United States General Accounting Office

GAO

Briefing Report to the Ranking Minority Member, Special Committee on Aging, U.S. Senate

December 1988

MEDICARE

An Assessment of HCFA's 1988 Hospital Mortality Analyses

GAO/PEMD-89-11BR

GAO

United States
General Accounting Office
Washington, D.C. 20548

Program Evaluation and
Methodology Division

B-229397

December 13, 1988

The Honorable John Heinz
Ranking Minority Member
Special Committee on Aging
United States Senate

Dear Senator Heinz:

In response to your request, we examined the analytical approach that the Health Care Financing Administration (HCFA) employed in its 1988 analyses of Medicare hospital mortality. We assessed the extent to which changes that HCFA made in its approach resolved the issues we had raised concerning its 1987 hospital mortality analyses (see Medicare: Improved Patient Outcome Analyses Could Enhance Quality Assessment, GAO/PEMD-88-23, June 1988). And we analyzed the likely effect of those changes on the accuracy, that is, the validity, of the upcoming results compared to those released last December.[1]

Results in Brief

HCFA has made several refinements in its analytical approach to hospital mortality analyses that address in whole or part some of the concerns we had raised about its 1987 analyses. It has (1) modified the composition of the 17 broad categories used to characterize the principal diagnosis of all Medicare patients—to reduce the variation in the mortality rates associated with the individual principal diagnoses consolidated under those categories,[2] (2) reported outcomes for each hospital over several years rather than a single year, and (3) initiated studies to validate its analytical approach.

[1]By analytical approach we mean the specific procedures followed, including the selection and measurement of variables incorporated into the analyses and the statistical techniques employed.

Validity refers to how well a specified measure or indicator represents the attribute or condition that it attempts to characterize in observable form. In this case, the validity of the HCFA hospital mortality analyses as an indicator of the quality of care provided by those hospitals depends on the extent to which HCFA's hospital ratings correspond to the actual occurrence of quality problems in those hospitals.

[2]Principal diagnosis is "the condition established after study to be chiefly responsible for occasioning the admission of the patient to the hospital for care." (See the National Committee on Vital and Health Statistics, "Uniform Hospital Discharge Data Set, Final Summary Report of Activities, 1975-1978," reprinted as appendix X in Robert B. Fetter et al., The New ICD-9-CM Diagnosis-Related Groups Classification Scheme, HCFA Pub. No. 03167 (Baltimore: Department of Health and Human Services, Sept. 1983), p. 456.)

Nevertheless, HCFA's current analytical approach and associated validation efforts still have several limitations that diminish its ability to ensure the validity of its analyses. First, HCFA's approach fails to take account of the wide variations that persist in the mortality rates of the principal diagnoses included in many of the 17 broad categories. Second, the three validation studies that HCFA has underway will produce fairly strong evidence on one important question: the degree to which the analyses are affected by the lack of detailed clinical data on individual patients. However, they will provide only tentative evidence on what we would argue is a more central validity issue: the correspondence between the results of the mortality analyses and the actual distribution of confirmed quality problems among hospitals. Moreover, none of HCFA's ongoing validity studies will consider alternative approaches that potentially could improve on its chosen approach. Finally, HCFA has so far undertaken only limited explorations of missing and inaccurate data in the computerized files it uses in performing its hospital mortality analyses. Although these explorations identify a number of serious deficiencies in the data, they cannot provide the comprehensive, systematic assessment needed to estimate the effect of any deficiencies on the results of the analyses.

In sum, HCFA has modified its approach for conducting hospital mortality analyses in ways that we believe will enhance the validity of the upcoming results—compared to those released last year—as an indication of the quality of care provided in different hospitals. However, until HCFA expands on its current efforts to validate its analytical approach and to examine the effect of data deficiencies, we will still lack a rigorous assessment of just how valid these analyses are in terms of the actual proportion of hospitals that are correctly identified as having, or not having, quality of care problems.

Background

In December 1987, HCFA released an analysis of 1986 Medicare patient mortality rates in each of 5,971 acute care hospitals. For each hospital, HCFA reported the number of Medicare patients treated, the percentage of them who died, and the range of mortality rates that would normally be expected for that hospital given the mix of its patients. HCFA calculated expected mortality by performing a logistic regression analysis of selected patient risk factors for 17 separate diagnostic categories. Summing across the 17 categories provided comparable estimates for overall mortality among all Medicare patients treated in each hospital. (Appendix I describes these procedures in greater detail.) In about 4 percent of

the hospitals, observed overall mortality rates fell outside the range of expected rates.

