed by Systemetrics,
- the multilevel care project of the Veterans Administration, and
- the Complexity Index developed at Johns Hopkins University.

This paper will summarize each method, and, because of its dominance in current case mix activities, describe the major strengths and weaknesses of the diagnosis related groups.

Diagnosis Related Groups (DRGs)

Diagnosis related groups were developed primarily at Yale-New Haven Hospital by health services researchers interested in defining expected lengths of patient stays so that utilization review activities could be focused on atypical patients. Using discharge abstracts, researchers found that the disease classification schemes used to code discharges had too many categories to produce statistically stable expected lengths of stay. Thus, their original research objective was to develop a procedure for aggregating similar diagnoses so that patients could be classified into fewer categories, with each category having more cases and with each category having a relatively low variation in the length of patient stays.

To accomplish their objective, Yale researchers initially collapsed diagnostic codes into 83 major diagnostic groups using the following criteria:

- major diagnostic categories must have consistency in terms of their anatomical, physio-pathological classification, or in the manner in which they are clinically managed;
- major diagnostic categories must have a sufficient number of patients; and
- major diagnostic categories must cover the complete range of codes without overlap.

When the lengths of stay for these 83 major diagnostic groups were examined, the frequency distributions for most groups were broad and not particularly helpful in specifying expected lengths of patient stays. Therefore, the next step was to divide each of the 83 groups if possible, into subgroups each of which had less variation in length of stay than its parent major diagnostic group. Using over one million patient records from Connecticut and New Jersey hospitals and six independent variables (primary diagnosis, secondary diagnosis, age, sex, primary treatment procedure, secondary treatment procedures), a computer program was used to subdivide the 83 major diagnostic groups. The statistical subdivision of a major diagnostic group was not accepted if it produced groupings the researchers judged to be medically uninterpretable and it was halted when one of the following conditions was met:

- the number of remaining cases was less than 100; or
- none of the variables reduced the unexplained variance by at least 1%.

When completed, the subdivision of the 83 major diagnostic groups yielded 383 terminal DRGs plus separate categories for patients lacking a primary diagnosis,

for deaths, and for patients having extremely long lengths of stay. For example, major diagnostic category #55, urinary calculus, was subdivided into four terminal DRGs on the basis of type of surgery and type of secondary diagnosis (see Figure 2). A more complete description of this grouping and subdividing procedure is presented in Appendix A and a complete list of the 83 major diagnostic groups and the 383 terminal DRGs is included as Appendix B of this paper.

While the DRG classification system was originally created for utilization review purposes, its creators (Robert Fetter, John Thompson, and Richard Averill) believe that the DRGs identify and describe the hospital's major products, and, they assert that it has much broader applicability. Within the hospital, they believe that DRG-based systems should be used for cost control, performance evaluation, and planning. Outside the hospital, they believe DRG's should be used for inter-hospital comparisons of costs, for determining hospital reimbursement categories and rates, and for evaluating service and facility proposals in health planning.

Most systems for categorizing patients into case mix groups are incomplete or still being developed. The DRG system, on the other hand, has been publically available for several years, is used in some applications, and has been considered for other applications. As a result, several advantages and disadvantages have been identified. The major and most cited advantages are: DRGs

- are conceptually appealing because they
  - --attempt to describe patterns of resource consumption in terms of the similarities among and differences between patients,
  - --are based upon patient diagnoses, and
  - --consider secondary diagnoses and surgical and medical procedures provided to the patient;

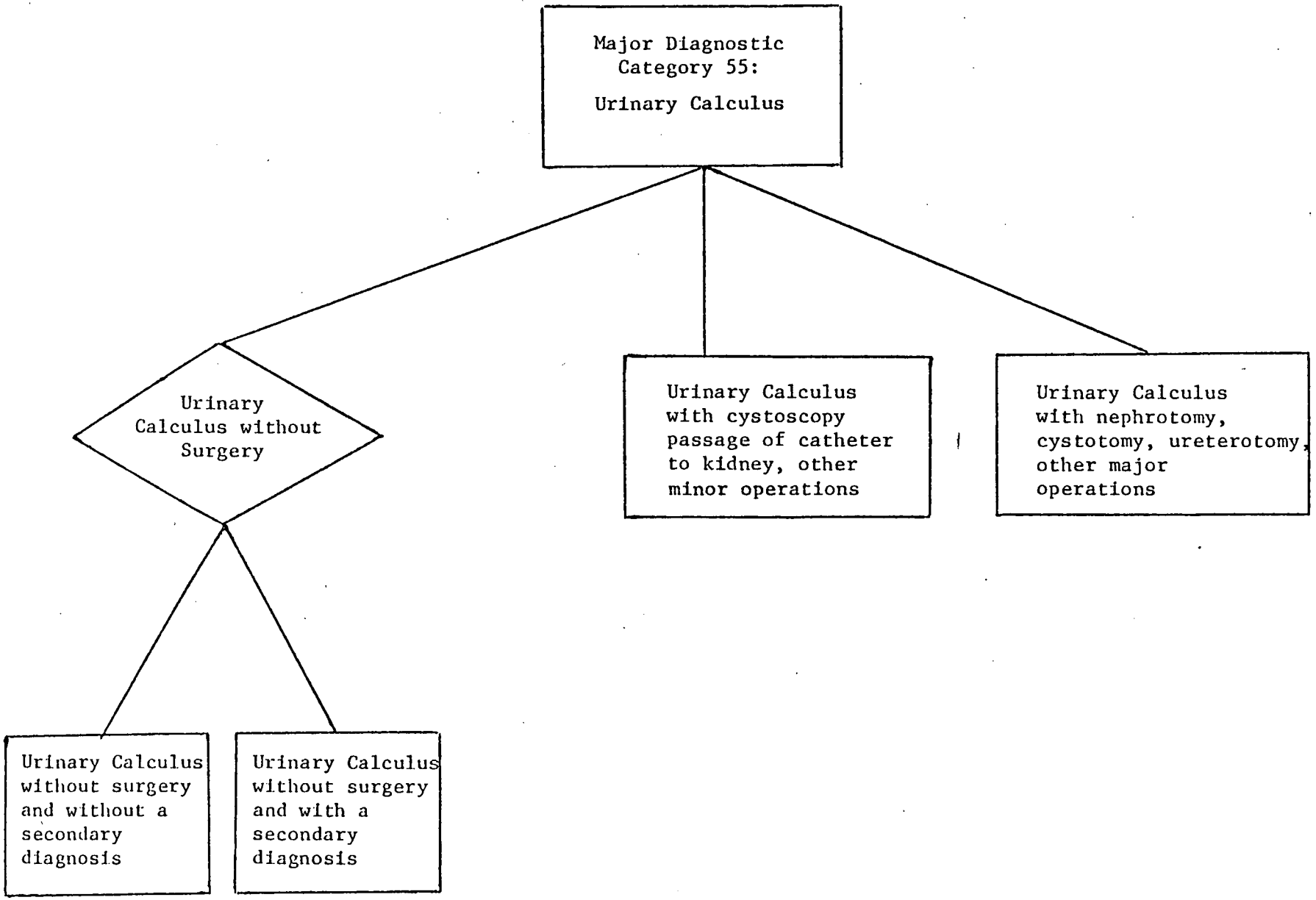


Figure 2
Tree Diagram Illustrating Partitioning of Urinary Calculus Patients

- result in a manageable number of diagnostic categories, 383;
- are organized in a hierarchical manner so that the terminal diagnostic groups can be collapsed into fewer categories which, while more heterogeneous, are still useful;
- can be easily created using any of the major diagnostic coding conventions, except ICD-9-CM.[2]

In addition:

- Some who have used DRGs for internal hospital management have been able to demonstrate that changes in hospital costs can be divided into the increased costs associated with a more complex case mix and increased costs for treating the same case mix.
- Some third-party payors have accepted DRG comparisons as the basis for obtaining case mix reimbursement exceptions.

The major <u>disadvantages</u> of the DRGs are:

- DRGs rely upon data on discharge abstracts which often include classification and coding errors, fail to include all diagnoses and procedures, and vary by the documentation of the attending physician and the conventions of the individual coder.
- DRGs reflect the state of medical technology and practice at the time of their development. To account for advances in diagnostic procedures and therapeutic modalities, the DRGs would have to be reformulated.
- The performance of a surgical procedure often categorizes a patient into a more complex DRG. If DRGs are used for reimbursement and if the reimbursement method reflects the complexity of the DRG, surgical procedures may be encouraged because they result in higher reimbursement.
- To create, evaluate, or redefine the DRGs, an extremely large data base is required.[3] In addition, if hospital cost or charge data is used as the dependent (i.e., resource consumption) variable, the data base is doubled because a discharge abstract and a hospital bill are required for each patient.

---

2. The Yale researchers have submitted a grant proposal to the Health Care Financing Administration to reformulate the DRGs using ICD-9-CM and using clinical advisors from the Commission on Professional and Hospital Activities (Ann Arbor).

3. The Blue Cross of Western Pennsylvania data base included 690,000 patient records. Even then, when grouped into the original DRGs, many DRGs had fewer than five patients.

- DRGs only group and classify inpatients.[4]

- DRGs group patients into categories asserted to be homogeneous on the basis of the historical consumption of patient days. Thus, DRGs are neither a standard of what should be done nor a measure of impact of the pattern of care upon the patient.

DRGs have been used internally by several hospitals, and they have been evaluated for and used in several reimbursement applications. As a result, several controversies surrounding the DRGs have been identified:

- While the DRG developers have asserted that the terminal DRGs group together patients who are logically similar from a medical viewpoint, some who have used DRGs argue

  --that the DRGs are not medically meaningful because they group together unrelated patients. For example, DRG 39 groups together all patients whose principal diagnosis is cancer of the bone, thyroid, connective tissue, and nerves and who did not recieve a surgical procedure.

  --that the DRGs are not medically meaningful because they fail to subdivide some broad diagnostic groups. For example, DRG 121 includes all patients whose principle diagnosis is acute myocardial infarction.

  --that the DRGs are not medically meaningful because they fail to recognize the standby capacity needed for high risk patients. For example, if a high risk pregnancy results in a normal delivery, the patient is classified as a normal delivery with no recognition of the special services required to be present in case the risk had materialized.

  --that the DRGs are not medically meaningful because they fail to differentiate patients in different stages of the same illness. For example, the DRGs group together in a single category lung cancer patients with a short diagnostic workup, a lengthy chemotherapy treatment, or a terminal admission.

- While the DRG developers have asserted that the terminal DRGs group together patients who use similar amounts of resources, some who have used DRGs argue

---

4. Yale researchers are presently in the preliminary stages of a project designed to develop DRG-like categories for ambulatory and emergency patients.

--that the length of stay is not an appropriate measure of resource consumption. An Illinois research project using DRGs has found there is no consistent relationship between the length of stay and the use of either routine or ancillary services.

--that the DRGs are not statistically meaningful when applied to populations other than that on which they were originally derived. In an analysis of 690,000 patient records in Western Pennsylvania, the statistical method used by Yale researchers to produce the 383 DRGs from Connecticut and New Jersey data did not produce identical terminal DRGs.

- While the independent variables used to subdivide the major diagnostic groups into the terminal DRGs included patient age and sex, many of those using DRGs have found

  --that the patient age needs to be given greater emphasis in formulating diagnostic groups. In one major Maryland teaching hospital, Medicare patients generally consumed 15% more resources than non-Medicare patients for the same DRG. In New York City, one teaching hospital found its over-65 patients stayed approximately fifty percent longer than its under-65 patients in the same DRG. The Director of the New Jersey reimbursement experiment has directed that approximately 50 of the 383 DRG be re-evaluated to establish age-related DRGs.

  --that the patient's socioeconomic status should be included in the formulation of diagnostic groups, and

  --that the type of patient admission (i.e., emergency, urgent, elective) should be included in the formulation of the diagnostic groups.

- Some who have attempted to use the DRGs for internal management of the hospital's clinical activities find:

  --the DRGs with large number of cases are for relatively routine patient services (e.g., hernia repairs, T and A's) for which physicians have highly similar practice patterns,

  --the DRGs with substantial differences in physician practice patterns often have less than five cases in a given year and it is difficult to make comparative or evaluative judgment with such small numbers. At one hospital with approximately 16,000 admissions in 1977, only twenty of the terminal DRG's had at least thirty cases.

Given their strengths and in spite of their weaknesses and controversies, DRGs have been used in several applications. These are described beginning on page 19 of this report.

Isocost Groups

The DRGs developed at Yale have been used in Maryland by PSRO's and the State's Cost Review Commission. In using the DRGs, many of the disadvantages previously discussed have been identified and researchers at Johns Hopkins University -- Dale Schumacher, M.D., and Susan Horn, Ph.D. -- have sought to develop a modification of the DRGs. Their approach involves two key differences: the dependent variable is total cost per case, rather than length of stay, and the grouping and subdividing is being done by panels of board-certified specialists.

To conduct a pilot test of this approach, three major disease areas were selected: malignancy of the gastrointestinal tract, cardiology conditions, and pulmonary conditions. A separate physician panel was selected for each of the three specialty areas and panelists initially were asked to review the original Yale major diagnostic categories in their specialty. Each of the panels rejected the Yale major diagnostic groups and formulated new diagnostic groups (see Figure 3). Within the new major diagnostic groups, panelists are being asked to establish patient and disease characteristics which subdivide the diagnostic group into categories having small variations in the expected cost per case.

The isocost grouping procedure is still in its infancy. Additional research funds are presently being sought to establish panels beyond the original three. When more of the isocost groups have been established, the isocost groups will be compared with the DRGs to determine which of the approaches is the better way to categorize patients diagnostically.

FIGURE 3

SOME MAJOR CATEGORIES USED IN THE DRG AND ISOCOST COST SYSTMES FOR CASE MIX

Specialty Panel	Yale DRG Categories No.	Description	Hopkins Isocost Categories
GI malignancy	02	Malignant Neoplasm of Digestive System	1) Head and Neck G. I. Tract Malignancy 2) Stomach, Bowel and Rectum Malignancy 3) Pancreas, Liver and Biliary Tract Malignancy
Cardiology	25	Hypertensive Heart Disease	1) Acute Myocardial Infarction
	26	Acute Myocardial Infarction	2) Chest Pain and Ischemic Heart Disease (except AMI)
	27	Ischemic Heart Disease except AMI	3) Hypertension
	28	Arrythmia and Slowed Conduction	4) Heart Failure
	29	Heart Failure	5) Valvular Disease
	30	Carditis, Valvular, and other Diseases	6) Carditis
Pulmonary	01	Infectious Diseases (Pulmonary)	1) Pulmonary Embolism
	03	Malignant Neoplasm of Respiratory System	2) Chronic Obstructive Lung Disease
	33	Pulmonary Embolism	3) Lung Malignancy
	37	Acute URI and Influenza	4) Pulmonary Infections
	38	Other Diseases of Upper Respiratory Tract	5) Asthma
	39	Pneumonia	6) Other pulmonary
	40	Bronchitis	
	41	Asthma	
	42	Other Lung and Pleural Diseases	

Patient Management Algorithms

The patient management algorithm, being directed by Wanda Young, Sc.D., of the Blue Cross/Blue Shield Plan of Western Pennsylvania, is a third approach to measure case mix. It differs from the Yale DRGs and the isocost groups by its emphasis on the "admissions state" of the patient. It is a three-step approach to measure case mix: (1) it groups together patients who present similar symptoms at the time of admission; (2) it identifies the diagnostic and treatment services provided to each "admissions state" group (i.e., the algorithm); and (3) it establishes "costliness weights" for each "admissions state" group using the costs of the diagnostic and treatment algorithm. Because this admission-focused approach could lead to a large number of categories, the researchers have limited themselves to "typical admission states" and to "typical" patterns of diagnosis and treatment for these states. The information and judgments used to identify typical admission states and typical management algorithms are being developed using a large data base of medical records and physician advisory panels composed of full-time hospital physicians and senior residents.

The patient management algorithm is still in its infancy with none of the algorithms having yet been completed. If the project is successful in identifying the algorithms and establishing costliness weights, hospitals would be described and categorized in terms of the relative costliness of their mix of patients.

Disease Staging

Disease staging is a method of grouping diagnostic classifications to identify major disease categories and their stages of severity. As presently

developed, a panel of physicians has identified major disease categories[5] and established stages for each disease as follows:

Stage I -- disease with no complications or with problems of minimum severity;

Stage II -- disease with local complications or problems of moderate severity; and

Stage III -- disease with symptomatic complications or problems of a severe nature.[6]

In the approach, each patient is classified according to the most advanced stage of his primary diagnosis. As envisioned by its developers, disease staging could be used to quantify case mix: (1) by identifying the tests and procedures generally deemed essential for the treatment of every stage of each disease and (2) by establishing standard costs for each essential test/procedure. Such an approach would establish a value indexing the relative weight of each stage of each disease.

VA Multi Level Care Project

The VA Multi Level Care Project, directed by Karl Eurenius, M.D., is modeled after the progressive patient care concept developed in several community and teaching hospitals in the mid-1960's. Under the project, which is presently in an experimental field test, patients admitted to VA hospitals are assigned to one of five levels of medical/surgical care:

---

5. The composition of these physician panels and their methods for selecting major diagnostic categories will be determined during a site visit with the developers of disease staging.

6. For example, for diverticulitis, stage one is limited to "diverticulitis without any complications;" stage two is "diverticulitis with perforation leading to peritonitis or abscess in peritoneum;" and stage three is "diverticulitis leading to peritonitis and/or abscess in peritoneum plus systemic problems such as shock or bacteremia causing metastatic infection in other organs."

- Intensive Care,
- Acute I Care,
- Acute II Care,
- Extended hospital care, and
- Minimal care.