In reporting these results, HCFA emphasized that limitations in the available data prevented it from adjusting fully for the variations among patients treated in different hospitals that could affect their probability of dying. It noted that the difference between observed and expected mortality should therefore not be interpreted as a direct measure of the quality of care provided by these hospitals. Nonetheless, HCFA believed that these results provided information that could usefully guide efforts by hospital administrators, Peer Review Organizations (PROS), and others responsible for monitoring hospital performance in their evaluation of the relative strengths and weaknesses of individual hospitals.

In June 1988, we issued the report cited above that examined the analytical approach employed in the 1987 hospital mortality analyses as part of a broader review of HCFA's analyses of Medicare patient outcomes. We assessed the substantive focus and technical adequacy of the analyses and compared them to six alternative approaches developed by HCFA contractors and independent researchers. Our evaluation encompassed the definition of the diagnostic categories, the selection of patient risk factors, and statistical methods used to estimate expected mortality and calculate confidence intervals around those estimates.

We concluded that the 1987 analyses represented a substantial improvement over an earlier set released by HCFA in March 1986. However, we recommended a number of additional improvements to the analyses of Medicare patient outcomes. In its official comments on the draft of that report, HCFA generally concurred with these recommendations, although it did not always address the specific points we raised.

In a second report issued in June 1988, we compared HCFA's analytical approach in the 1987 hospital mortality analyses with plans developed by the Veterans Administration for similar analyses of its own hospitals.[3] Although the VA based its approach on HCFA's, it made a number of refinements that paralleled several of the recommendations we had made to HCFA.

[3]VA Hospital Care: A Comparison of VA and HCFA Methods for Analyzing Patient Outcomes (GAO/PEMD-88-29, June 1988).

Objectives, Scope, and Methodology

As requested, our objectives in this study were to describe any changes made in the analytical approach employed in HCFA's 1988 hospital mortality analyses compared to the year before, to analyze the extent to which those changes resolved the issues raised in our previous report, and to assess the likely effect of those changes on the validity of the 1988 mortality analyses as an indicator of hospital performance.

Your request focused specifically on HCFA's 1988 hospital mortality analyses. Therefore we did not examine related studies of patient outcomes that HCFA has recently undertaken as part of its "effectiveness initiative," which are designed to assess the relative efficacy of different medical interventions.

Your desire that we issue this report concurrently with HCFA's release of its mortality data limited the time available for our study. Thus, we focused our data collection efforts on interviews with and solicitation of documents from the HCFA staff responsible for the hospital mortality analyses and the contractors who have performed some of the analytical tasks involved.

We relied primarily on the HCFA staff to identify the changes made in the approach employed for the 1988 analyses. We drew wherever possible for our description of those changes from internal papers, computer printouts, or any other documents that HCFA provided in response to our request. Where necessary we supplemented these written sources by interviewing HCFA analysts and contractors conducting the analyses. Our description of HCFA's changes to its analytical approach and of its associated validation studies reflects the information obtained from all these sources as of September 30, 1988. Because our data collection and analysis took place while these analyses and studies were still underway, our description does not incorporate any changes or decisions that may have occurred after that date.

We also examined the changes made in HCFA's 17 broad groupings of principal diagnoses. (Appendix II compares the 1987 and 1988 diagnostic categories.) We analyzed the data file that a HCFA contractor, Michael Pine and Associates, used to develop the modified categories. This data set, which contains the frequency and death rate for each principal diagnosis recorded for a random sample of approximately one million Medicare hospital patients in 1985 and 1986, enabled us to calculate the range of mortality rates found among principal diagnoses included within each of the 1987 and 1988 diagnostic categories (see appendix

III). However, we did not independently verify the accuracy of the data in this file.

In accordance with your request, our analysis of HCFA's changes in approach took as its point of departure the issues we raised in our previous report. We assessed the extent to which HCFA's changes resolved those issues, either by adopting the recommendations we had made or through some other means. As part of that assessment, we asked the responsible HCFA staff to explain their reaction to the issues and recommendations outlined in our earlier report, and we present here their reasons for sometimes coming to different conclusions than we did.

The following sections describe and analyze HCFA's changes in terms of four key questions. They are: (1) To what extent has HCFA used available diagnostic data to adjust hospital mortality rates for variations in the mix of patients treated by different hospitals? (2) To what extent has HCFA reduced the uncertainty in individual hospital assessments caused by random or chance fluctuations in their observed death rates? (3) To what extent does HCFA intend to validate its analytical approach? (4) To what extent is HCFA's approach vulnerable to inaccuracies in the computerized data employed for the hospital analyses? Although the third question addresses most explicitly the issue of validity, the other three also focus on factors that are likely to affect the validity of mortality analyses as indicators of quality of care differences among hospitals.

For each question we (1) explain the nature of the problem we identified in our earlier report as it relates to hospital mortality analyses, (2) recount the rationale for the recommendation we made to address that problem, (3) describe those changes HCFA has made that could affect the problem, and (4) analyze the probable effects of those changes, including the extent to which they are likely to resolve the original problem and enhance the validity of HCFA's hospital mortality analyses.

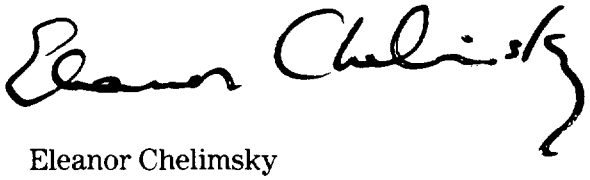
As you requested, we obtained informal, oral agency comments on a draft report from HCFA officials. Most of their suggested changes were editorial in nature. In addition, we obtained comments from Dr. Michael Pine and Dr. Arthur Hartz on the portions of the report that pertain to their work as HCFA contractors. We revised the draft, where appropriate, in response to the comments received from both the HCFA officials and contractors.

We plan no further distribution of this report for 30 days. At that time we will send copies to the Secretary of Health and Human Services, the

Administrator of HCFA, and to other interested congressional committees. We will also make copies available to others on request. If you have any questions, please call me at (202) 275-1854.

This report was prepared under the direction of Lois-ellin Datta, Associate Director. Other major contributors are listed in appendix IV.

Sincerely yours,



Eleanor Chelimsky
Director

Contents

Abbreviations

DRG	Diagnosis-related group
GAO	General Accounting Office
HCFA	Health Care Financing Administration
ICD-9-CM	International Classification of Diseases, 9th Revision, Clinical Modification
MEDPAR	Medicare Provider Analysis and Review File
PRO	Peer Review Organization
VA	Veterans Administration

The Use of Available Diagnostic Data to Adjust for Patient Case-Mix

Nature of the Problem

We noted in an earlier report that each of HCFA's 17 diagnostic categories included a large number of individual principal diagnoses (see appendix II).[1] Within any given category, the mortality rate experienced by patients having those specific diagnoses could vary substantially (see appendix III). Nonetheless, the 1987 analyses relied on the 17 categories alone to adjust for differences among hospitals in their case-mix, that is, the distribution of principal diagnoses among the patients they treated. As a result, the 1987 HCFA analyses tended to underestimate expected mortality in hospitals admitting a disproportionate share of patients with high-risk diagnoses and overestimate expected mortality in hospitals treating relatively more patients with lower risk diagnoses within a given diagnostic category.

Prior GAO Recommendation

We observed in our June report that several alternatives to HCFA's approach to mortality analyses took account of differences in the death rates associated with individual principal diagnoses in calculating expected mortality rates. We therefore recommended that HCFA adopt, after appropriate testing, a more sophisticated adjustment for patient severity that would exploit more fully the available diagnostic data on individual patients.[2]

Relevant Changes in the 1988 Approach

HCFA has made three changes in an effort to improve the adjustment for patient severity. First, it modified the 17 diagnostic categories, sacrificing a degree of clinical coherence in order to reduce the variation within each category in the mortality rates of the discrete principal diagnoses. Appendix II lists the ICD-9-CM codes included in the 1987 and 1988 diagnostic categories.[3]

Second, HCFA altered its method for calculating two patient risk factors. Age, which HCFA had entered into the 1987 analyses as six discrete

[1]Medicare: Improved Patient Outcome Analyses Could Enhance Quality Assessment (GAO/PEMD-88-23, June 1988).

[2]We use the terms "patient severity" or "severity of illness" to refer to the full range of demographic (e.g., age, sex) and clinical factors, including both principal diagnosis (the main reason for admission to a hospital) and comorbidities (diagnosed problems that are not related to the principal diagnosis), that could affect a patient's prospects for recovery.