The assignment, which is re-evaluated at regular intervals during a patient's stay, is based on several subjective evaluations of the patient's needs and on an estimate of the hours of nursing care required. If successful, the project will describe each VA hospital in terms of the number of patient days in each category and, using a to-be-developed budgeting and accounting system, hospital costs will be assigned and allocated to each of the five classes of patients. As a result, the VA will have an estimate of the relative costliness of its major types of medical and surgical care. While this approach may be a substantial improvement for VA institutions which have had global budgeting, it is too elementary a description of case mix for the questions presently being addressed to non-Federal hospitals.

Complexity Index

The final case mix measure, the complexity index developed at Johns Hopkins University, is an institutional measure of case mix. It is " . . . based on the assumption that relatively rare or complex cases will be concentrated in a few specialized institutions while common or less complex conditions

will be distributed more evenly . . ."[7] To compute the complexity index, data on all patients for every hospital being compared must be analyzed using a two-step procedure. In step one, each patient is categorized according to case characteristics[8] and each hospital is described according to the proportion of its patients in each case type. In the second step, a mathematical formula is used to compare the hospitals by the proportion of their patients in each case type. The result of the formula is a numerical index in which the more complex hospitals have higher scores.[9] Significantly, the index number provides no information on actual or estimated cost of treating a given mix of patients. Thus, unless further work establishes a relationship between the index and a measure of hospital cost, this approach appears to be more useful to those doing statistical analysis than to those interested in new or revised reimbursement approaches.

PRELIMINARY REVIEW OF REIMBURSEMENT APPLICATIONS

Hospital payment systems which are based upon or use case mix measures are a development of the last three years. Prior to that time, third party payors, principally Medicaid agencies and Blue Cross plans, established payment

---

7. Susan Horn and Dale Schumacher, "An Analysis of Case Mix Complexity Using Information Theory and Diagnostic Related Grouping," Medical Care, XVII (April, 1979), p. 383.

8. In an application of the method to Maryland hospitals, a collapsed version of the Yale DRGs with 272 case categories was used to classify cases.

9. In an application using all Maryland hospitals, the index for small, rural hospitals was 0.67 to 0.88, for Baltimore community teaching hospitals it was 0.93 to 1.11 and for Baltimore university hospitals it was 1.21 and 1.37.

limitations and budget screens using cross-classification schemes which attempted to establish relatively homogeneous groups of hospitals. While the payors had concerns about this approach, hospitals were the major force pushing for the addition of case mix to the payment methodology. This push developed from two distinct viewpoints: (1) hospitals with high costs believed the addition of case mix would demonstrate the reasonableness of their costs, and (2) hospitals with low costs believed the addition of case mix would demonstrate their efficiency. Payors have usually responded to the hospitals' interest by developing case mix experiments or demonstration projects, most of which have been funded by HEW's Health Care Financing Administration. This section of the preliminary report will review the case mix reimbursement applications underway in Maryland and New Jersey and briefly summarize pending applications in the Medicare program and in New York and Georgia.

Maryland: The Guaranteed Inpatient Revenue System

In 1971, the State of Maryland established the Health Services Cost Review Commission (HSCRC) to review, evaluate, and approve the rates charged for hospital services. In its brief history, the HSCRC has reviewed the budgets of all Maryland hospitals, established approved revenues for all hospitals, imposed uniform financial and discharge abstract reporting, and tried several different approaches to determining allowable hospital revenues. The Guaranteed Inpatient Revenue system, a prospective payment system recognizing changes in case mix, was introduced in 1976; today it is being used in several different forms in

fourteen Maryland hospitals.[10] The essential steps of the GIR system may be summarized, in an oversimplified manner, as follows:

- the Rate Commission and the hospital select a base period during which the hospital operated with Commission approved revenues;
- the hospital arrays its live discharges by diagnostic group and principal source of payment[11];
- for each discharge-payor category, the average hospital charges per admission are computed;
- the Commission establishes an inflation factor which is used to convert average per admission charges, by diagnostic group and payor, from the base period into GIR target charges for the payment year;
- the hospital's actual revenues, by diagnosis and payor, are compared with the GIR target charges. Because this comparison is done by diagnostic category and principal source of payment, the hospital's GIR target revenue reflects both changes in the diagnostic mix and changes in the mix of payors.
- If the hospital's actual revenues are less than the GIR target revenues, the hospital may include 50% of the difference in its future allowable revenues and this additional revenue, when collected, may be spent as discretionary income. If, on the other hand, the hospital's actual revenues are greater than its GIR target revenues, the hospital will have to subtract a portion of the difference from its approved rates.

In the fourteen hospitals presently under the GIR system, several variations of this general approach are used: some hospitals use the Yale DRGs for case mix, others use the ICDA codes; some hospitals use their own per admission charges for the base period, others are required by the Commission to use the per admission charges of another hospital.

---

10. COTH members participating in the GIR system are Johns Hopkins Hospital, Sinai Hospital of Baltimore, Union Memorial Hospital, and Prince George's General Hospital.

11. Principal payment sources are Medicare, Medicaid, Blue Cross, and all other.

Given its recent implementation, no comprehensive evaluation of the Guaranteed Inpatient Revenue System has been conducted. At the same time, HSCRC staff and several Maryland hospitals continue to accept and use the system. In interpreting this acceptance, however, it must be remembered that Maryland is a small state with only fifty hospitals, the Commission staff have evaluated each hospital's revenues and operations and understand the hospitals they control, and the state hospital association and hospital executives generally have a favorable view of the competence and objectivity of the Commission staff. If these factors were absent, the GIR system, despite its clear recognition of the financial impact of changes in case mix, might be opposed rather than accepted.

New Jersey's Case-Mix Experiment

The Maryland case mix system is unique -- the hospitals and the Commission have established a contract by which both sides must abide. In New Jersey, the case-mix system remains an experiment, and hospitals in the experiment must, at the end of their 1979 fiscal year, choose between the rates and revenues allowed under the case mix system and those presently available under the State's budget review system. If the State completes regulations mandating the case mix system, this choice will not be available next year. Nevertheless, the experimental nature of this year's activities has influenced the views of all those participating.

As developed for the experiment, the New Jersey case mix system has the following essential characteristics:

- from the State's short-term general hospitals, a sample of hospitals was selected and each was asked to participate in the experiment. Eventually, twenty-two hospitals operating twenty-three facilities agreed to participate.[12]

- each participating hospital was required to submit a discharge abstract for each patient, a copy of each patient's inpatient hospital bill, and a standard hospital financial report to the State Health Department.

- the State Health Department divided each hospital's costs into a case mix related set of costs and a set of costs not related to changes in case mix. (A detailed description of this process is included as Appendix C). Using these two sets of costs and each patient's bill to identify the specific services used, the case mix costs and the fixed costs were computed for each discharge.

- hospitals and their patients were divided into two groups: teaching hospital discharges and community hospital discharges.

- within each group of hospitals, patients were categorized by the Yale DRGs into 383 categories, and the average hospital cost per DRG was determined for case mix related costs.

- prospective DRG payment rates for each hospital were established using a combination of the hospital's own cost for treating that DRG and the average teaching or community hospital's cost for treating that DRG. The proportions used to form the combination depended upon the observed variation, across hospitals, in the costs of treating that DRG.

  --If hospitals varied significantly in the costs of producing a DRG, relatively more of the individual hospital's costs were included in determining its perspective rate.

  --If hospitals produced the DRG at relatively similar costs, relatively more of the average cost was used in each hospital's prospective rate.

---

12. Six COTH members are participating: Cooper Medical Center, Camden; Monmouth Medical Center, Long Branch; Morristown Memorial Hospital; Newark Beth Israel Medical Center; Overlook Hospital, Summit; and St. Michael's Medical Center, Newark.

- A hospital's allowable revenue is determined by adding: (1) the product of the number of discharges in a DRG and the DRG-related perspective rate, (2) the hospital's actual costs for deaths and for treating patients with unusually long lengths of stay in a DRG, and (3) the hospital's approved budget for costs determined not to vary with changes in case mix.

The New Jersey experiment, which the State hopes will become operational with twenty-six hospitals on January 1, 1980, has been controversial. The hospital concerns seem to focus in several specific areas:

- hospitals are concerned that the DRGs are being accepted as "the only case mix measure available" despite the disadvantages and controversies described in the previous section of this report.

- urban and teaching hospitals are especially concerned that the DRGs make no allowance for the socioeconomic status of the patient or his stage of illness. There is a fear that DRG reimbursement without these factors will lead to patient dumping by community and suburban hospitals;

- the state agency has repeatedly revised statistical procedures so that the prospective rates are constantly changing;

- by selecting the average hospital's cost of producing a DRG, some hospitals, by definition, always exceed the standard and the approach is perceived as punative;

- the data processing procedures used by the state do not permit hospitals to audit or reconcile either patient discharge or hospital financial data; and

- the data processing procedure involves long time lags between data input and returned reports. Some hospitals feel this lag prevents the hospital from using the system in the management of clinical activities.

In addition, some hospitals have concluded that the state's primary interest is a reduction in hospital payments rather than a more equitable payment system. This perception leads the hospitals to be suspect of and question each change in the experiment proposed by the state.

As an experiment funded by the Health Care Financing Administration, the New Jersey experiment will be subject to an evaluation study considering its design, implementation, and impact. At least one evaluation proposal has been submitted, although the status of its technical review and funding are unknown.

The Medicare Program

In 1972, Congress passed Medicare amendments, P.L. 92-603, allowing Medicare to establish limitations on the allowable hospital costs it would recognize for care provided to Medicare beneficiaries. To date, Medicare has used this authority only to establish per diem limitations on routine inpatient service costs using "peer" groups of hospitals to determine the limitation. In using a limitation methodology which assumes all hospitals within a given bed size range are comparable, Medicare has been repeatedly criticized for its failure to recognize and adjust for differences in hospital case mix.

In establishing payment limitations for cost reporting periods beginning on or after July 1, 1980, Medicare authorities are actively working to add a case mix feature to their system. Their efforts remain in an early stage of development with present efforts devoted to the development of the necessary data; however, they hope to adopt an approach consistent with the following five step outline:

(1) hospitals would be grouped into comparison categories using the hospital's bed size and its rural-urban location;

(2) for each hospital in a category, the average per admission costs[13]

13. At this time, it is not known whether fixed costs such as capital-related costs or highly variable costs such as medical education costs will be included or excluded from the average per admission cost.

for Medicare beneficiaries would be determined and adjusted by an index to reflect the hospital's economic environment;

(3) a statistical threshold would be selected and used to identify the reimbursement limitation or ceiling for each group of hospitals.

In applying the group limitation to the individual hospital, the hospital would multiply its group limitation by a case mix index created by HEW as follows:

(4) For each hospital:

(4a) determine the percentage of the hospital's patients in each of the Yale DRGs using a 20% sample of Medicare hospital discharges, and

(4b) determine the average cost for all sampled cases and the average cost for each DRG by applying the hospital's 1978 ratio of cost to charges to the charges shown for each sampled patient.

(5) With the data from steps 4a and 4b for each hospital, the case mix index for each hospital in a bed size group would be created by:

(5a) establishing a "383 by N" matrix where the columns are the 383 DRG's, the rows are the individual hospitals in the bed size group, the tabular entries are the percentage of a hospital's cases in each DRG, and the column totals are the mean costs of producing a DRG across all hospitals; (see example in Figure 4);

(5b) computing the row totals as the DRG weighted mean cost per case as the product of (1) the percentage of the hospital's cases in each DRG, the tabular entries, and (2) the average costs across hospitals of treating each DRG, the column totals, (see example in Figure 4), and

FIGURE 4

EXAMPLE OF HCFA HOSPITAL CASE MIX INDEX

Hosp.	Total	Percentage of Admissions in Each of Nine DRGs* 1	2	3	4	5	6	7	8	9-383	DRG Weighted Mean Cost/ Case **	Case-Mix Index ***
A	100	1.3	.5	6.8	4.6	13.1	6.8	6.8	12.7	47.4	$1434.56	1.21
B	100	1.2	1.9	7.5	2.9	11.8	22.1	20.3	4.7	27.6	$1118.25	.94
C	100	.7	0	20.0	14.3	2.8	30.7	6.4	6.4	18.6	$983.11	.83
D	100	.6	2.8	8.9	5.0	25.6	20.6	2.5	1.6	32.4	$1139.01	.96
E	100	2.6	.3	4.2	4.2	12.9	13.5	1.3	2.9	58.1	$1385.03	1.17
F	100	5.2	.7	12.0	19.1	13.5	21.7	.4	3.0	24.4	$1034.57	.87
Average Cost per DRG's across all hospitals		909	291	690	662	1114	634	892	2191	1720	1182.42	

* Adjusted to make these 9 DRGs hypothetically represent all 383 DRGs.

** For hospital A, $1434.56 = (.013) (909) + (.005) (291) + (.068) (690) + ... + (.474) (1720)

*** For hospital A, 1.21 = $1434.56 divided by $1182.42

(5c) computing the case mix index for the hospital by dividing each hospital's DRG weighted mean cost per case by the grand total DRG weight cost per case, (see example in Figure 4).

To date, HCFA has not finished gathering the data necessary to create the case-mix index developed in steps (4a) - (5c). In public statements, they have said they hope to finish the data base in September so that analyses and evaluation can take place in October and November. By December, they hope to be making the decision to accept or postpone the per admission case-mix approach.

This HCFA approach to adjusting reimbursement ceilings for case mix raises several questions:

- Is HCFA willing to accept the DRGs as an appropriate and unbiased case mix measure in spite of the disadvantages and controversies listed on pages 11 - 13?
- Are the DRGs created using length of stay data for Connecticut and New Jersey hospitals appropriate categories when applied only to elderly patients?
- Are the diagnostic and procedural codes shown on hospital claim forms sufficiently accurate to classify Medicare patients by DRG?
- Will using a hospital-wide cost-to-charge ratio to estimate per case costs produce unbiased estimates of the costs of each DRG, especially if fixed costs are not removed?
- Will the 20% sample of Medicare patients provide an unbiased estimate of the DRG distribution of all Medicare patients?
- Will the 20% sample of Medicare patients provide an unbiased estimate of the DRG costs of treating all Medicare patients?
- Can the hospital's 1978 Medicare case mix accurately describe the hospital's current Medicare patients?
- Does the hospital's relative costs per 1978 DRG accurately describe its present relative costs per DRG?

To date, HCFA has neither publically addressed these questions nor publically established the criteria it will use to answer them. Given the proposed magnitude of the change, the questions, and criteria used to respond to them, should be answered.

New York State Case Mix Study

In 1978, the New York State Office of Health System Management began a major DRG based study. The study is designed to:

- evaluate DRGs as a methodology for measuring case mix,
- develop methods for relating the costs of hospital operations to the DRG mix of the hospital, and
- investigate the feasibility of using DRG case mix measures and standardized cost reporting to begin reimbursing hospitals on a prospective payment basis with the rates either set by DRG or adjusted by the hospital's overall DRG complexity.

The New York project is organized into four major phases, two of which have been completed.[14]

In Phase I, five New York City teaching hospitals[15] were studied. Each hospital provided the study with discharge abstracts and a detailed bill for each 1977 patient and with supplementary hospital financial reports. Using these materials, each patient was assigned to a DRG and each patient's care was costed out by (1) allocating nursing costs using a nursing intensity measure, (2) allocating dietary costs using a dietary weighting scale, (3)

---

14. A more complete description is provided in Appendix D.

15. All are COTH members: Montefiore Medical Center, Mt. Sinai Medical Center, New York Hospital, St. Luke's Hospital, and St. Vincent's of New York.

allocating the remaining routine costs on a per diem basis, and (4) allocating ancillary costs by applying the hospital's ratio of cost to charges to the patient's gross ancillary charges. In Phase II, additional financial data on 35 cost centers were obtained for the five teaching hospitals and a more detailed matrix method for allocating costs to individual DRGs was created. In the ongoing third Phase, discharge and financial data from 41 hospitals across the state[16] are being collected and DRG specific costs are being developed using the methodology developed in Phase II. When these DRG costs are created, the findings will be examined by hospital type, hospital size, teaching status, and source of payment. In the final phase, reimbursement, planning, and internal management applications will be developed using the data from Phase III.

At the present time, some New York State officials hope to use case mix payment rates as early as 1980. There is, however, a difference of opinion within the state: some officials would like to use a DRG-based intensity index with "peer" groups of hospitals to individualize payment and revenue rates; other officials would like to establish prospective payment rates by DRG rather than by hospital. It is unclear which view will prevail and unlikely that a decision will be made before the Phase III analysis is completed.

---

16. COTH members included in Phase III are: Albany Medical Center, Beth Israel Medical Center, New York City; Long Island Jewish Medical Center; Mary Imogene Bassett Hospital, Cooperstown; Millard Fillmore Hospital, Buffalo; Montefiore Hospital and Medical Center; Mt. Sinai Hospital; Nassau Hospital, Mincola; New York Hospital; St. Luke's Hospital, New York City; and St. Vincent's Hospital, New York City.

The Georgia Medicaid Experiment

Using a grant from the Health Care Financing Administration, the Georgia Department of Medical Assistance is conducting an experiment to develop and evaluate a case mix reimbursement system for state Medicaid patients. While AAMC staff have not made a site visit to Georgia yet, the HCFA grant manager summarized the project as an attempt to use patient discharge data to establish groups of comparable hospitals in order to set reimbursement targets which would make incentive payments to those below the targets and impose penalties on those above. It is understood that the Yale DRGs are being used as one hospital classification variable. It is also understood that the Georgia researchers have concluded that the DRG variable must use all hospital patients rather than only Medicare and Medicaid patients to appropriately classify hosptials.

Summary

This section has reviewed case mix reimbursement applications that are presently underway or in experimental stages. It is clear from this review that the availability of the Yale Diagnosis Related Groups has led to their adoption in each of the reimbursement applications. It is also clear, from staff site visits, that many hospitals are suspicious of the DRGs and regard them as not validated for reimbursement purposes. Some state and federal officials share this concern but most defend the DRGs' use for two reasons: (1) in spite of some practical shortcomings in the DRGs, their general conceptual approach is appealing; (2) hospitals have pushed payors to use case mix and the DRG is the only case mix measure available. The hospital concern about the validity

of the DRGs is seen by some state and federal officials as a red herring. These officials believe that hospitals now realize that case-mix payment systems will create winners and losers, and that hospitals will not endorse DRGs until they either learn how the system will impact upon them or until they learn to manipulate the system. Thus, in many areas, the move toward case mix reimbursement is taking place with the hospitals believing the payor is accepting case mix to provide "academic respectability" to a method for reducing hospital payments and with the paying agencies believing hospitals are more interested in the number of dollars received than in the equity of the payment system.

OUTLINE OF PROPOSED REPORT

This is a preliminary report. It is based primarily on a series of site visits and only secondarily on published literature and the evaluation of empirical data. Given the long-term importance of case mix measures, more attention needs to be given to the literature and available empirical data. Additional attention should also be given to developing criteria for case mix measures and for reimbursement and planning applications and to determining or anticipating the second-order policy consequences of adopting case mix reimbursement and planning systems. Staff believe a more detailed and complete assessment of case mix should be prepared for the January meeting of the Executive Council using the following outline:

I. Statement of AAMC member interest in case mix

II. Specification and selection of criteria for

A. Case mix measures

B. Case mix applications

III. State of the art/research in progress

A. Case mix measures

B. Case mix applications

IV. Policy implications of case mix

A. Payor and regulatory implications

B. Hospital implications

C. Medical school implications

V. Recommendations for AAMC actions

A. Case mix measures and applications to be monitored

B. Case mix research to be sponsored or supported, if any

RECOMMENDATIONS

Having completed only a preliminary review of case mix measures and their applications, staff are not in a position to present a complete set of recommendations at this time. Nevertheless, it appears that the failure to include case mix differences in establishing hospital payment formulas has disadvantaged tertiary care hospitals caring for the most seriously ill patients, and it is clear that federal and state officials are interested in experimenting with and implementing payment approach which provide recognition of case mix measures. Therefore, at this time, staff recommend that the AAMC Executive Council:

- support private, state and federal efforts to develop and evaluate case mix measures designed to classify patients according to the severity of their condition and the resources required to care for them,

- support private, state and federal efforts to alter hospital payment procedures to provide explicit recognition of the medical intensity or severity of the patients provided that the approach used has previously been shown to establish a direct relationship between the case mix measure and the cost of caring for the patient,

- direct staff to send a letter to the Administrator of the Health Care Financing Administration summarizing AAMC concerns about the Yale DRG's and about the proposed case-mix methodology HCFA plans to use to establish Medicare limitations.

APPENDIX A

THE METHOD FOR CREATING

DIAGNOSIS RELATED GROUPS

Source: R. B. Fetter et al. "Case Mix Definition by Diagnosis Related Groups," Working Paper Series B-Technical

An Example

The iterative partitioning process used in forming the DRGs can best be illustrated in the context of an example - the classification of Major Diagnostic Category 55: Urinary Calculus. This category contains patients with a primary diagnosis (ICDA8 codes) of either:

592 Calculus of kidney and ureter
594 Calculus of other parts of the urinary system

The formation of the DRGs from this Major Diagnostic Category is summarized in the tree diagram presented in Figure 2. First, this category is partitioned into three groups based on the variable primary surgical procedure. The first group contains nonsurgical patients, which are those with either no operation or with a procedure code (ICDA8) outside the range 010-999, A10-A59.* The second and third groups are formed on the basis of the specific procedure performed. In particular, the more complicated procedures performed on patients with a urinary calculus - nephrotomy, ureterotomy, cystotomy - are in the third group, while relatively minor procedures associated with this diagnosis - cystoscopy, passage of catheter to kidney - are contained in the second. The nonsurgical group is partitioned further into two groups based on the presence or absence of a secondary diagnosis. In summary, the classification process resulted in the formation of four terminal groups or DRGs 239-242 from the Major Diagnostic Category Urinary Calculus:

---

*Operations coded outside these ranges are not considered actual surgical procedures since they represent minor procedures or therapies.

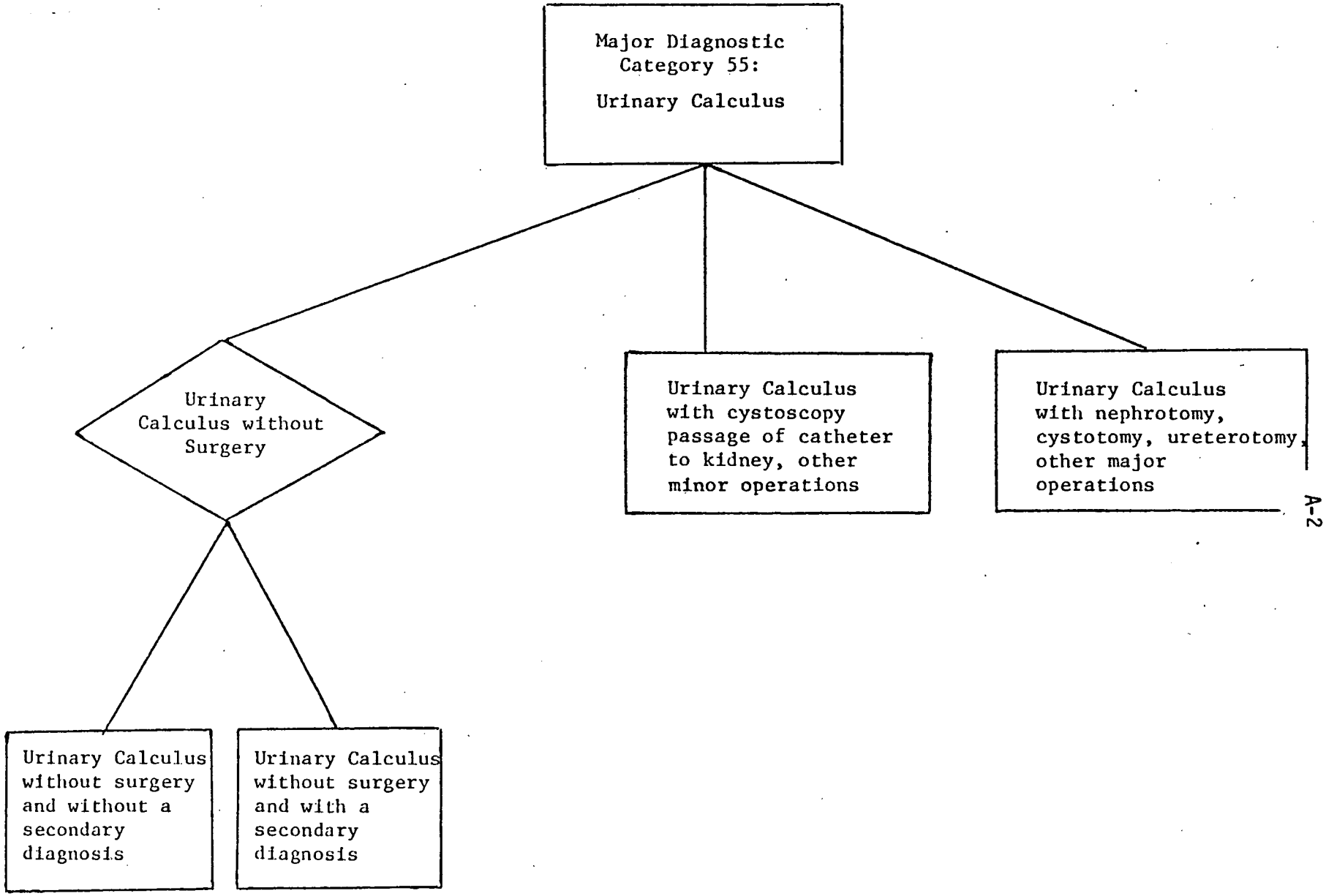


Figure 2
Tree Diagram Illustrating Partitioning of Urinary Calculus Patients

239 Urinary calculus without surgery, and without a secondary diagnosis

240 Urinary calculus without surgery and with a secondary diagnosis

241 Urinary calculus with cystoscopy, passage of catheter to kidney, other operations

242 Urinary calculus with nephrotomy, cystotomy, ureterotomy, other major operations

A descriptive statistical summary of data coded in ICDA8 from the original database used to construct the DRGs, is presented in Figure 3. The entire Major Diagnostic Category contains 1425 observations, with a mean length of stay of 6.93 and a standard deviation of 6.44. The variables used in partitioning this group, primary surgery and secondary diagnosis, explain 42.93% of the total variance with 41.75% attributed to the former and 1.17% to the latter.

The actual process of forming these DRGs from the Major Diagnostic Category Urinary Calculus is summarized in the following steps:

STEP 1: Fifteen records were eliminated: three with a discharge status of death, ten with invalid surgical or diagnosis codes, and two with lengths of stay greater than 60 days. This reduced the size of the category from 1440 to 1425 observations.

STEP 2: The algorithm was invoked on this refined data set to determine the basis for an initial split. The independent variables selected to define potential subgroups were primary surgical procedure (oper1), secondary surgical procedure (oper2), primary diagnosis (dx1), secondary diagnosis (dx2), age, and sex.

The number of groups formed by the algorithm and the corresponding percent reduction in unexplained variation for each of the variables were as follows:

Variable	Number of Groups	Percent Reduction
oper1	3	41.89%
oper2	4	21.37%
dx1	1	0.0 %
dx2	5	30.11%
age	3	8.19%
sex	2	1.63%

Major Diagnostic Category 55: Urinary Calculus

Size= 1425 Mean= 6.93 Standard Deviation = 6.44

Independent Variables		Partial Variance Explained	Drg #	Size	Mean	Standard Deviation
Primary Surgery:		41.75				
None	Secondary Diagnosis	1.17				
	None		239	449	3.28	2.88
	One or More		240	262	5.32	5.01
Minor			241	428	6.36	4.30
Major			242	286	14.99	7.37

Total Variation Explained = 42.93

Figure 3

Descriptive Statistics for the Partitioning of Urinary Calculus

Since the greatest reduction in unexplained variation was achieved with oper1, and a limited number of groups (3) this variable was considered the prime candidate for initial subdivision of the category. The algorithm suggested three groups whose contents are described in Figure 4. This figure presents the different surgical procedures contained in each group (INDEP VAR), the corresponding number of observations (SIZE), and the mean length of stay (MEAN). Note that over 98% of the observations in the first group have no surgical procedure listed. The second group primarily contains observations with relatively minor procedures such as cystoscopy and urethroscopy (A46) and passage of catheter to kidney (557), while the third group includes somewhat more complex procedures as ureterotomy (550), cystotomy (560), and pyelotomy (541).

On the basis of these results, it was decided to divide the initial group of Urinary Calculus patients into three groups, similar to those suggested by the algorithm. Namely a group of nonsurgical patients, a group with relatively major procedures as those listed under group 3 in Figure 4, and finally a group of all other procedures which includes cases with minor procedures such as those listed under groups 1 and 2 , and biopsy of urinary tract (A21) in group 3. While this latter group represents all other surgeries not explicitly listed under group 3, it is primarily represented by the two procedures cystoscopy and urethroscopy (A46) and passage of catheter to kidney (557).

STEP 3: Each of the groups formed in Step 2 was then considered for further subdivision. First of all, with respect to the nonsurgical patients, the number of groups formed by the algorithm and the corresponding percent reduction in unexplained variation for each of the variables (except oper1 and oper2) were as follows:

Variable	Number of Groups	Percent Reduction
dx1	1	0.0%
dx2	4	22.66%
age	4	14.18%
sex	1	0.0 %

A closer examination was made of the characteristics of the four groups formed using the variable secondary diagnosis (dx2), since it exhibited the greatest percent reduction in unexplained variation. The descriptive statistics for each of the groups are summarized below:

Group 1

SIZE	MEAN	INDEP VAR	
1	2.00	749	Other antepartum procedures to terminate pregnancy
1	2.00	571	Meatotomy
1	2.00	277	Venous anastomosis, intra-abdominal
1	2.00	249	Other operations on peripheral vessels
1	3.00	430	Incision of bile (hepatio) ducts
1	3.00	862	Arthrocentesis
1	3.00	601	Vasectomy
1	3.00	921	Local excision of lesion of skin and subcutaneous tissue
23	3.28	000	No code
688	4.08		No code
1	5.00	551	Ureterectomy

Group 2

SIZE	MEAN	INDEP VAR	
2	5.50	574	Repair and plastic operations on urethra
7	5.71	559	Other operations on ureter
218	6.25	A46	Cystoscopy and urethroscopy without effect upon tissue
5	6.40	A45	Endoscopy of colon and rectum without effect upon tissue
15	6.40	568	Removal of calculus and drainage of bladder without inc
2	6.50	572	Excision or destruction of lesion of urethra
146	6.59	557	Passage of catheter to kidney
21	7.14	575	Dilation of urethra
1	9.00	A16	Biopsy of thorax

Group 3

SIZE	MEAN	INDEP VAR	
2	10.00	A21	Biopsy (continued) of urinary tract
2	11.50	566	Repair and other plastic operations on bladder
1	12.00	A44	Esophagoscopy and gastroscopy without effect upon tissue
1	13.00	549	Other operations on kidney
1	13.00	556	Repair and plastic operations on ureter
3	13.67	561	Local excision and destruction lesion of bladder trans
2	14.00	562	Local excision and destruction of lesion of bladder ot
3	14.00	582	Prostatectomy, transurethral
1	14.00	583	Prostatectomy, other
8	14.13	545	Nephrectomy, complete
72	14.46	541	Pyelotomy
40	14.47	560	Cystotomy
101	14.63	550	Ureterotomy
19	15.89	540	Nephrotomy
1	16.00	513	Hemorrhoidectomy
11	16.82	544	Nephrectomy, partial
1	17.00	546	Repair and plastic operations on kidney
		570	Urethrotomy, external
1	21.00	A27	Biopsy of bone
1	21.00	563	Cystectomy, complete or partial
1	22.00	685	Ligation and division of fallopian tubes bilateral
3	22.33	558	Ureterolysis
1	29.00	543	Local excision and destruction of lesion of kidney

Figure 4

Suggested Partitioning (three groups) of
Urinary Calculus Patients on the Basis of
Type of Primary Surgery

Group	Number Obs	Mean	Standard Deviation
1	534	3.22	2.71
2	109	4.87	2.70
3	50	7.68	4.93
4	18	12.83	12.37

Several things were considered in evaluating the potential partitioning on secondary diagnosis. With respect to the distribution of observations, groups 3 and 4 were definitely too small (i.e. less than 100 observations) to be considered terminal groups and group 2 with 109 observations was marginal. Further, it was noted that over 80% of the observations in Group 1 had no secondary diagnoses listed and that the remaining cases in all four groups were distributed across 105 different secondary diagnosis codes, usually with less than 10 cases represented for each disease and with no apparent clinical pattern. Thus, it was decided that groups formed on the basis of specific secondary diagnosis were not particularly meaningful, but that a more manageable and interpretable partition from a medical perspective would be two groups based on the presence or absence of a secondary diagnosis. The descriptive statistics of these groups were as follows:

Group	Number Obs	Mean	Standard Deviation
No Secondary	449	3.28	2.88
Secondary	262	5.32	5.01

This alternative partition results in a markedly lower percent reduction in unexplained variation - 6.3%. But, in terms of the overall objectives of the classification process, the increase in interpretability and manageability was considered more important than the sacrifice in predictive error.

STEP 4: With respect to the other two groups formed in Step 2 on the basis of specific surgical procedure, the algorithm was applied using the variables secondary surgical procedure, primary diagnosis, secondary diagnosis, age, and sex. For the group with minor surgeries, the number of subgroups formed by the algorithm and the corresponding percent reduction in unexplained variation for the variables were as follows:

Variable	Number of Groups	Percent Reduction
oper2	2	13.36%
dx1	1	0.0 %
dx2	4	34.62%
age	2	4.73%
sex	1	0.0 %

Likewise the partitions with respect to these variables suggested for the group of relatively major procedures have the following characteristics:

Variable	Number of Groups	Percent Reduction
oper2	3	18.36%
dx1	2	1.26%
dx2	4	43.03%
age	2	3.85%
sex	1	0.00%

In both cases it appeared that secondary diagnosis had the strongest effect and was selected as the potential variable to use in forming subgroups. However, after examining the contents of the suggested groups, it was found in both instances that at least half the observations had no secondary diagnosis listed and the others had secondary diagnoses distributed across at least 100 different codes, with no apparent clinical consistency. That is, the diagnoses were dissimilar and few were represented by more than 10 cases. Thus, like the nonsurgical cases discussed in Step 3, it did not appear that further subsetting these groups on specific secondary diagnosis was meaningful from a clinical perspective.

Partitioning each group on the basis of the presence or absence of secondary diagnosis was considered. This would achieve a 2.1% reduction in unexplained variation for the minor surgical group and a 5.6% reduction for the major surgical group. In both instances, it was decided that there was not sufficient medical justification for a further breakdown of the surgical groups on the basis of secondary diagnosis. Moreover, in light of one of the major objectives of keeping the total number of classes low, additional groups formed at this stage of the partitioning of Urinary Calculus patients would be of questionable value. Therefore, the two surgical groups were not subsetted further but considered terminal groups.

STEP 5: The two subgroups formed from the nonsurgical cases on the basis of presence or absence of other diagnoses were evaluated to determine if they should be partitioned further or left intact as terminal groups. The algorithm was applied and produced the following results for the nonsurgical cases without multiple diagnoses.