[3]ICD-9-CM stands for the "International Classification of Diseases, 9th Revision, Clinical Modification," the coding scheme mandated by the federal government for reporting patient diagnoses and diseases to HCFA and U.S. Public Health Service programs. It is an extension of the "International Classification of Diseases, 9th Revision," published by the World Health Organization.

groupings, was transformed into a continuous variable designed to capture better the exponential increase in mortality observed in older age cohorts. Prior hospital admissions, which in 1987 had been a simple count of previous admissions for any reason within the same calendar year, was adjusted in the 1988 analyses to count prior admissions over a standard 6-month period, including the previous calendar year if need be. This variable now also distinguished among admissions for high-, medium-, and low-risk conditions.[4]

HCFA analysts report that these three changes—particularly the modification of the diagnostic categories—greatly improved the ability of the model to predict mortality among individual patients.

GAO Analysis of HCFA's Changes

HCFA revised the composition of its 17 diagnostic categories to try to make the mortality rates of the principal diagnoses included within them more uniform or homogeneous. To the degree this goal was achieved, the revised categories should provide a better adjustment for differences among hospitals in the mix of patients they treat. We analyzed the data HCFA used to create these revised categories in order to provide a quantitative indication of how much the mortality risk within categories actually narrowed. We also examined the magnitude of the changes in these categories, that is, the relative proportion of Medicare patients who shifted categories.

The results of our comparison of the 1987 and 1988 diagnostic categories appear in appendix III. We found that the range of mortality rates associated with the principal diagnoses assigned to most of the categories decreased somewhat, but often a substantial amount of variation in rates remained. In three categories the range of mortality rates actually increased appreciably.[5] Major disparities in mortality rates persist within most of the high-risk diagnostic categories, including severe trauma (4.6 to 100 percent), gastrointestinal catastrophes (9 to 80.4 percent), severe acute heart disease (9.9 to 79.2 percent), and cancer (0 to 54.5 percent). The mortality rates representing the 10th through the 90th percentiles of cases within the high-risk categories show that this dispersion is not limited to a few extreme cases. For most categories, though, the variation in mortality rates over the mid-range diagnoses (30th to 70th percentiles) is considerably smaller than the overall range.

[4]These three groups represent an aggregation of the 17 diagnostic categories shown in appendix II.

[5]Severe trauma, sepsis or infectious disease, and ophthalmologic or neuropsychiatric and sensory disease.

HCFA staff members explain that disparities remain in the mortality rates of the principal diagnoses included in the diagnostic categories because they wanted to maintain some of the clinical coherence that guided the construction of those categories in 1987. However, the data in appendix III provide mixed support for this explanation. Several categories with sizable disparities in their principal diagnosis mortality rates experienced relatively little change. Other categories continue to have large disparities in mortality rates, even with major changes in composition. Overall, the assignment of principal diagnoses to the 17 diagnostic categories changed substantially. Approximately 30 percent of Medicare patients shifted from one category to another under HCFA's new classification scheme.

Although HCFA has reduced the magnitude of the disparity in mortality rates within most categories, the appreciable differences that remain limit the capacity of these categories alone to adjust for variations in patient case-mix at different hospitals. This problem is most acute for analyses that focus on individual diagnostic categories, particularly those such as severe trauma and renal disease that represent a broad range of mortality rates but a relatively small proportion of Medicare patients. Variability within diagnostic categories should have less impact on analyses of overall mortality, in part because the categories with the largest number of patients and patient deaths will most heavily influence the range of expected mortality rates. Several of the larger categories in the high-risk group, most notably pulmonary disease and chronic heart disease, have less variation in the mortality rates of their constituent principal diagnoses than do most other high-risk categories.

The HCFA staff responsible for the hospital mortality analyses have specifically rejected one strategy for dealing with variation in mortality rates within diagnostic clusters that the Veterans Administration and others have employed in their hospital mortality analyses. This alternative to HCFA's approach involves adjusting in one way or another for the mortality rate of individual principal diagnoses as part of the logistic regression equation intended to model patient condition or severity.[6] Unlike the analysts who have made this adjustment, HCFA analysts consider it illegitimate to include a risk factor in the regression analysis reflecting variation in mortality risk among individual diagnoses. This

[6]Medicare: Improved Patient Outcome Analyses Could Enhance Quality Assessment (GAO/PEMD-88-23, June 1988) assesses alternative analytical approaches developed by HCFA contractors and independent researchers.

would represent, in their view, a circular logic that simply used mortality to predict mortality.