Variable	Number of Groups	Percent Reduction
age	2	2.73%
oper2	2	2.06%
dx1	1	0.0 %
sex	1	0.0 %

and the results listed below for the nonsurgical cases with multiple diagnoses:

Variable	Number of Groups	Percent Reduction
age	3	13.05%
oper2	1	0.0 %
dx1	1	0.0 %
sex	1	0.0 %

With respect to the nonsurgical cases without multiple diagnoses, both sets of groups formed on the basis of age and secondary surgical procedure, respectively, were determined unacceptable. In each instance, over 95% of the observations fell into the first group, leaving the second group with fewer than 25 cases.

For the nonsurgical cases with multiple diagnoses, the three groups formed using age levels were considered as potential subgroups. The age levels defining the boundaries of the groups were 66 and 70. This partition was rejected for reasons similar to those above, namely the lopsided distribution of cases in the groups. Almost 90% of the observations had an age under 66.

Thus, the nonsurgical groups with and without multiple diagnoses were considered terminal groups.

We conclude, then, that specific surgical procedures and the presence of multiple diagnoses were important variables in predicting length of stay for Urinary Calculus patients. The four DRGs formed were significantly different ($\alpha = .01$) with respect to their average lengths of stay and are clinically interpretable. To be sure, by overruling some of the partitions suggested by the algorithm, a certain amount of explanatory power was sacrificed. But, the tradeoff was generating a reasonable number of subgroups or DRGs which could be interpreted from a medical perspective. Figure 5 presents a descriptive summary of the length of stay distributions for the groups formed as part of the partitioning process in this example.

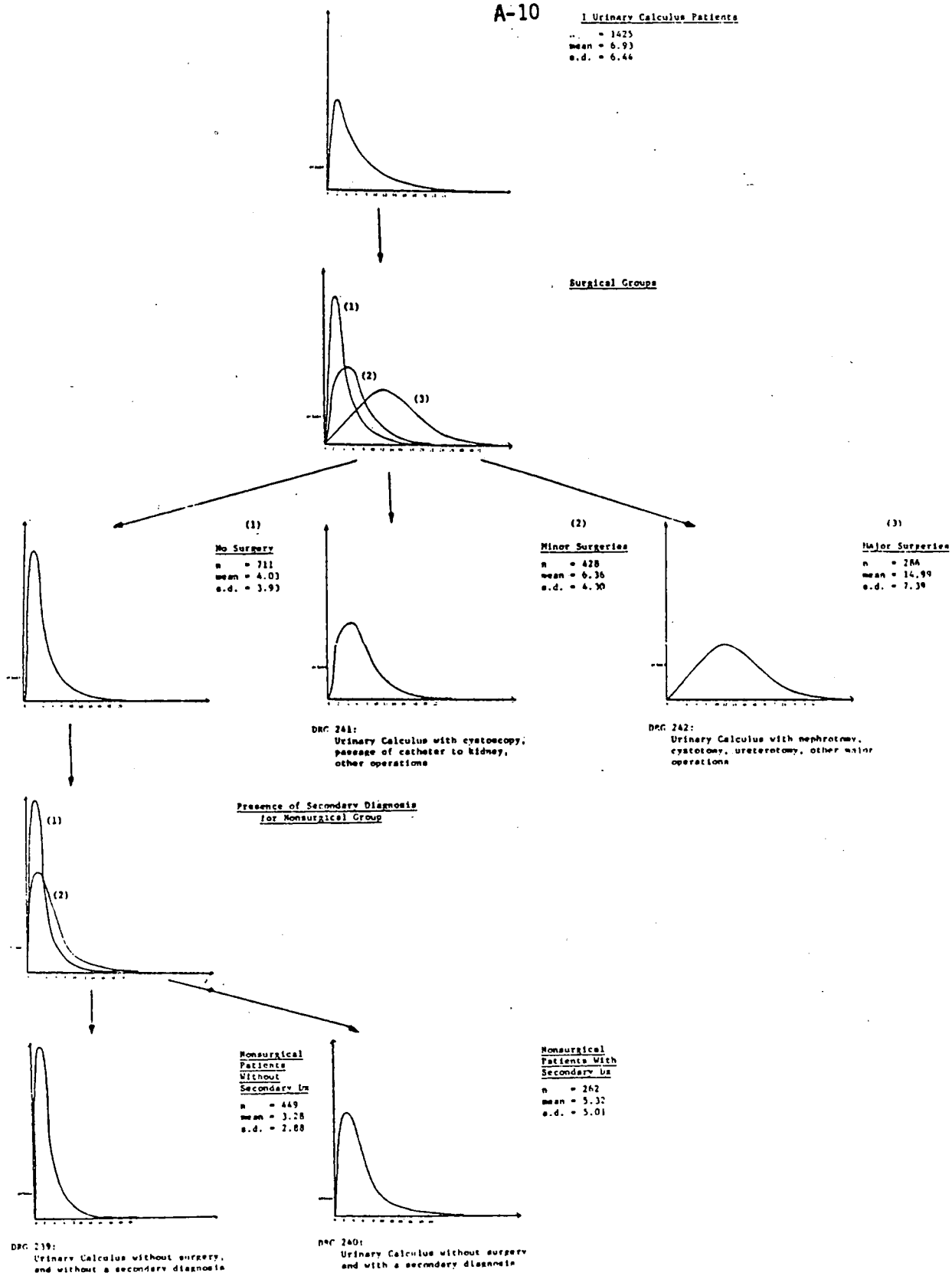


FIGURE 5
Summary of Length of Stay
Distributions for Groups formed in Partitioning Process

APPENDIX B

The Yale Diagnosis Related Groups

Source: R. B. Fetter et al. "Case Mix Definition by Diagnosis Related Groups," Working Paper Series B-Technical

APPENDIX B

Diagnosis Related Group Descriptions

MAJOR DIAGNOSIS CATEGORY		DIAGNOSIS RELATED GROUPS
01:	Infectious Diseases	001 Infectious Disease (Enteritis, Diarrhea) with Age less than 16
		002 Infectious Disease (Enteritis, Diarrhea) with Age greater than 15
		003 Infectious Disease (Viral Disease, VD, Meningitis) without Secondary Diagnosis
		004 Infectious Disease (Viral Disease, VD, Meningitis) with Secondary Diagnosis
		005 Infectious Disease (Blood Infection, TB, Salmonella) without Surgery
		006 Infectious Disease (Blood Infection, TB, Salmonella) with Surgery
02:	Malignant Neoplasm of the Digestive System	007 Cancer of the Mouth, Tongue, Large Intestine, Liver, Gallbladder without Surgery
		008 Cancer of the GI System (Esophagus, Stomach, Pancreas, Small Intestine, Rectum) without Surgery
		009 Cancer of the GI System with Surgical Procedure (Biopsy, Endoscopy, Local Excision, Centesis) without Secondary Diagnosis
		010 Cancer of the GI System with Surgical Procedure (Biopsy, Endoscopy, Local Excision, Draining) with Secondary Diagnosis
		011 Cancer of the GI System with Surgery (Gastric Resection, Colon Resection, Esophagus Resection)
03:	Malignant Neoplasm of the Respiratory System	012 Cancer of the Respiratory System (Trachea, Lung, Larynx, Thorax, Mediastinum) without Surgery without Secondary Diagnosis
		013 Cancer of the Respiratory System (Trachea, Lung, Larynx, Thorax, Mediastinum) without Surgery with Secondary Diagnosis
		014 Cancer of the Respiratory System with Surgical Procedure (Biopsy, Endoscopy, Excision of Lesion) without Secondary Diagnosis
		015 Cancer of the Respiratory System with Surgical Procedure (Biopsy, Endoscopy, Excision of Lesion) with Secondary Diagnosis
		016 Cancer of the Respiratory System with Surgery (Lobectomy, Laryngectomy, Radical Resection)
04:	Malignant Neoplasm of the Skin	017 Cancer of the Skin except Malignant Melanoma without Secondary Diagnosis
		018 Cancer of the Skin except Malignant Melanoma with Secondary Diagnosis
		019 Cancer of the Skin - Malignant Melanoma with Surgical Procedure without Secondary Diagnosis
		020 Cancer of the Skin - Malignant Melanoma with Surgical Procedure with Secondary Diagnosis
05:	Malignant Neoplasm of the Breast	021 Cancer of the Breast without Surgery with Age less than 63
		022 Cancer of the Breast without Surgery with Age greater than 62
		023 Cancer of the Breast with Surgery without Secondary Diagnosis
		024 Cancer of the Breast with Surgery with Secondary Diagnosis
06:	Malignant Neoplasm of the Female Reproductive System	025 Cancer of the Female Reproductive System (Uterus, Cervix, Vagina, Ovary, Fallopian Tube) without Surgery without Secondary Diagnosis
		026 Cancer of the Female Reproductive System (Uterus, Cervix, Vagina, Ovary, Fallopian Tube) without Surgery with Secondary Diagnosis
		027 Cancer of the Female Reproductive System with Surgical Procedure (D&C, Biopsy, Excision of Lesion) without Secondary Diagnosis
		028 Cancer of the Female Reproductive System with Surgical Procedure (D&C, Biopsy, Excision of Lesion) with Secondary Diagnosis
		029 Cancer of the Uterus Body with Surgery (Removal of Uterus)
		030 Cancer of the Uterus, Cervix, Ovary with Surgery (Removal of Uterus or other Major Operation)

07:	Malignant Neoplasm of the Male Reproductive System	031 Cancer of the Male Reproductive System (Penis, Prostate, Testicle) without Surgery
		032 Cancer of the Male Reproductive System with Surgical Procedure (Biopsy, Cystoscopy, Removal of Testicle) without Secondary Diagnosis
		033 Cancer of the Male Reproductive System with Surgical Procedure (Biopsy, Cystoscopy, Removal of Testicle) with Secondary Diagnosis
		034 Cancer of the Male Reproductive System with Surgery (Amputation of Penis, Removal of Prostate, Radical Excision of Lesion)
08:	Malignant Neoplasm of the Urinary System	035 Cancer of the Urinary System (Bladder, Urethra, Kidney, Ureter) without Surgery
		036 Cancer of the Urinary System with Surgical Procedure (Cystoscopy, TUR, Excision of Lesion) without Secondary Diagnosis
		037 Cancer of the Urinary System with Surgical Procedure (Cystoscopy, TUR, Excision of Lesion) with Secondary Diagnosis
		038 Cancer of the Urinary System with Surgery (Removal/Excision of Bladder, Kidney, Ureter, Urethra)
09:	Malignant Neoplasm of Other and Unspecified Sites	039 Cancer of the Bone, Thyroid, Connective Tissue, Nerves without Surgery
		040 Cancer of the Brain, Secondary Cancer, Multiple Cancer Sites without Surgery without Secondary Diagnosis
		041 Cancer of the Brain, Secondary Cancer, Multiple Cancer Sites without Surgery with Secondary Diagnosis
		042 Cancer of the Thyroid, Connective Tissue, Nerves with Surgical Procedure (Biopsy, Excision)
		043 Cancer of a Secondary Site, Multiple Sites with Surgical Procedure (Biopsy, Excision)
		044 Cancer of the Bone, Connective Tissue, Nerves, Secondary Site, Multiple Sites with Surgery
10:	Neoplasm of the Lymphatic and Hemopoietic Tissue	045 Tumor of the Lymphatic System, Blood Making Tissue without Secondary Diagnosis with Age less than 16
		046 Tumor of the Lymphatic System, Blood Making Tissue with Secondary Diagnosis with Age less than 16
		047 Disease of the Lymphatic System, Hodgkins Disease, Sarcoma without Surgery without Secondary Diagnosis with Age greater than 15
		048 Disease of the Lymphatic System, Hodgkins Disease, Sarcoma without Surgery with Secondary Diagnosis with Age greater than 15
		049 Tumor of the Lymphatic System, Multiple Myeloma, Leukemia without Surgery with Age greater than 15
		050 Tumor of the Lymphatic System, Blood Making Tissue with Surgical Procedure (Excision of Node) without Secondary Diagnosis with Age greater than 15
		051 Tumor of the Lymphatic System, Blood Making Tissue with Surgical Procedure (Excision of Node) with Secondary Diagnosis with Age greater than 15
		052 Tumor of the Lymphatic System, Blood Making Tissue with Surgery (Splenectomy, Radical Resection) with Age greater than 15
11:	Benign Neoplasm of the Female Reproductive System	053 Benign Tumor (Papilloma, Polyp) of the Uterus, Vagina, Vulva without Secondary Diagnosis
		054 Benign Tumor (Papilloma, Polyp) of the Uterus, Vagina, Vulva with Secondary Diagnosis
		055 Benign Tumor (Fibroma) of the Uterus, Ovary without Surgery
		056 Benign Tumor (Fibroma) of the Uterus, Ovary with Surgical Procedure (D&C, Excision of Lesion) without Second Surgery
		057 Benign Tumor (Fibroma) of the Uterus, Ovary with Second Surgery
		058 Benign Tumor (Fibroma) of the Uterus, Ovary with Surgery (Removal of Ovary)
		059 Benign Tumor (Fibroma) of the Uterus, Ovary with Surgery (Removal of Uterus)

12:	Benign Neoplasm of Other Sites	060 Benign Tumor of the Intestines, Urinary System, without Surgery
		061 Benign Tumor of the Brain, Pituitary Gland without Surgery
		062 Benign Tumor of the Skin, Bone, Urinary System (Kidney, Bladder), Connective Tissue with Surgery without Secondary Diagnosis
		063 Benign Tumor of the Skin, Bone, Urinary System (Kidney, Bladder), Connective Tissue with Surgery with Secondary Diagnosis with Age less than 43
		064 Benign Tumor of the Skin, Bone, Urinary System (Kidney, Bladder), Connective Tissue with Surgery with Secondary Diagnosis with Age greater than 42
		065 Benign Tumor of the Intestines, Nerves with Surgical Procedure (Excision, Other) without Secondary Diagnosis
		066 Benign Tumor of the Intestines, Nerves with Surgical Procedure (Excision, Other with Secondary Diagnosis
		067 Benign Tumor of the Intestines, Nerves with Surgery (Colon Resection Craniotomy Radical Resection, Other Major Operation)
		068 Benign Tumor of the Stomach, Brain, Respiratory System, Esophagus, Pituitary Gland with Surgery
13:	Diseases of Thyroid and Other Endocrine Glands	069 Disease of the Thyroid (Non-Toxic, Simple), Other Endocrine Glands (Adrenal, Pancreas without Surgery
		070 Disease of the Thyroid (Toxic), Low Function Pituitary without Surgery
		071 Endocrine Disorder with Surgical Procedure (Thyroidectomy, Other)
		072 Endocrine Disorder with Surgery
14:	Diabetes	073 Diabetes without Surgery without Secondary Diagnosis or with Minor Secondary Diagnosis with Age less than 36
		074 Diabetes without Surgery without Secondary Diagnosis or with Minor Secondary Diagnosis with Age greater than 35
		075 Diabetes without Surgery with Major Secondary Diagnosis
		076 Diabetes with Surgical Procedure (Endoscopy, Biopsy)
		077 Diabetes with Surgery (Amputation of Extremity, Other Major)
15:	Nutritional and Other Metabolic Diseases	078 Metabolic Disorder (Gout, Blood Globulin) without Secondary Diagnosis
		079 Metabolic Disorder (Gout, Blood Globulin) with Secondary Diagnosis (Nutrition Deficiency)
		080 Metabolic Disease (Cystic Fibrosis, Sprue, Unspecified)
		081 Metabolic Disease (Obesity, Malnutrition, Unspecified)
16:	Diseases of the Blood and Blood Forming Organs	082 Mediterranean Anemia, Hemophilia without Surgery without Secondary Diagnosis or with Minor Secondary Diagnosis with Age less than 11
		083 Mediterranean Anemia, Hemophilia without Surgery without Secondary Diagnosis or with Minor Secondary Diagnosis with Age greater than 10
		084 Disease of Blood Hemoglobin without Surgery without Secondary Diagnosis or with Minor Secondary Diagnosis
		085 Disease of the Blood (Anemias), Blood Forming Organs (Spleen) without Surgery with Major Secondary Diagnosis
		086 Disease of the Blood (Anemias), Blood Forming Organs with Surgery with Age 2-52
		087 Disease of the Blood (Anemias), Blood Forming Organs with Surgery with Age less than 2 or greater than 53
17:	Psychoses Not Attributed to Physical Conditions	088 Schizophrenia (Paranoid, Catatonic, Unspecified) Involutional Melancholia with Psychiatric Service
		089 Schizophrenia (Paranoid, Catatonic, Unspecified) Involutional Melancholia without Psychiatric Service
		090 Schizophrenia (Affective, Acute Episode), Manic - Depressive Psychosis

8:	Neuroses	091 Neurosis (Anxiety, Hysterical, Phobic, Hypochondriacal Unspecified) 092 Neurosis (Obsessive-Compulsive, Depressive), Personality Disorders
9:	Alcoholic Mental Disorder and Addiction	093 Alcoholism without Secondary Diagnosis or with Minor Secondary Diagnosis 094 Alcoholism with Major Secondary Diagnosis (Liver Cirrhosis, Delirium Tremens, Other)
0:	Other Mental Disorders	095 Drug Dependence, Physical Disorder (Probably Psychiatric Origin), Cephalgia 096 Psychosis, Non-Psychosis Related Brain Condition
1:	Diseases of the Central Nervous System	097 Epilepsy, Migraine, Brain Disorder (Unspecified) without Surgery without Secondary Diagnosis 098 Epilepsy, Migraine, Brain Disorder (Unspecified) without Surgery with Secondary Diagnosis 099 Multiple Sclerosis, Paralysis Agitans, Meningitis, Hemiplegia without Surgery 100 Disease of the Central Nervous System with Surgical Procedure (Nerve Block, Other) 101 Disease of the Central Nervous System with Surgery (Laminectomy, Spinal Fusion, Ventricular Shunt)
2:	Diseases of the Peripheral Nervous System	102 Facial Paralysis, Neuralgia (Trigeminal, Other Unspecified) without Surgery 103 Sciatica, Polyneuritis without Surgery 104 Disease of the Median Nerve with Surgery 105 Disease of the Peripheral Nerves except Median with Surgical Procedure (Nerve Block, Other Unspecified) 106 Disease of the Peripheral Nerves except Median with Surgery (Spinal Cord, Nerve Roots)
3:	Diseases of the Eye	107 Cross Eyedness, Cataract, Cyst of the Eyelid without Surgery 108 Glaucoma, Corneal Inflammation/Ulceration, Disease of the Iris, Retina without Surgery 109 Disease of the Eye with Surgical Procedure (Muscle Repair of Eyelid, Other) 110 Disease of the Eye with Surgical Procedure (Removal of Lens, Incision into Sclera) 111 Disease of the Eye with Surgical Procedure (Reattachment of Retina, Repair of Cornea)
4:	Disease of the Ear and Mastoid Process	112 Disease of the Middle Ear (Inflammation, Chronic Mastoid Bone Inflammation) without Surgery 113 Disease of the Inner Ear (Inflammation, Menieres Disease) without Surgery 114 Disease of the Ear with Surgical Procedure (Incision of Membrane, Removal of Adenoids, Other) 115 Disease of the Middle Ear with Surgery (Removal of Bone, Repair of Membrane) 116 Disease of the Ear with Surgery (Removal of Mastoid Bone, Excision of Middle Ear, Other)
5:	Hypertensive Heart Diseases	117 Hypertensive Heart Disease without Surgery without Secondary Diagnosis or with Minor Secondary Diagnosis 118 Hypertensive Heart Disease without Surgery with Major Secondary Diagnosis 119 Hypertensive Heart Disease (Fatal) with Kidney Involvement without Surgery with Major Secondary Diagnosis 120 Hypertensive Heart Disease with Surgery

1:	Acute Myocardial Infarction	121 Disease of the Heart - Acute Myocardial Infarction
2:	Ischemic Heart Diseases Except AMI	122 Disease of the Heart, Ischemia (Blood Deficiency) except AMI without Surgery without Secondary Diagnosis 123 Disease of the Heart, Ischemia (Blood Deficiency) except AMI without Surgery with Minor Secondary Diagnosis 124 Disease of the Heart, Ischemia (Blood Deficiency) except AMI without Surgery with Major Secondary Diagnosis 125 Disease of the Heart, Ischemia (Blood Deficiency) except AMI with Cardiac Catheterization 126 Disease of the Heart, Ischemia (Blood Deficiency) except AMI with Surgical Procedure (Endoscopy, Insertion of Electronic Device) 127 Disease of the Heart, Ischemia (Blood Deficiency) except AMI with Surgery (Shunt, Other Major)
3:	Arrythmia and Slowed Conduction	128 Disease of the Heart, Irregular Heart Rhythm, Slowed Conduction without Surgery without Secondary Diagnosis or with Minor Secondary Diagnosis 129 Disease of the Heart, Irregular Heart Rhythm, Slowed Conduction without Surgery with Major Secondary Diagnosis 130 Disease of the Heart, Irregular Heart Rhythm, Slowed Conduction with Replacement of Heart Device or Cardiac Catheterization 131 Disease of the Heart, Irregular Heart Rhythm, Slowed Conduction with Insertion of Electronic Heart Device
9:	Heart Failure	132 Disease of the Heart, Failure (Poor Function) without Surgery 133 Disease of the Heart, Failure (Poor Function) with Surgery
0:	Carditis, Valvular and Other Diseases	134 Disease of the Heart, Inflammation, Valve Problem without Surgery without Secondary Diagnosis or with Minor Secondary Diagnosis 135 Disease of the Heart, Inflammation, Valve Problem without Surgery with Major Secondary Diagnosis 136 Disease of the Heart, Inflammation, Valve Problem with Cardiac Catheterization without Secondary Diagnosis or with Minor Secondary Diagnosis 137 Disease of the Heart, Inflammation, Valve Problem with Cardiac Catheterization with Major Secondary Diagnosis 138 Disease of the Heart, Inflammation, Valve Problem with Surgery (Valve Replacement, Other Major)
1:	Cerebrovascular Diseases	139 Circulatory Disorder of the Brain, Occasional Blood Deficiency without Surgery without Secondary Diagnosis or with Minor Secondary Diagnosis 140 Circulatory Disorder of the Brain, Occasional Blood Deficiency without Surgery with Major Secondary Diagnosis 141 Blood Clot in Brain Obstructing Circulation without Surgery without Secondary Diagnosis or with Minor Secondary Diagnosis 142 Blood Clot in Brain Obstructing Circulation without Surgery with Major Secondary Diagnosis 143 Brain Hemorrhage (Stroke) without Surgery without Secondary Diagnosis or with Minor Secondary Diagnosis 144 Brain Hemorrhage (Stroke) without Surgery with Major Secondary Diagnosis 145 Circulatory Dysfunction in Brain with Surgery
2:	Diseases of the Vascular System	146 Disease of the Circulatory System, Inflammation of the Lymph Glands, Varicose Veins (Legs), Raynauds Disease without Surgery 147 Disease of the Circulatory System (Hardening of Arterial Walls, Arterial Blood Clot) without Surgery without Secondary Diagnosis or with Minor Secondary Diagnosis 148 Disease of the Circulatory System (Hardening of Arterial Walls, Arterial Blood Clot) without Surgery with Major Secondary Diagnosis 149 Disease of the Circulatory System with Surgical Procedure (Excision of Varicose Veins, Other) with Age less than 51 150 Disease of Vascular System with Surgery (Excision of Varicose Veins, Other) with Age greater than 50 151 Disease of Vascular System with Surgery (Excision of Nerve, Vessel) without Secondary Diagnosis 152 Disease of Vascular System with Surgery (Excision of Nerve, Vessel) with Secondary Diagnosis 153 Disease of Vascular System with Surgery (Arterial Reconstruction, Amputation of Extremity)

33:	Pulmonary Embolism	154	Blood Clot of the Lung without Secondary Diagnosis or with Minor Secondary Diagnosis
		155	Blood Clot of the Lung with Major Secondary Diagnosis
34:	Phlebitis and Thrombophlebitis	156	Inflammation of the Veins, Blood Clot without Secondary Diagnosis or with Minor Secondary Diagnosis
		157	Inflammation of the Veins, Blood Clot with Major Secondary Diagnosis
35:	Hemorrhoids	158	Hemorrhoids
36:	Hypertrophy of Tonsil and Adenoid	159	Enlargement of the Tonsils/Adenoids
37:	Acute Upper Respiratory Tract Infection and Influenza	160	Acute Upper Respiratory Tract Infection, Influenza with Age less than 45
		161	Acute Upper Respiratory Tract Infection, Influenza with Age greater than 44
38:	Other Diseases of the Upper Respiratory Tract	162	Disease of the Upper Respiratory Tract except Acute Upper Respiratory Infection and Influenza without Surgery
		163	Disease of the Upper Respiratory Tract with Surgical Procedure (Biopsy, Visualization of the Nasal Septum)
		164	Disease of the Upper Respiratory Tract with Surgery (Nose Reconstruction, Incision and Drainage of Sinus)
39:	Pneumonia	165	Pneumonia with Age less than 31
		166	Pneumonia without Surgery without Seconary Diagnosis with Age greater than 30
		167	Pneumonia without Surgery with Secondary Diagnosis with Age greater than 30
		168	Pneumonia with Surgery
40:	Bronchitis	169	Bronchitis with Age less than 46
		170	Bronchitis without Secondary Diagnosis or with Minor Secondary Diagnosis with Age greater than 45
		171	Bronchitis with Major Secondary Diagnosis with Age greater than 45
41:	Asthma	172	Asthma with Age less than 31
		173	Asthma without Secondary Diagnosis with Age greater than 30
		174	Asthma with Secondary Diagnosis with Age greater than 30
42:	Other Lung and Pleural Diseases	175	Lung Collapse, Pleurisy, Pulmonary Congestion without Surgery
		176	Emphysema, Embyema, Abscess, Acute Swelling without Surgery without Secondary Diagnosi or with Minor Secondary Diagnosis
		177	Emphysema, Empyema, Abscess, Acute Swelling without Surgery with Major Secondary Diagnosis
		178	Disease of the Lung and Pleura with Surgical Procedure (Bronchoscopy, Chest Incision, Other) without Secondary Diagnosis
		179	Disease of the Lung and Pleura with Surgical Procedure (Bronchoscopy, Chest Incision, Other) with Secondary Diagnosis
		180	Disease of the Lung and Pleura with Surgery (Removal of Lobe, Other Major)
43:	Diseases of the Oral Cavity, Salivary Glands and Jaw	181	Minor Problems of the Teeth
		182	Major Problems of the Teeth (Jaw, Salivary Glands, Other Oral Soft Tissue)
44:	Gastric and Peptic Ulcer	183	Stomach Ulcer without Surgery without Secondary Diagnosis
		184	Stomach Ulcer without Surgery with Secondary Diagnosis
		185	Stomach Ulcer with Surgical Procedure (Biopsy, Visualization, Other)
		186	Stomach Ulcer with Surgery (Removal of Portion of Stomach, Other Major) without Secondary Diagnosis
		187	Stomach Ulcer with Surgery (Removal of Portion of Stomach, Other Major) with Secondary Diagnosis

45:	Upper Gastro-Intestinal Diseases except Gastric and Peptic Ulcer	188 Upper GI Disease Except Stomach Ulcer without Surgery without Secondary Diagnosis
		189 Upper GI Disease Except Stomach Ulcer without Surgery with Secondary Diagnosis
		190 Upper GI Disease Except Stomach Ulcer with Surgical Procedure (Visualization, Other Minor) without Secondary Diagnosis
		191 Upper GI Disease Except Stomach Ulcer with Surgical Procedure (Visualization, Other Minor) with Secondary Diagnosis
		192 Upper GI Disease Except Stomach Ulcer with Surgery
46:	Appendicitis	193 Appendicitis (without Peritonitis) without Secondary Diagnosis
		194 Appendicitis (without Peritonitis) with Secondary Diagnosis
		195 Appendicitis (with Peritonitis, Other) without Secondary Diagnosis
		196 Appendicitis (with Peritonitis, Other) with Secondary Diagnosis
47:	Hernia of the Abdominal Cavity	197 Abdominal Hernia with Age less than 15
		198 Inguinal Hernia (without Obstruction) with Age greater than 14 and less than 65 without Secondary Diagnosis
		199 Inguinal Hernia (without Obstruction) with Age greater than 14 and less than 65 with Secondary Diagnosis
		200 Abdominal Hernia Except Simple Inguinal with Age greater than 14 and less than 65 without Surgery
		201 Abdominal Hernia Except Simple Inguinal with Age greater than 14 and less than 65 with Minor Surgery
		202 Abdominal Hernia Except Simple Inguinal with Age greater than 14 and less than 65 with Major Surgery
		203 Abdominal Hernia with Age greater than 64 without Surgery
		204 Abdominal Hernia with Age greater than 64 with Minor Surgery
		205 Abdominal Hernia with Age greater than 64 with Major Surgery
48:	Enteritis, Diverticula, and Functional Disorders of the Intestine	206 Functional Disorder of the Intestine without Surgery
		207 Intestinal Pouching, Regional Enteritis, Ulcerative Colitis without Surgery
		208 Intestinal Pouching (Functional Disorder) with Minor Surgery without Secondary Diagnosis
		209 Intestinal Pouching (Functional Disorder) with Minor Surgery with Secondary Diagnosis
		210 Intestinal Pouching (Functional Disorder) with Major Surgery (Resection, Other)
49:	Diseases of the Anus	211 Disease of the Anus without Secondary Diagnosis
		212 Disease of the Anus with Secondary Diagnosis
50:	Miscellaneous Diseases of the Intestine and Peritoneum	213 Miscellaneous Disease of the Intestine and Abdominal Lining with Age less than 56 without Surgery
		214 Miscellaneous Disease of the Intestine and Abdominal Lining with Age greater than 55 without Surgery without Secondary Diagnosis
		215 Miscellaneous Disease of the Intestine and Abdominal Lining with Age greater than 55 without Surgery with Secondary Diagnosis
		216 Miscellaneous Disease of the Intestine and Abdominal Lining with Surgical Procedure (Local Incision, Excision)
		217 Miscellaneous Disease of the Intestine and Abdominal Lining with Visualization of the Intestine without Secondary Diagnosis
		218 Miscellaneous Disease of the Intestine and Abdominal Lining with Visualization of the Intestine with Secondary Diagnosis
		219 Miscellaneous Disease of the Intestine and Abdominal Lining with Major Surgery without Secondary Diagnosis
		220 Miscellaneous Disease of the Intestine and Abdominal Lining with Major Surgery with Secondary Diagnosis
51:	Diseases of the Liver	221 Hepatitis,(Infectious, Serum) Subacute Necrosis of the Liver with Age less than 41

	222	Hepatitis (Infectious, Serum) Subacute Necrosis of the Liver with Age greater than 40
	223	Liver Cirrhosis without Secondary Diagnosis or with Minor Secondary Diagnosis
	224	Liver Cirrhosis with Major Secondary Diagnosis
52: Diseases of the Gall-Bladder and Bile Duct	225	Disease of the Gallbladder and Bile Duct without Surgery with Age less than 51
	226	Disease of the Gallbladder and Bile Duct without Surgery with Age greater than 50
	227	Disease of the Gallbladder and Bile Duct with Surgery without Secondary Diagnosis
	228	Disease of the Gallbladder and Bile Duct with Surgery with Secondary Diagnosis with Age less than 65
	229	Disease of the Gallbladder and Bile Duct with Surgery with Secondary Diagnosis with Age greater than 64
53: Diseases of the Pancreas	230	Disease of the Pancreas without Surgery
	231	Disease of the Pancreas with Surgery
54: Diseases of the Kidney and Ureter	232	Disease of the Kidney and Bladder without Surgery without Secondary Diagnosis
	233	Kidney Inflammation without Surgery with Secondary Diagnosis
	234	Nephrotic Syndrome, Nephritis (Chronic) Uremia without Surgery with Secondary Diagnosis with Age less than 65
	235	Nephrotic Syndrome, Nephritis (Chronic) Uremia without Surgery with Secondary Diagnosis with Age greater than 64
	236	Disease of the Ureter, Nephrotic Syndrome, with Surgical Procedure (Cystoscopy, Biopsy, Other Minor)
	237	Kidney Inflammation and Degenerative Disease (Including Kidney Pelvis) with Surgical Procedure
	238	Disease of the Kidney and Ureter with Surgery (Kidney Removal, Kidney Transplant, Other Major)
55: Urinary Calculus	239	Urinary Stone without Surgery without Secondary Diagnosis
	240	Urinary Stone without Surgery with Secondary Diagnosis
	241	Urinary Stone with Surgical Procedure (Visualization, Catheter to Kidney Other)
	242	Urinary Stone with Surgery (Incision and Drainage of Kidney, Bladder, Ureter and Other Major)
56: Cystitis and Other Urinary Diseases	243	Bladder Inflammation with Other Urinary Disease without Surgery without Secondary Diagnosis
	244	Inflammation of the Bladder and Urethra with Narrowing of the Urethra without Surgery with Secondary Diagnosis
	245	Bladder (Abnormal Passage, Pouching, Other Disease) without Surgery with Secondary Diagnosis with Age less than 46
	246	Bladder (Abnormal Passage, Pouching, Other Disease) without Surgery with Secondary Diagnosis with Age greater than 45
	247	Disease of the Bladder and Urethra with Surgical Procedure (Visualization, Opening
	248	Disease of the Bladder and Urethra with Surgical Procedure (Visualization, Excision, Dilatation, Repair) with Age less than 15
	249	Disease of the Bladder and Urethra with Surgical Procedure (Visualization, Excision, Dilatation, Repair) with Age greater than 14
	250	Disease of the Bladder and Urethra with Surgery (Removal of Bladder, Removal of Prostate, Other Major)
57: Disease of the Prostate	251	Disease of the Prostate without Surgery
	252	Disease of the Prostate with Surgical Procedure (Bladder Visualization, Dilatation of Urethra, Biopsy) without Secondary Diagnosis
	253	Disease of the Prostate with Surgical Procedure (Bladder Visualization, Dilatation of Urethra, Biopsy) with Secondary Diagnosis
	254	Disease of the Prostate with Surgery (Non-Incisional Removal of Prostate) without Secondary Diagnosis
	255	Disease of the Prostate with Surgery (Non-Incisional Removal of Prostate) with Secondary Diagnosis
	256	Disease of the Prostate with Surgery (Incisional Removal of the Prostate)