We nevertheless continue to urge HCFA to evaluate, through appropriate validation studies, an adjustment for the mortality rates of individual principal diagnoses, rather than dismiss this approach out of hand. In our view, HCFA's objection would have more force if the regression analyses were intended to identify the fundamental reasons why particular patients live and others die. However, HCFA uses the regression equations for a quite different purpose: to adjust comparisons of outcomes among groups of patients treated at different hospitals. Taking account of the overall mortality rate for a given medical condition does not distort a comparison of the outcomes of one hospital to another, but it could permit a finer degree of risk adjustment than HCFA's present approach can achieve. Any fairly small number of diagnostic categories will inevitably contain principal diagnoses that vary somewhat in their risk of mortality. Inclusion of a patient risk factor that in some way takes account of the mortality rate of individual diagnoses provides a means of compensating for that heterogeneity without excessively expanding the number of diagnostic categories.

One of the three validation studies that HCFA currently has underway (described in section 3) should bring some empirical data to bear on this issue. The study involves abstracting detailed clinical findings from medical records for a sample of Medicare hospital patients in order to address the question of how much the results of HCFA's mortality analyses would differ with a more precise adjustment for variations in patient severity across hospitals. Should the study demonstrate that even relatively comprehensive adjustments for patient severity based on medical record reviews produce essentially the same results as HCFA's current approach, that would indicate that little could be gained by an additional adjustment for the mortality rates of individual principal diagnoses. However, should more precise severity adjustments make a substantial difference, that would suggest the value of expanding that study. This could provide an explicit comparison of the appropriateness of adjustments for differences in patient case-mix based on diagnostic categories alone—the approach HCFA has chosen—versus an approach that added an adjustment for the mortality risk associated with specific principal diagnoses to the analysis of HCFA's 17 broad diagnostic categories.

HCFA's revised method for computing two of its patient risk factors should also contribute to a more appropriate adjustment for patient

severity. The modification of the prior hospital admissions variable resolves an issue raised in our earlier report concerning the unequal amounts of time over which prior admissions were counted for different patients in HCFA's 1987 analyses. The revised age variable makes sense as well, given the disproportionately large increases in mortality rates that occur among the oldest age cohorts.

Additional improvements might be obtained by adding several more variables to the equations estimating expected mortality. One risk factor that several analysts have found useful is the source of an admission, particularly whether or not the patient came from a nursing home. A second promising risk factor is the type of admission—elective, urgent, or emergency. This can be especially important for distinguishing between low- and high-risk surgical cases. Again, appropriate validation studies could determine whether these factors do in fact make HCFA's hospital mortality analyses more accurate as an indicator of hospital performance.[7]

[7]A related issue that should also be investigated is the accuracy of the data in Medicare's files for admission source and type. See the general discussion of the potential effects of inaccurate data in section 4.

Reducing the Uncertainty in Hospital Assessments Caused by Random Fluctuations in Observed Death Rates

Nature of the Problem

An assessment of hospital performance based on a comparison between observed and expected mortality logically assumes that observed mortality reflects the combined effect of patient condition at admission and the results of hospital treatment. The more accurate the adjustment for patient severity in the calculation of expected mortality, the closer the contrast between observed and expected mortality represents an indicator of the quality of care provided. However, any estimate of expected mortality is necessarily probabilistic: patients with a given set of characteristics will, on average, experience a given mortality rate. Since individual deaths cannot be predicted with certainty, even when patients receive appropriate medical treatment, observed mortality will necessarily include a component of random variation. That is, among patients with seemingly equivalent levels of severity, some will live and some will die within a certain time period, independent of the quality of care they receive.

Over large numbers of patients, these random fluctuations will usually even out. But some hospitals treat very few Medicare patients. Some in HCFA's 1987 analyses treated only one Medicare patient in the year studied, and many treated fewer than 10 patients within a diagnostic category. Whenever the outcomes of relatively few patients are analyzed, particularly for conditions with low overall death rates, one or two patient deaths can lead to large discrepancies between observed and expected mortality rates. Therefore, hospitals treating few patients were more likely to have substantially higher observed than expected mortality rates in the 1987 analyses due strictly to random fluctuations in observed mortality (rather than differences in the quality of care provided) than were hospitals treating a larger number of patients.

HCFA dealt with this problem by calculating the range of expected mortality for individual hospitals using a formula that widened the range as the number of cases grew smaller. In extreme instances this made the range very large. However, it reduced the capacity of the analyses to identify those smaller hospitals where genuine differences in quality of care accounted for the discrepancy between expected and observed mortality.