:	Disease of the Male Reproductive System	257 Excessive Foreskin over the Glans Penis with Surgery 258 Disease of the Male Reproductive System Except Circumcision without Surgery 259 Disease of the Male Reproductive System Except Circumcision with Surgery with Age less than 45 260 Disease of the Male Reproductive System Except Circumcision with Surgery with Age greater than 44
:	Disease of the Female Reproductive System	261 Disorder of Menstruation without Surgery 262 Disease of the Female Reproductive System Except Disorder of Menstruation without Secondary Diagnosis 263 Disease of the Female Reproductive System Except Disorder of Menstruation with Secondary Diagnosis 264 Disease of the Female Reproductive System with Surgical Procedures (D&C, Visualization, Removal Fallopian Tubes) without Secondary Diagnosis 265 Disease of the Female Reproductive System with Surgical Procedure (D&C, Visualization, Other) with Secondary Diagnosis 266 Disease of the Female Reproductive System with Surgery (Removal of Womb, Repair of Female Reproductive Organ, Other Major)
):	Diseases of the Breast	267 Benign Breast Tumor, Chronic Cystic Disease without Secondary Diagnosis 268 Acute Inflammation of the Breast, Enlarged Breast without Secondary Diagnosis 269 Disease of the Breast with Secondary Diagnosis with Age less than 56 270 Disease of the Breast with Secondary Diagnosis with Age greater than 55
1:	Abortion	271 Abortion without Secondary Diagnosis 272 Abortion with Secondary Diagnosis
2:	Obstetrical Diseases of the Antepartum and Puerperium	273 False Labor without Surgery 274 Threatened Abortion Premature Separation of the Afterbirth, Other Hemorrhage During Pregnancy without Surgery 275 Obstetrical Complications, Poisons in Blood, Excessive Vomiting, Blood Clot Vein-Extremity without Surgery 276 Obstetrical Disease Before and After Delivery with Surgical Procedure (D&C, Repair of Neck of Womb) 277 Obstetrical Disease Before and After Delivery with Surgery (Removal of Tubes and Ovaries, Other Major)
3:	Normal Delivery	278 Delivery without Surgery or with Surgery Assisting Delivery 279 Delivery with Tying of Tubes, Removal of Tubes 280 Delivery with Cesarean Section
4:	Delivery with Complications	281 Delivery with Complications without Surgery or with Surgery Assisting Delivery 282 Delivery with Complications with Cesarean Section
5:	Diseases of the Skin and Subcutaneous Tissue	283 Excessive Scar Tissue, Excessive Pigment, Fatty Cyst, Other Minor Skin Disease without Secondary Diagnosis 284 Excessive Scar Tissue, Excessive Pigment, Fatty Cyst, Other Minor Skin Disease with Secondary Diagnosis 285 Skin Inflammation, Abscess, Eczema, Chronic Ulcer without Surgery with Age less than 21 286 Skin Inflammation, Abscess, Eczema, Chronic Ulcer without Surgery with Age greater than 20 287 Skin Inflammation, Abscess, Eczema, Reddened Skin with Surgery without Secondary Diagnosis 288 Skin Inflammation, Abscess, Eczema, Reddened Skin with Surgery with Secondary Diagnosis 289 Psoriasis, Eruptive Skin Lesions, Chronic Skin Ulcer

66: Arthritis	290	Arthritis without Surgery with Age less than 65
	291	Arthritis without Surgery with Age greater than 64
	292	Arthritis with Surgery (Excision of Bone, Joint, Membrane Surgical Joint Fixation)
	293	Arthritis with Surgery (Joint Incision, Spinal Fusions, Excision of Tissue Between Vertebrae)
	294	Arthritis with Surgery (Repair and Restoration of Joint, Removal of Membrane between Vertebrae)
67: Derangement and Displacement of Intervertebral Disc	295	Disorder and Displacement of Disc Between Vertebrae without Surgery
	296	Disorder and Displacement of Disc Between Vertebrae with Surgery
68: Diseases of the Bone and Cartilage	297	Rheumatism and Inflammation Tissue Covering Bone, Other Minor Bone Disease without Surgery
	298	Disease of the Bone, Inflammation of Marrow (Acute, Chronic), Spongy Bone, Unaided Fracture without Surgery
	299	Disease of the Bone, and Bone Tissue Lining, with Surgery (Excision Bone Lining, Repair of Other Joint)
	300	Disease of the Bone and Bone Tissue Lining with Surgery (Joint Incision, Bone Excision, Bone Fusion)
	301	Disease of the Bone and Bone Tissue Lining with Surgery (Amputation, Hip Restoration, Other Major)
69: Other Disease of the Musculo-Skeletal System	302	Inflammation of the Component Parts of the Joints, Curvature of the Spine, Deformed Foot without Surgery
	303	Backache, Diffuse Disease of Connective Tissue, Inflammation of Muscle without Surgery without Secondary Diagnosis
	304	Backache, Diffuse Disease of Connective Tissue, Inflammation of Muscle without Surgery with Secondary Diagnosis
	305	Inflammation of the Component Parts of Joints with Deformity (Palm, Finger, Toe) with Surgery
	306	Other Disease of the Muscle and Bone (Major) with Surgical Procedure
	307	Other Disease of the Muscle and Bone (Major) with Surgery (Removal, Repair of the Small Joint, Bone)
	308	Other Disease of the Muscle and Bone (Major) with Surgery (Joining Vertebrae, Other)
70: Congenital Anomalies	309	Birth Defect (Bone, Stomach, Testicle) without Surgery
	310	Birth Defect (Heart, Kidney, Other Major) without Surgery
	311	Birth Defect (Testicle, Skin, Stomach, Other Minor) with Surgery
	312	Birth Defect (Heart Valve, Other Unspecified Heart Site) with Surgical Procedure (Cardiac Catheterization)
	313	Birth Defect (Palate, Lip, Hip or Other Extremity) with Surgery (Repair of Mouth, Fixation of Hip)
	314	Birth Defect (Heart Valve, Other Unspecified Site) with Surgery (Heart Valve, Septal Repair)
	315	Congenital Diseases (Tetralogy of Fallot, Atrial Septal Defect, Hyposnadia, Other) with Surgical Procedure (Catheterization, Repair of Urethra)
	316	Congenital Diseases (Tetralogy of Fallot, Atrial Septal Defect, Other) with Surgery (Valve, Septum, Shunt)
	317	Birth Defect (Spine, Gullet, Large Bowel) with Surgery
71: Normal Mature Newborn	318	Normal Full Term Newborn
72: Certain Diseases and Conditions Peculiar to Newborn Infants	319	Well Baby Care (Pregnancy greater than 9 months), Other Minor Disease or Condition of the Newborn Infant
	320	Immaturity, Hyaline Membrane Disease, Other Major Disease or Condition of the Infant without Secondary Diagnosis
	321	Immaturity, Hyaline Membrane Disease, Other Major Disease or Condition of the Infant with Secondary Diagnosis

73:	Signs and Symptoms Pertaining to the Nervous, Respiratory, and Circulatory Systems	322 Indications of Nervous, Respiratory, Circulatory System Disease without Surgery without Secondary Diagnosis
		323 Convulsions, Fainting, Nosebleed, Chest Pain without Surgery with Secondary Diagnosis
		324 Brain Disorder of Dizziness, Shortness of Breath, Coughing up Blood without Surgery with Secondary Diagnosis
		325 Indications of Nervous, Respiratory, Circulatory System Disease with Surgical Procedur
		326 Indications of Nervous, Respiratory, Circulatory System Disease with Major Surgery
74:	Signs and Symptoms Pertaining to the Gastro-Intestinal and Urinary Systems	327 Indications of Gastro-Intestinal, Urinary System Disease without Surgery without Secondary Diagnosis
		328 Indications of Gastro-Intestinal, Urinary System Disease without Surgery with Secondary Diagnosis
		329 Indications of Gastro-Intestinal, Urinary System Disease with Surgical Procedure (Visual Inspection, Other)
		330 Indications of Gastro-Intestinal, Urinary System Disease with Surgery (Abdominal, Other Major)
75:	Miscellaneous Signs, Symptoms, and Ill-Defined Conditions	331 Sterility (Male, Female), Admission for Observation without Surgery
		332 Chemical Imbalance, Headache, Fever, Other Ill-Defined Indication of Disease without Surgery with Age less than 15
		333 Chemical Imbalance, Headache, Fever, Other Ill-Defined Indication of Disease without Surgery with Age greater than 14
		334 Miscellaneous Indication of Disease with Surgical Procedure (Visual Inspection, Other)
		335 Miscellaneous Indication of Disease with Surgery (Abdominal Surgery, Removal of Uterus, Other Major)
76:	Fractures	336 Fracture (Skull, Face, Forearm, Leg, Foot, Hand) without Surgery with Age less than 30
		337 Fracture (Skull, Face, Forearm, Leg, Foot, Hand) without Surgery with Age greater than 29
		338 Fracture (Spine, Ribs, Bone of the Upper Arm) without Surgery with Age less than 65
		339 Fracture (Spine, Ribs, Bone of the Upper Arm) without Surgery with Age greater than 64
		340 Fracture (Thigh Bone, Pelvis, Multiple) without Surgery
		341 Fracture (Nose, Forearm, Hand, Lower Leg, Foot) with Surgical Procedure (Closed Reduction) without Secondary Diagnosis
		342 Fracture (Nose, Forearm, Hand, Lower Leg, Foot) with Surgical Procedure (Closed Reduction) with Secondary Diagnosis
		343 Fracture (Lower Jaw, Upper Arm, Ankle) with Surgical Procedure (Closed Reduction, Open Reduction of Face) without Secondary Diagnosis
		344 Fracture (Lower Jaw, Upper Arm, Ankle) with Surgical Procedure (Closed Reduction, Open Reduction of Face) with Secondary Diagnosis
		345 Fracture (Arm, Hand, Foot, Shoulder Blade) with Surgery (Open Reduction, External Fixation, Other)
		346 Fracture(Ankle, Leg Bones) with Surgery (Open Reduction, External Fixation, Other)
		347 Fracture (Thigh Bone, Pelvis) with Surgery (Open Reduction, External Fixation, Other)
		348 Fracture with Major Surgery (Amputation, Restoration of Hip Joint, Other Major)
77:	Dislocations and Other Musculo-Skeletal Injuries	349 Dislocation (Shoulder, Elbow, Wrist, Knee), Sprains (Ankle, Foot, Hand) without Surgery
		350 Dislocation (Jaw, Hip), Sprains (Knee, Scroiliac, Other Unspecified) without Surgery
		351 Dislocation (Shoulder, Elbow, Hand), Sprains (Elbow, Wrist, Hand) with Surgery
		352 Dislocation (Knee, Ankle), Sprains (Shoulder, Knee, Ankle) with Surgery
		353 Dislocation (Hip, Multiple), Sprains (Hip, Sacroiliac, Other Unspecified) with Surgery

8:	Internal Injuries of the Cranium, Chest, and Other Organs	354 Internal Injury of the Skull, Other Organ without Surgery without Secondary Diagnosis with Age less than 41
		355 Internal Injury of the Skull, Other Organ without Surgery with Secondary Diagnosis with Age less than 41
		356 Internal Injury of the Skull, Other Organ without Surgery with Age greater than 40
		357 Internal Injury with Surgical Procedure (Suture of Skin, Nerve, Nerve Repair, Other)
		358 Internal Injury with Surgery (Removal of Spleen, Drainage of Chest Cavity, Excision of Skin)
		359 Internal Injury with Surgery (Opening of Skull, Exploration of Abdominal Cavity)
9:	Open Wounds and Superficial Injuries	360 Open Wound (Uncomplicated), Superficial Injury, Foreign Body without Surgery
		361 Open Wound (Complicated), Bruise, Multiple Injuries without Surgery without Secondary Diagnosis
		362 Open Wound (Complicated), Bruise, Multiple Injuries without Surgery with Secondary Diagnosis
		363 Open Wound (External), Foreign Body with Surgical Procedure (Visualization, Suturing, Other)
		364 Open Wound (Complicated) of the Head, Multiple Sites with Surgical Procedure (Visualization, Suturing, Other)
		365 Open Wound (External), Superficial Injury with Surgery (Excision, Other Major)
		366 Open Wound (Complicated) of the Head, Multiple Sites with Surgery (Excision, Other Major)
30:	Burns	367 Burn of the 1st Degree (Uncomplicated) Covering less than 20% of the Body
		368 Burn of the 2nd Degree (Complicated), 3rd Degree Covering more than 20% of the Body
31:	Complications of Medical and Surgical Care	369 Complications of Medical or Surgical Care without Surgery without Secondary Diagnosis
		370 Complications of Medical or Surgical Care without Surgery with Secondary Diagnosis
		371 Complications of Medical or Surgical Care with Surgical Procedure
		372 Complications of Medical or Surgical Care with Surgery (Replacement of Heart Device, Repair of Stomach)
		373 Complications of Medical or Surgical Care with Surgery (Revision of Shunt, Other Major)
32:	Adverse Effects of Certain Substances	374 Adverse Effect of a Drug, Toxic Effect of Alcohol without Secondary Diagnosis
		375 Adverse Effect of a Drug, Toxic Effect of Alcohol with Secondary Diagnosis
		376 Toxic Effect (Lead, Acid, Alkali, Carbon Monoxide, Radiation) without Secondary Diagnosis
		377 Toxic Effect (Lead, Acid, Alkali, Carbon Monoxide, Radiation) with Secondary Diagnosis
33:	Special Admissions and Examinations without Reported Diagnoses	378 Prenatal Care, Medical and Surgical after Care (Dialysis) without Surgery
		379 Admission for Sterilization, Chemotherapy, Radiation Therapy without Surgery
		380 Follow up (Cancer) Surgery, Medical after Care (Colostomy, Orthopedic, Other) without Surgery
		381 Special Admission with Surgery (Sterilization, D&C, Other)
		382 Special Admission with Surgical Procedure (Bladder Visualization, Removal of Fixed Internal Device)
		383 Special Admission with Surgery (Exploration of Abdominal Cavity, Removal of Uterus, Other Major)

APPENDIX C

The New Jersey Model

for

Case Mix Reimbursement

Source: New Jersey Department of Health, "Prospective Reimbursement Experiment: Preliminary Design," September 10, 1976.

Table 4

C-1

SHARE COST CENTERS	SERVICE DEPARTMENTS
A. Direct Cost Centers	A. "Room & Board" Services
Nursing Administration, Acute Care Units	Nursing
Dietary	Dietary
Housekeeping, Laundry	Hotel
Residents, Physicians Coverage, Malpractice Insurance	Hospital Medical
Medical Records	Medical Records
Patient Care Coordination	Patient Care Coordination
Newborn Nursery	B. Charging Services
ICU	Newborn Nursery
Anesthesiology	ICU
Blood Bank	Anesthesiology
Central and Sterile Supply	Blood Bank
Delivery and Labor Rooms	Central and Sterile Supply
Dialysis	Delivery and Labor Rooms
Electrodiagnosis	Dialysis
Laboratory	Electrodiagnosis
Nuclear Medicine	Laboratory
Operating and Recovery Rooms	Nuclear Medicine
Other Physical Medicine	Operating and Recovery Rooms
Pharmacy	Other Physical Medicine
Physical Therapy	Pharmacy
Radiology Diagnostic	Physical Therapy
Respiratory Therapy	Radiology Diagnostic
Therapeutic Radiology	Respiratory Therapy
Other Ancillary Services	Therapeutic Radiology
	Other Ancillary Services
B. Indirect Cost Centers	
Administration & General	
Fiscal	
Plant	
Utilities	
Other General Services	
Education & Research	
Legal Fringe Benefits	
Policy Fringe Benefits	
Pensions	
Interest	
Misc. Overhead Recoveries	
C. Non-inpatient Cost Centers	
Sub-Acute Care Units	
Skilled Nursing Facility	
Emergency Room	
Clinics	
Home Health Services	

The reimbursement model which produces costs for treating each type of patient consists of four major steps.

STEP 1 MAPPING OF HOSPITAL ACCOUNTS TO COST CENTERS

In New Jersey, this function is performed within the SHARE accounting system. SHARE produces the cost centers shown as the first column in Table 4. The first set is considered Direct Cost Centers which map directly into the Service Departments shown in Column 2. The remainder are Indirect Cost Centers which are not allocated to the Service Departments.

The costs used for each SHARE center are only those pertinent to inpatients. The third listed set of SHARE Cost Centers are not inpatient related and, currently, will not be used in the model. This decision may be reversed during the experiment.

This step is illustrated in Figure 1.

STEP 2 ALLOCATION OF COSTS TO SERVICE DEPARTMENTS

The Service Departments listed in Column 2 of Table 4 are identified as those normally recovered under the room and board rate and those which charge for services. The second step of the model allocates all Direct to the Service Departments costs centers.

Table 4 is a draft of the Cost Centers and Service Departments to be used. Both lists may be modified by the State Department.

The solution to the allocation results in a matrix of unit values for each Coast Center where each element is a fraction of the Cost Center allocated to a Service Department.

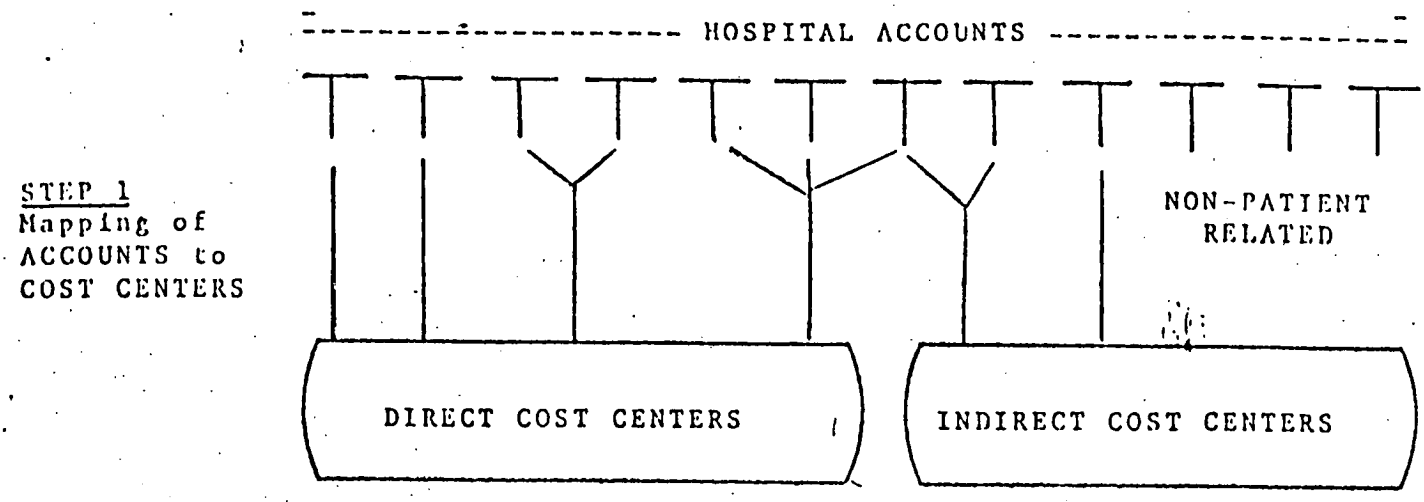
This step is illustrated in Figure 2.

---

1. Center for the Study of Health Services, Yale University SSA Contract 600-75-0180. Progress Report July 15, 1976.

Figure I

THE DRG COSTING MODEL

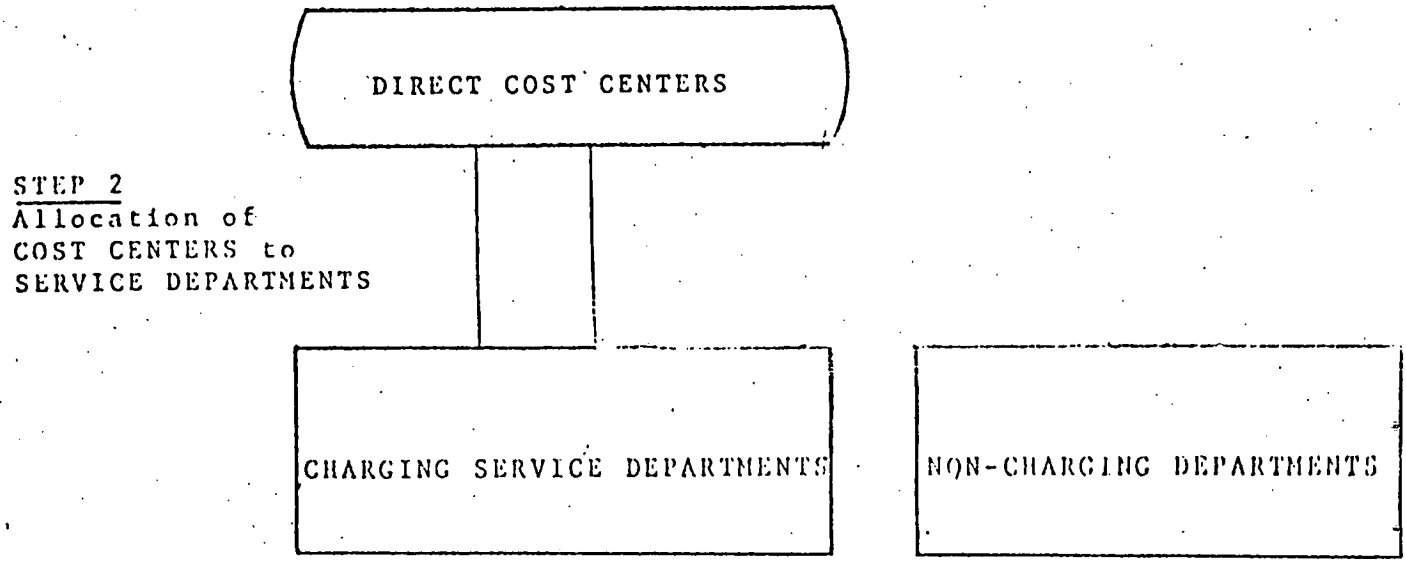


- Direct Cost Centers, e.g., lab, pharmacy
- Indirect Cost Centers, e.g., administration, plant operation
- Non-Patient Related Cost Centers, e.g., fund-raising, TV rentals, depreciation
- Outpatient costs are separated from the cost centers according to SHARE procedures

STEP 1 MAPPING OF HOSPITAL ACCOUNTS TO COST CENTERS

Figure 2

THE DRG COSTING MODEL



- To charging departments, e.g. lab, pharmacy
- To non-charging departments, e.g., nursing, dietary, hotel services

(Per Diem Costs are disaggregated)

STEP 2 ALLOCATION OF COSTS TO SERVICE DEPARTMENTS

STEP 3 SPREADING OF SERVICE DEPARTMENT COSTS TO DRGs.

The result of this step is a series of DRG-specific cost profiles. E.g., each DRG is shown with the total dollar amount consumed from each Service Department. This produces a "budget" for each DRG. The nature of the Service Department determines the method by which costs are spread to the DRGs using that service.

Nursing

A study was designed and conducted to measure the differences in the amount of nursing time consumed by patients according to their diagnostic classification.

From May to September of 1975 the Community Systems Foundation conducted a study of 1400 patients to determine staffing requirements. Twice daily nurses completed a checklist of procedures required by each patient. Weights reflecting nursing time were applied to each item on the list based on a time study at Rush-Presbyterian St. Luke's Hospital in Chicago. The results were the total requirements for nursing care for each shift. Given the cost of nursing for the year, the average nursing intensity per shift for a patient in each of the DRGs, and the total patient days for each of the DRGs, the nursing costs may be spread to the DRGs. A more complete description of the study including the 25 item nurses checklist is available upon request.

Dietary

A dietary study was conducted at Yale New Haven Hospital to determine whether the costs of meals varied across DRGs. The results indicated significant differences, hence dietary in addition to nursing is also disaggregated from Room & Board.

The first dietary study produced a range of raw food costs from zero to $6.55 per day for 19 different diet classifications. The second study determined the types and costs of meals consumed by members of the different DRGs based on a sample of 1,451 patients. To produce the average daily cost, each diet was costed for a full week to take into account unusually high or low cost food items. The daily raw food cost included breakfast, lunch and dinner. The hospital provided a Menu Item Index and Serving Cost report which showed, by month, the raw food cost per standard portion serving weight for all menu items. This report was used to determine raw food cost values.

The 1,451 patients in the study resulted in diet requirement measures for 65 of the initial patient groups. Demand levels for the remaining nine groups were established by physicians and dieticians. Given the average raw food requirements by

patient day within each DRG, and given case mix, total dietary costs may be allocated to the DRGs based on their proportional requirements for raw food. In the absence of preferred statistics, this ratio will be used in New Jersey allocations. A more complete description is available on request.

Hotel Services

Hotel services include the portions of housekeeping, laundry and other indirect costs which relate to direct patient care. Even though there may be variations across DRGs, for laundry for example, practicality causes hotel services to be allocated to DRGs on a daily rate per patient.

Hospital Medical

Using the number of hospital residents and interns assigned to each major clinical service (medicine, surgery, pediatrics etc.), the total hospital medical cost may be spread to the clinical services. The case mix provides the number of patient days spent by each DRG on each service. This statistic allows clinical service costs to be spread to the DRGs.

Medical Records and Patient Care Coordination

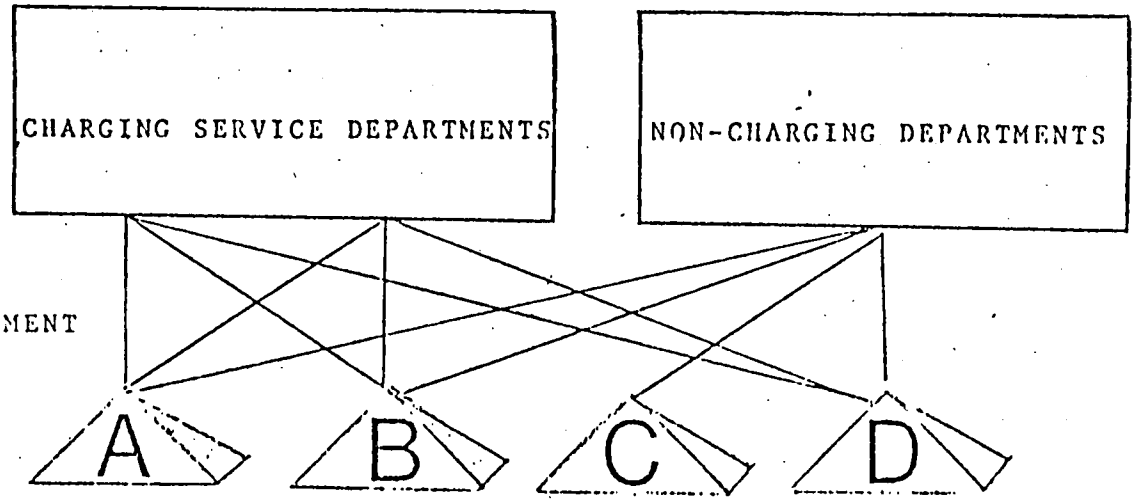
Medical records keeping effort is directly related to length of stay and number of patients. Medical records staffs have established a weighting scale: 1 - 5 days is Factor 1; 5 - 15 days is Factor 2; over 15 days is Factor 3. Medical records costs are distributed to the DRGs based on the portion of patients within each of the 3 categories. Patient Care Coordination efforts may be weighted similarly.

Charging Services

The logic used for calculating Medicare reimbursable costs by "department method" is applied to spread Service Department costs to DRGs. Each DRG generates a portion of Service Department revenue. That portion is used to allocate the Service Department costs to the DRG. In the absence of better measures of resource consumption by patient, this proportional method must be used.

Figure 3 summarizes the process.

Figure 3
THE DRG COSTING MODEL



STEP 3
Spreading of
SERVICE DEPARTMENT
COSTS to DRGs

- By ratio of costs to charges, e.g., lab, pharmacy
- Nursing costs by nursing intensity required for each DRG
- Dietary costs by diet-specific days required for each DRG
- By patient days, e.g., hotel services

STEP 3 SPREADING OF SERVICE DEPARTMENT COSTS TO DRGs

Certainly these methodologies are not sufficiently sensitive to measure all the realities of the hospital environment. The argument to be made, however, is not in defense of the ultimate methods chosen, but in favor of the awareness that resource consumption varies among Service Departments by DRG. We feel that the methods being used are at the state of the art and represent significant improvements over traditional cost accounting methods which are, themselves, never fully accurate in representing the hospital environment.

STEP 4 DETERMINATION OF PER-PATIENT COSTS

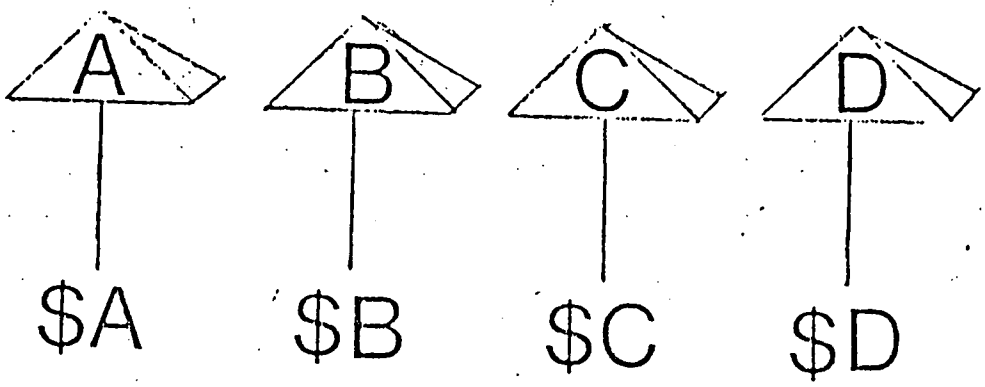
The hospital case mix provides the number of cases treated within each DRG. This number is divided into each of the Service Department totals for the DRG to determine the cost per patient. Summed, these per patient costs provide the total average cost to treat each type of patient.

Figure 4 summarizes the process while Figure 5 provides an overview of all four model steps.

The next section discusses different ways the State may use the data provided and suggests a methodology for budgeting.

Figure 4
THE DRG COSTING MODEL

STEP 4
Determination of per-patient costs



- A single cost per patient for each DRG is given, e.g., $2500 to treat a hip fracture.
- The single cost is divided into costs for each of the SERVICE DEPARTMENTS, e.g., for a hip fracture:

$150	Lab
$100	Pharmacy
$140	Operating Room
$1000	Nursing

- The makeup of COST components for the SERVICE CENTERS are retained, e.g., the total cost above is composed of:

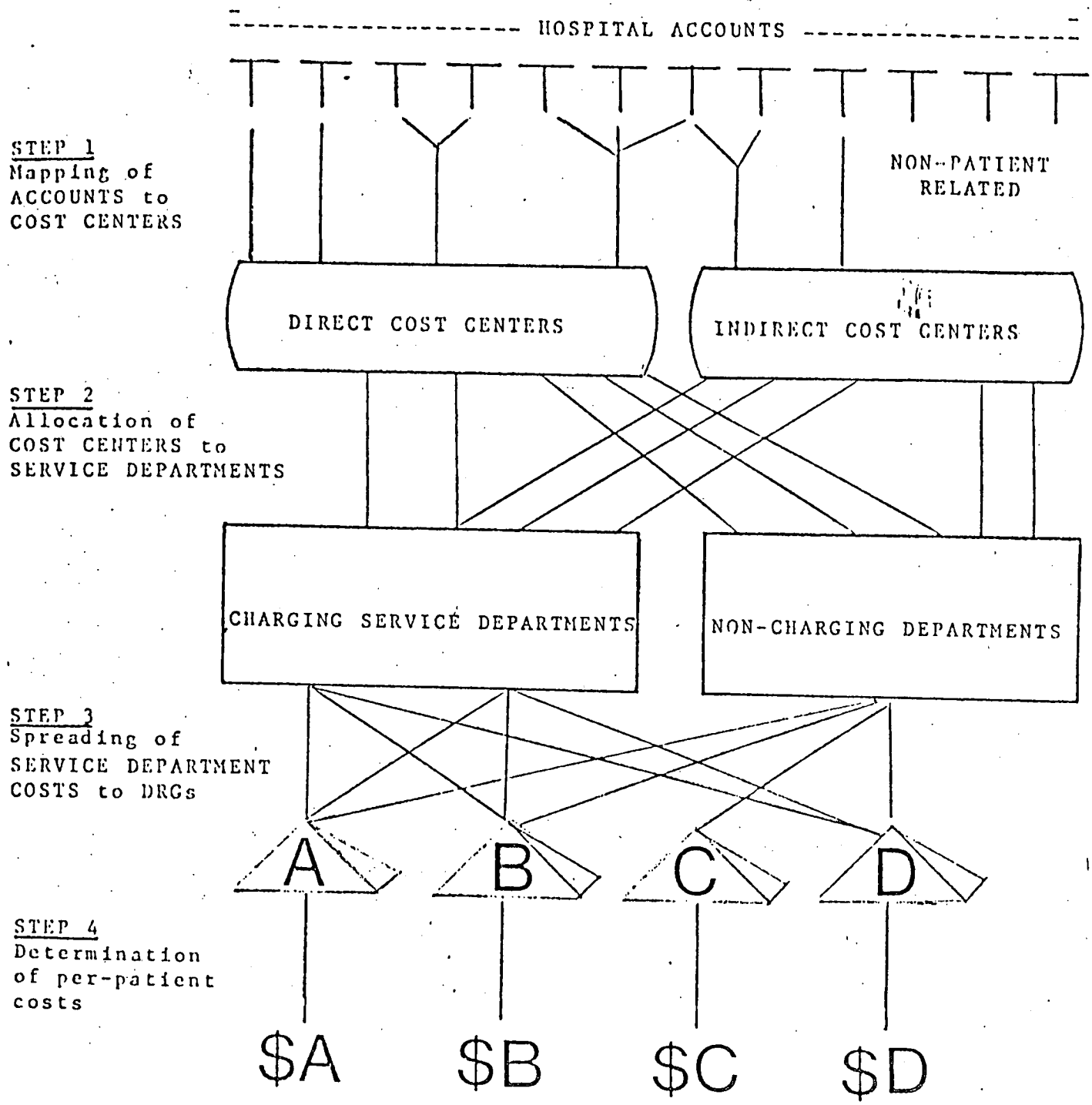
$1500	Direct Expense
$1000	Indirect Expense

- Total cost/charge comparisons can be made, e.g., $2400 charge; $2500 cost.

STEP 4 DETERMINATION OF PER PATIENTS COSTS

Figure 5

THE DRG COSTING MODEL



APPENDIX D

The New York State Case Mix Study

Source: NYS Office of Health Systems Management, January, 1979

IV. STRUCTURE

A. Overview of Four Phases of the Case Mix Study

The Case Mix Study is structured into four phases. Each phase produces a discrete but cumulative product; that is, each phase builds in part upon the data analysis and technical developments of the previous phase. The phases are not strictly sequential. Phases I and II focus on collecting and analyzing 1977 patient discharge, billing data and financial information from 5 major New York City teaching hospitals. During Phase I, software program development needed to merge the patient discharge and billing information and to allocate costs to cases and DRG's takes place. The conceptual work and the software for the cost finding and allocation process will be tested, refined and finalized during Phase II.

Phase III of the Study will concentrate on collection, processing and analysis of 1978 patient billing and medical abstract data from the expanded sample of 41 hospitals (Appendix A) throughout the State and apply the refined Phase II cost allocation process. During Phase III the DRG and its value as the basic payment unit for reimbursement and as a tool for planning will be examined. We will also continue to examine the need for adjustments to the cost allocation methodology.

Finally, Phase IV will focus on reimbursement and planning applications of case mix data. As part of this phase, staff will develop several reimbursement experiments which use case mix complexity. Experimental design uses of case mix range across the spectrum from an adjustment factor for clustering hospitals to the basis for developing case-specific or average case payment rates. Investigation into a series of planning and research questions, which will be outlined in more detail later, will also be a prime focus of attention during Phase IV.