Prior GAO Recommendation

We recommended in our June report that HCFA analyze multiple years of data when the analysis of an individual hospital or diagnostic category would otherwise involve relatively few cases. Hospitals whose observed outcomes significantly deviated from the expected over several years should be considered prime candidates for intensified review, along with

hospitals whose deviation beyond the range of expected mortality in a single year was based on enough cases to reduce the effect of random fluctuations in observed hospital mortality rates.

Relevant Changes in the 1988 Approach

In its 1988 analyses, HCFA will present two sets of results for each hospital, one for patients discharged in 1986 and the other for patients discharged in 1987.

GAO Analysis of HCFA's Changes

HCFA's 1988 analyses will basically follow the approach we recommended in our earlier report. The addition of at least 1 more year of data in future mortality analyses would provide 3 years of observations from which to discern patterns and trends.

Validating the Analytical Approach

Nature of the Problem

HCFA developed an approach for its 1987 hospital mortality analyses that differed substantially from any that had ever been employed for outcome analyses of this type. And without having validated this approach, it publicly released results attributed to specific hospitals. HCFA did not assess through independent data sources (such as medical record reviews of a sample of cases) whether hospitals identified in the analyses as having excessive mortality rates actually were relatively more likely to provide poorer quality of care. In fact, a subsequent analysis of medical record reviews for a sample of hospital patients in New York contradicted the results of HCFA's mortality analyses. It suggested that hospitals whose observed mortality exceeded the range of their expected mortality in the HCFA analyses actually had fewer quality problems than other hospitals.[1]

Prior GAO Recommendation

We recommended in our June report that HCFA systematically assess the strengths and weaknesses of alternative approaches for outcome analyses such as those of hospital mortality and that HCFA should ensure that the approaches selected be validated at least to some degree. Moreover, if HCFA publicly releases the results of such analyses, it should describe the extent of that validation.

Relevant Changes in the 1988 Approach

HCFA formally reviewed possible changes in its analytical approach at a meeting of technical advisors that it convened on May 10 and 11, 1988.[2] HCFA staff reported that the consensus of this meeting was to make minimal changes in the approach for the 1988 analyses and to focus on implementing studies to validate the approach.

Following this meeting, HCFA initiated three such studies. In the absence of any single established measure of quality of care, the three studies follow different strategies—with a variety of measures and data sources—which HCFA hopes will produce generally consistent and mutually reinforcing results.

[1]New York State Department of Health, "A Critique of the 1987 HCFA Mortality Study Based on New York State Data," Office of Health Systems Management (Albany, N.Y.: no date), pp. 13-15.

[2]The experts were Frederick Detmann (Wisconsin Peer Review Organization), Barbara McNeil (Brigham and Women's Hospital), Mark Moskowitz (Boston University), Frederick Mosteller (Harvard School of Public Health), Alfred Rimm (Medical College of Wisconsin), Paul Russell (Massachusetts General Hospital), J. Sanford Schwartz (Hospital of the University of Pennsylvania), Frank Sloane (Vanderbilt University), Earl Steinberg (Johns Hopkins University Hospital), and John Wennberg (Dartmouth Medical School). David Eddy (Duke University) was consulted separately.

The goal of the validation effort is to establish whether the approach that HCFA has adopted will perform well enough to serve its own operational needs, rather than determine its relative strength compared to alternative analytical approaches.[3] HCFA staff members expect that other researchers will soon start to take advantage of the data sets that HCFA has begun to make widely available, and that over time, a broad-based consensus will emerge on how best to analyze hospital mortality data.

One of the HCFA validation studies draws on the results of generic screen reviews performed by Peer Review Organizations.[4] HCFA has contracted with the Wisconsin PRO to assemble the results of generic screen reviews conducted by all the PROs since May 1, 1987, and analyze the correlation between the proportion of reviewed cases for each hospital that the PROs find have quality problems and that hospital's residual mortality rate as reported in HCFA's 1988 hospital mortality analyses.[5] HCFA staff believe that quality assessments based on the generic screens have an advantage over other forms of medical peer review because the generic screens focus on a specified set of "intermediate outcomes." The study will compute and analyze these correlations separately for each state, because different PROs apply the screens in various ways. A final report was due to HCFA on November 10, 1988.

A second validation study addresses what HCFA itself considers the key limitation in its hospital mortality analyses: the lack of a direct measurement of patient severity of illness. This study involves the abstraction of "key clinical findings" for a sample of 44,500 Medicare patients in 87 hospitals, with an oversampling of hospitals having substantially higher or lower observed mortality compared to their expected mortality rates. MediQual Systems, Inc., under contract to HCFA, is abstracting the data

[3]By this and later references to alternative approaches we mean not only the six specific analytical approaches developed by HCFA contractors and independent researchers that we assessed in our June report, but also any other analytical approach appropriate to an analysis of hospital mortality using Medicare's computerized data files. Such alternative approaches vary in their selection of specific patient risk variables and in the statistical techniques used to take account of differences among hospitals with respect to those variables.

[4]The 54 PROs are private organizations, under contract to HCFA, that review the appropriateness and quality of care provided to selected groups of Medicare patients in a particular state or territory. The generic screens, which the PROs have applied since 1986 to all cases that they review, require reviewers to examine the medical record for indications of six specific types of adverse events. These include inadequate discharge planning, premature discharges, unexpected deaths, nosocomial infections, unscheduled returns to surgery, and drug reactions or medication errors.

[5]Residual mortality rate is the difference between observed and expected mortality. Professors Alfred Rimm and Arthur Hartz of the Medical College of Wisconsin will conduct the analysis as subcontractors to the Wisconsin PRO.

using its Medisgrps methodology.[6] HCFA will analyze the data intramurally.

The results of these analyses are scheduled to be released in late December concurrently with the hospital mortality analyses. They will assess the degree to which the more precise severity adjustment provided by the key clinical findings would alter the ratings of individual hospitals in HCFA's hospital mortality analyses.

A third validation study examines patterns of correlations between a set of hospital structural characteristics—including payroll expenses per bed and the proportion of medical staff who are specialists—and the residual mortality rate of hospitals as reported in the 1988 mortality analyses. HCFA constructed a national sample of 3,000 hospitals for this analysis, largely by dropping from the universe of Medicare hospitals those with extreme values for expected mortality rates as well as very small hospitals. To the extent that associations are found between residual mortality and those structural variables that appear to have a plausible conceptual relationship to quality of care, such as the proportion of specialists treating patients, the results of this study could help to reinforce the validity of HCFA's approach.

GAO Analysis of HCFA's Changes

HCFA has accepted the need to validate the analytical approach it uses in its hospital mortality analyses and has initiated several studies that together will provide some evidence on the validity of its approach. If, as planned, these studies are completed before the scheduled release of the 1988 hospital mortality analyses, and if their results generally support the validity of HCFA's analytical approach, then this year's approach will have been validated to some degree.

However, the scope and rigor of HCFA's proposed validation is also an issue. The HCFA staff members responsible for these activities have stated fairly modest goals. For example, while recognizing the need to show that HCFA's chosen approach is satisfactory, they have no plans to compare this approach with other, possibly superior alternatives. In this section we discuss the extent and definitiveness of the validating evidence likely to be produced by the three studies HCFA has initiated. A

[6]The Medical Illness Severity Grouping System, or Medisgrps, is a patient severity assessment methodology developed by MediQual Systems, Inc. It specifies standardized procedures for abstracting selected clinical information from individual patient records and evaluates the severity of illness for each case based on those clinical findings.

final assessment of these issues must await the completion of the studies, but several questions can be raised now based on the study designs.

We have viewed the validation of an analytical approach to patient outcome analyses as an ongoing process in which different types of studies using different kinds of data provide a basis for evaluating the results of that approach with respect to distinct aspects of quality of care. Nevertheless, the basic criterion we have focused on is the capacity of a given approach to successfully identify groups of cases—in this instance patients treated at specific hospitals—that when subjected to in-depth review, prove to have a disproportionate share of quality problems. In other words, the validation should examine whether the analytical approach functions effectively to screen out hospitals with minimal quality problems while targeting the hospitals that provide relatively poor quality care.

The Generic Screen Validation Study

HCFA's study of generic screen results is the only one of the three that addresses validation in terms of the successful identification of hospitals with comparatively high or low levels of quality problems. Moreover, there is a particular advantage in its focus on the results of actual PRO reviews, since under the current program structure it is the PROs that are responsible for ensuring quality of care to Medicare patients. However, the use by PROs of the generic screens does not in itself attest to the validity of their results as an indicator of quality problems. In the discussion that follows, we outline several reasons for caution in attributing to the generic screens sufficient validity in their own right to make them a measure suitable for evaluating the validity of HCFA's approach to hospital mortality analyses.