A detailed description of each four phases follows:

1. Case Mix Study: Phase I (Completion September 1978)

a. Objectives: The first phase of the Study has:

- completed the development of the methodology to be used to find and allocate cost to the DRG; tested and modified software developed for matching and merging patient discharge and billing data;

- developed a financial questionnaire which will convert the current "responsibility" based Uniform Financial Report to a functional reporting system. This will facilitate more consistent and more accurate cost allocation/cost finding processes among the hospitals.

b. Data Inputs: Phase I work was based upon patient discharge data abstracts and detailed patient bills collected for calendar year 1977 from 5 major teaching hospitals in New York City. These 5 hospitals are: Montefiore Medical Center, Mt. Sinai Medical Center. The New York Hospital-Cornell Medical Center. St. Luke's Hospital and St. Vincent's Hospital (NYC). Each hospital was also asked to submit its Uniform Financial Report for 1977 and to fill out the financial questionnaire discussed above which displays each cost element in the cost center where the cost is incurred. This has promoted better cost finding and a basic level comparability of cost allocation among the five hospitals.

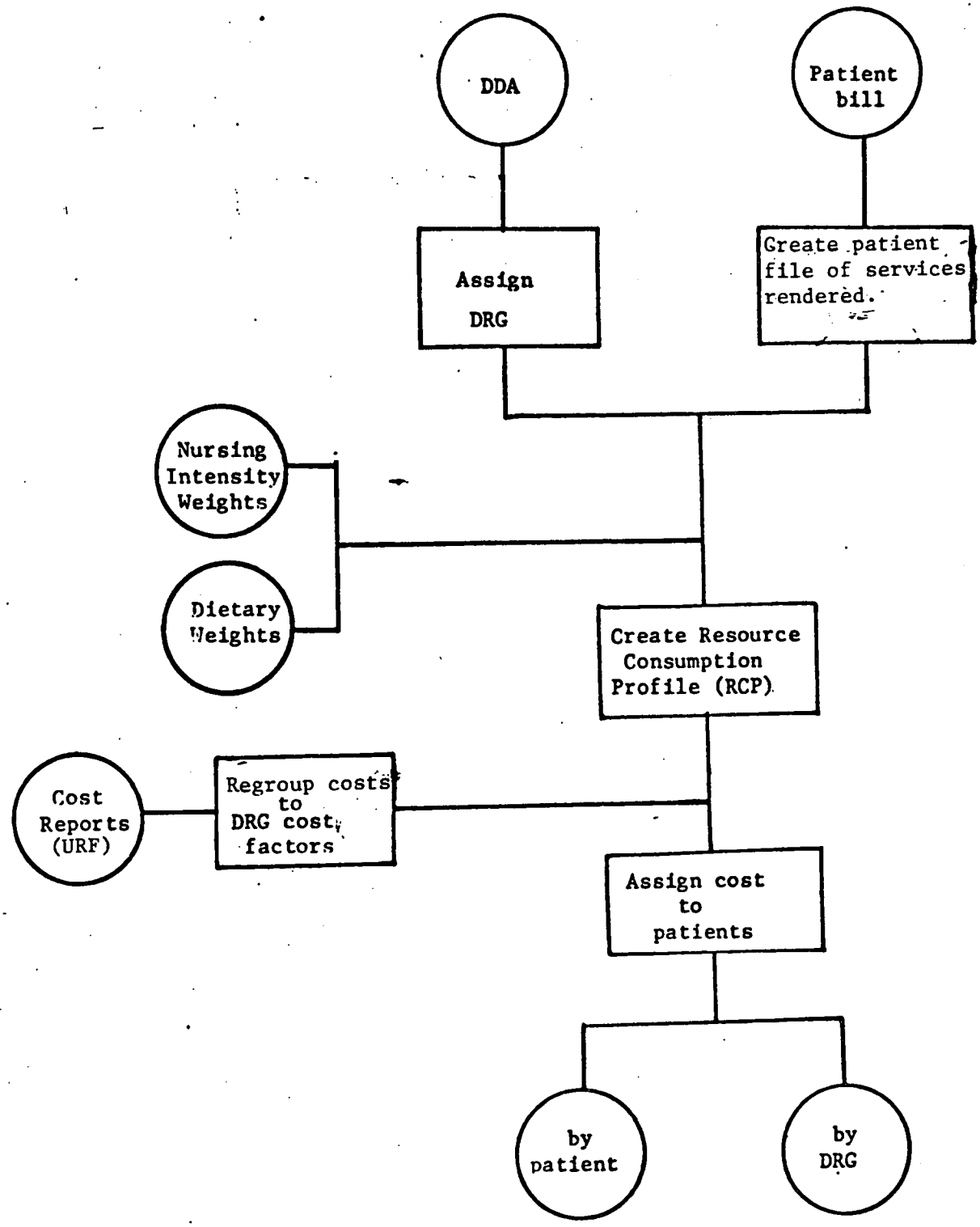
c. Data Processing and System Output: The hospital profile and comparative analysis reports have been completed and sent to each of the Phase I participants. We have talked to the participants individually and as a group about the results of Phase I processing. The "front-end" preparation of the input for the cost processing involved considerable firsthand contact with the executive and financial officers of participating hospitals. Patient bills, discharge data abstracts, and hospital expenses were processed according to a cost finding methodology developed for Phase I of the Case Mix Study. The following is an abbreviated step by step description of the Phase I costing process:[5] (see Exhibit I)

---

[5]"Case Mix Study Phase I Cost Processing Methodology", Hoffman, Michael, August 1978.

Exhibit I

Condensed Case Mix Processing Flow



Routine Cost Matrix
Ancillary Cost Matrix

Step 1: Data contained on the discharge data abstracts is used to assign each patient to a Diagnosis Related Group (DRG).

Step 2: Data contained on the patient bill is extracted and used to create a service demand profile on each patient, that is, a listing of all the ancillary and routine services used by the patient.

Step 3: The cost of operating routine inpatient areas is regrouped (from UFR) into three categories: nursing, dietary and routine support. (Ancillary costs are treated separately. See Step 7) In the costing process these three categories of routine service must be distinguished from one another since on the patient bill all routine services are aggregated under a single daily room and board charge.

Step 4: Nursing costs are associated with the patient through use of a nursing intensity weighting scale. This scale, which ranges from 1 to 8, assigns a weight factor to each DRG. Once a patient has been classified by DRG (Step 1) a weighting factor can be identified. The factor is then multiplied by the number of days the patient spent in the hospital giving nursing units per patient. These units are aggregated by DRG and are used to allocate the total nursing costs recorded on the UFR (Step 3).

Step 5: Dietary costs are associated with the patient through use of a dietary weighting scale. This scale is used in the same manner as the nursing intensity weight scale described in Step 4.

Step 6: Routine support costs are the residual regrouped costs remaining under routine services once nursing and dietary costs have been regrouped from department costs reported on the UFR. Routine support costs are associated with the patient on the basis of (unweighted) patient days.

Step 7: Ancillary costs are associated with the patient on the basis of a ratio of cost to charges (RCC) developed for each ancillary service, where the cost of an ancillary service is divided by its inpatient revenue. The resulting RCC is then multiplied by the gross charges for the patient to produce an estimated cost per patient for a particular ancillary service department.

Step 8: The Routine Cost per patient (Steps 3 through 6) and the Ancillary Cost per patient are summed to produce total cost per patient. The average cost per DRG can then be obtained by summing cost per patient by DRG and dividing by the number of patients in the DRG.

It should be noted that the nursing intensity weights for Phase I cost processing are based upon an application of the Rush-Presbyterian-St. Luke's Hospital Nursing task classification methodology for a study of nursing usage by DRG at Yale-New Haven Hospital.[6] A HANYS study of nursing usage by patients occupying medical-surgical units in N.Y.S. hospitals, which determined that 30% of nursing hours are fixed, i.e. not case-related, was used to modify the Yale-New Haven weights. These fixed nursing hours are allocated to the patient on an undifferentiated patient day basis. The remaining 70% of nursing usage in non-critical care units will be associated with the DRG using Yale-New Haven weighted days of care. All days spent in critical care will be associated with the DRG on an unweighted daily basis.[7] Dietary weights, developed on the basis of relative food costs for various patient diets, were based upon a study performed at hospitals in the State of New Jersey. The dietary weights are used in a manner similar to nursing weights to define relative daily consumption of dietary services by DRG.

---

[6] Yale University, Institution for Social & Policy Studies, Center for the Study of Health Services, Progress Report, Yale Univ. July 1976.

[7] "New York State Case Mix Study Nursing Intensity Weights: Phase I and II, "Pihlcrantz, David, September 1978.

2. Phase II: (Completion January 1979)

a. Objectives: On the basis of the information gathered, processed and analyzed during Phase I we have completed the development of the cost finding/allocation process. This included effort to develop more sensitive nursing intensity weights and to better distinguish between DRG and non-DRG related costs. With the aid of the Case Mix Advisory Group, staff has identified cost finding/allocation issues and their corresponding solution/options.

b. Data Input: Phase II work was also based on the 1977 patient billing and abstract data from the five major New York City teaching hospitals, their Uniform Financial Reports (UFR), and a financial questionnaire which asks each participating hospital to display 35 identified cost elements in the cost center where cost is incurred. This facilitated better cost finding and a basic level of comparability among hospitals. The 35 cost elements are listed on Table II.

c. Output: The cost allocation methodology that resulted from Phase II represents refinement of the various elements of the Phase I process displayed in Table III. For example, nursing intensity weights used in Phase I were validated before being used in Phase II processing. Work in this area was conducted with the Hospital Association of New York State (HANYS) taking the lead in this study. They conducted their own nursing task study during December of 1978. The HANYS study plus the results from four studies being conducted in New Jersey and a validation study at Yale-New Haven should enable us to complete the development of the nursing intensity weights by the end of Phase II.[8] Dietary weights developed in the State of New Jersey are used in Phases I, II and III.

[8] A synopsis of the New Jersey studies can be found in the Annual Report, Volume I, "A Prospective Reimbursement System Based on Patient Case-Mix for New Jersey Hospitals 1976-1978," New Jersey State Department of Health.

Perhaps the major distinction between Phases I and II vis-a-vis the cost allocation process is the expansion of the number of cost factors or elements which will be investigated. In contrast to Phase I where four cost elements were used to classify expenses, 35 cost elements have been identified for Phase II processing. (See Table II)

Another important distinction between Phase I and Phase II is the introduction of matrix inversion (versus single stepdown) and a traceback methodology. This traceback enables the retention of information regarding the ultimate origin and beginning expense of each cost center.

Completion of the cost processing methodology and resolution of cost allocation issues for Phase II forms the basis for Phase III.

3. Phase III: (September 1978 - September 1979)

a. Objectives: The collection, processing and the analysis of data from the 41 hospitals participating in the 1978 Case Mix Study is being carried out in Phase III. The analysis conducted during this phase will be based on a series of case mix hospital profile and comparative group analysis reports that will be generated during Phase III. Investigations into the utility of the DRG as a basic investigation unit i.e., its variance and value as a service/pricing instrument will be examined in Phase III. One of the fundamental objectives of the CMS is to examine and explain the differences in costs among individual hospitals and hospital groupings. In the pursuit of this objective we are making certain equalizing adjustments in Phase III to wages and salaries, utility costs and other input prices. These adjustments are being made either on an individual hospital or regional level depending upon information availability and significance.

b. Data Input: Patient billing and patient medical abstract data from the 41 hospitals throughout the State are being used in conjunction with their 1978 Uniform Financial Reports to develop case mix data for the 1978 study. (For a list of the 41 hospitals see Appendix I). The financial questionnaire developed for Phase II is also used for Phase III.

TABLE II

CASE MIX STUDY

List of 35 Major Cost Elements to be Studied in Phase II and Phase III

Capital Costs

1. Depreciation and Interest - Building and Fixed Equipment
2. Leases and Rentals - Building and Fixed Equipment
3. Depreciation - Movable Equipment
4. Leases and Rentals - Movable Equipment

Salary Costs

5. Intern's and Resident's Salaries - Approved Programs
6. House Staff Salaries (Non-Approved Interns and Residents)
7. Supervising Physician's Salaries
8. Other Physician's Salaries
9. R.N. Salaries (Patient care only, including supervisors)
10. L.P.N. Salaries
11. Nurse Aides, Orderlies, and Ward Clerk Salaries
12. Nursing Administration Salaries (Other than Direct Patient Care, Including Clerical Support)
13. School of Nursing Salaries
14. Maintenance and Repair Salaries
15. Laundry Salaries
16. Administrative and General Salaries (Including Admin., Bus. Off., Acct., Admitting, etc.)
17. Other Salaries (Non-Physician)
18. Transporter Salaries

Fringe Benefit Costs

19. Legally Mandated Fringes (FICA, Workmen's Comp., Disability Insurance, Unemployment Insurance)
20. Pensions
21. Other Fringes
22. Accrued Vacation Front End Costs (Conversion from cash method to accrued method)

Other Costs

23. Physician Fees
24. Electricity
25. Oil, Natural Gas, Steam, Water, and Sewer, and other Utilities
26. Other Maintenance and Repair Costs
27. Non-Salary Housekeeping Costs
28. Non-Salary Laundry Costs
29. Food Costs
30. Insurance Costs - Malpractice
31. Insurance Costs - Other
32. Other Non-Salary A & G Costs
33. Drugs
34. Medical Supplies
35. Other Non-Salary Costs

c. Tasks and Outputs: Data tapes have been received from nearly all of the Phase III participants. The tapes have begun to be processed and where errors were identified hospitals have been notified so that corrections can be made. Phase III will also produce a series of reports which profile case mix and per case costs for each hospital plus group comparison of hospitals in the sample. On the basis of these reports, staff will examine patient mix and how it varies by hospital type, size, teaching status and payor. The Study will also begin to examine the utility of its classification system (the DRG) by testing the effect of using cost as the dependent variable in the DRG grouping process versus the length of stay. Finally, research during Phase III will focus on developing a system of "service intensity weights" (SIWs); that is, a relative measure or index of resource consumption as a proxy for complexity. Staff will also examine whether a single complexity scale is applicable to all hospitals.

4. Phase IV: (December 1978 - Ongoing)

a. Objectives: The fourth phase of the Case Mix Study will focus on application of the methodologies, technology and findings of the CMS to health care reimbursement, planning and management. Seven major applications of this data that take place during Phase IV are discussed below.

b. Tasks and Outputs:

(1) Several reimbursement experiments currently under development in New York will utilize CMS data for per discharge payment. Other experimental designs to be explored include:

- case-specific payment
- composite average per discharge payment
- capped revenue with case mix adjustments
- hospital grouping techniques using case mix complexity measures as an independent variable

(2) Processing of hospital reimbursement appeals based on case mix using CMS methodology and software support.

(3) Development of a software statewide reimbursement system incorporating a case mix complexity factor.

(4) Research and analysis of questions on the use of case mix complexity indices for reimbursement, financing, and planning.

(5) Use of CMS data for regional health care planning.

(6) Transfer of Case Mix Study software technology onto the N.Y. Statewide Planning and Research Cooperative System (SPARCS), including merging of patient bills, medical abstracts, and hospital financial statements and the use of the Case Mix System as a SPARCS report generator.

(7) Use of Case Mix System reports in the area of quality assurance; i.e, cost profiles by DRG, by provider for the purposes of medical audit, utilization review, monitoring and surveillance.

Among the questions regarding the reimbursement financing and planning which the availability of case mix data will permit us to investigate during Phase IV are the following:

-Does the case mix of a hospital vary from year to year, and if so does it vary in a predictable way?

-If case mix is not constant and not predictable how can adjustments be made and if so how often should they be made?

-In structuring a reimbursement system what elements of cost should be considered "core costs" (i.e., case-related) and which should be considered fixed or non-case related?

-Does case mix adequately explain cost differences across hospitals?

-What are the relative merits of case specific vs average case payment systems?

SELECTED BIBLIOGRAPHY

GENERAL BACKGROUND

Lave, Judith R. and Lave, Lester B., "The Extent of Role Differentiation Among Hospitals," Health Services Research. VI (Spring, 1971), pp. 15-38.

Luke, Roice D., "Dimensions in Hospital Case Mix Measurement," Inquiry. XVI (Spring, 1979), pp. 38-49.

DIAGNOSIS RELATED GROUPS

Fetter, R. B. et al., Case Mix Definition by Diagnosis Related Groups. Yale School of Organization and Management, Working Paper, Series B-Technical.

Thompson, John D. et al., "One Strategy for Controlling Costs in a University Teaching Hospital," Journal of Medical Education. LIII (March, 1978), pp. 167-175.

DISEASE STAGING

Garg, Mohan L. et al., "Evaluating Inpatient Costs: The Staging Mechanism," Medical Care. XVI (March, 1978), pp. 191-201.

COMPLEXITY INDEX

Horn, Susan D. and Schumacher, Dale N., "An Analysis of Case Mix Complexity Using Information Theory and Diagnostic Related Grouping," Medical Care. XVII (April, 1979), pp. 382-389.

MARYLAND GUARANTEED INPATIENT REVENUE SYSTEM

A Guide to Rate Review in Maryland Hospitals -- Volume II: The Guaranteed Inpatient Revenue System: Lutherville, Maryland: Maryland Hospital Education Institute, 1979.

NEW JERSEY CASE-MIX EXPERIMENT

New Jersey Department of Health, A Prospective Reimbursement System Based on Patient Case-Mix for New Jersey Hospitals, 1976-1983: DRG Manual, 1979 NJBC Payment Experiment, New Jersey Department of Health; Trenton, New Jersey.

NEW YORK STATE CASE MIX STUDY

"An Overview of the New York State Case Mix Study," Data System Development Project, New York State Office of Health Systems Management, (January, 1979).