First, the results of generic screen reviews are likely to be an unreliable measure, and no measure can be valid to the extent that it lacks reliability.[7] In addition to the inconsistencies noted by HCFA staff in how different PROs apply the generic screens, we would expect considerable variability within states among different reviewers and across time. HCFA has provided only limited guidance as to how the screens should be applied in different types of cases; it revised that guidance in mid-1987, and it strictly prohibited the PROs from supplementing these instructions for their own reviewers. Moreover, these limited guidelines only apply to the initial screening of each case, not to the final determination on

[7]We use the term "reliability" in its technical sense—the extent to which one would obtain the same result for equivalent cases across different raters or time points.

whether a quality problem occurred.[8] Therefore, the indicator used in the HCFA validation study—the proportion of reviewed cases with confirmed quality problems—ultimately reflects the same individual professional judgment inherent in any peer review, with all its intrinsic variability.

The analysts conducting this study for HCFA acknowledge that the generic screen results are an imperfect measure, and in particular, some cases with quality problems are likely to be missed. However, they argue that any such deficiencies in the measure, to the extent that they are random (including the effect of low reliability), would simply tend to lower the apparent correlation between PRO-confirmed quality problems and residual mortality, compared to what it actually should be. From this point of view, any correlations found by HCFA between residual mortality and PRO-confirmed quality problems could be treated as conservative underestimates of the true relationship between residual mortality and quality of care.

However, not all potential deficiencies in the generic screen results will necessarily produce errors that are random in nature. There is also the possibility of systematic error or bias, that is, error that follows a consistent pattern. If PRO generic screen results and HCFA residual mortality rates both have systematic errors that are statistically related to each other, then the correlations between them could be inflated as well as deflated.

One possible source of such bias in the generic screen results stems from variations in the types of cases that PROs review in different hospitals. Only about 14 percent of the cases that have undergone generic screening were selected randomly across all hospitals. The rest derive from specific review objectives, which often focus on the appropriateness of a hospital admission or the accuracy of the diagnosis recorded for billing purposes rather than the quality of care provided. Differences among hospitals in the proportion of their cases reviewed that fall into one or another of these focused review groups could affect their overall percentage of PRO-confirmed quality problems. The analysts conducting this study for HCFA are considering some additional analyses focusing strictly

[8]Generally, all cases reviewed by the PRO are examined first by a nurse reviewer, who passes on to a physician reviewer only those cases that "fail" one or more of the generic screens, that is, cases that deviate from the specified range of acceptable outcomes or clinical findings (such as temperature, blood pressure). The physician then determines if a quality of care problem occurred in that case. For certain screens the nurse reviewer can confirm instances of poor quality care. These include the adequacy of discharge planning and nosocomial infections.

on the minority of reviewed cases selected randomly from each hospital. These analyses could help to determine if the nonrandom selection of most cases reviewed by the PROs does in fact affect the rates of confirmed quality problems reported for different hospitals.

If such bias exists in the generic screen results, the next question is whether there are related biases in HCFA's calculation of residual mortality. One factor that could have a critical effect on both residual mortality and generic screen results is variation in the severity of patients treated in different hospitals. Inadequate adjustment for differences in severity across hospitals could clearly distort the results of HCFA's mortality analyses. HCFA initiated its severity validation study specifically to address this concern. Similarly, variation in the severity of patients treated by different hospitals could also influence the types of cases that PROs review in those hospitals. For example, regional medical referral centers treating more complicated cases might have relatively fewer preadmission reviews for elective surgery and relatively more readmissions within 15 days compared to local community hospitals. If both PRO generic screen reviews and HCFA residual mortality rates have a tendency to disadvantage hospitals treating more severely ill patients, this could produce an inflated correlation between PRO-confirmed quality problems and residual mortality.

Another reason for caution in using generic screen results as an indicator of quality derives from their limited scope. The six separate screens focus on discrete aspects of patient care that address some but not all of the quality problems likely to influence a hospital's mortality rate. The screen most commonly failed, representing more than 40 percent of all cases with PRO-confirmed quality problems, assesses the adequacy of hospital discharge planning. The second largest group of confirmed quality problems involves nosocomial infections, which vary greatly not only in severity but also in the proportion detected and noted in patient records across different hospitals.[9] By contrast, the screen concerned specifically with unexplained deaths accounts for less than 2 percent of total cases with PRO-confirmed quality problems. Some major categories of quality problems are not considered at all by HCFA's generic screens. For example, the screens ask whether abnormal laboratory results have

[9]Nosocomial infections are infections acquired in the hospital, for example, a surgical wound infection.

been addressed, but not whether the appropriate diagnostic tests were conducted.[10]

Taken together, these characteristics of HCFA's generic screens raise questions about using the results of generic screen reviews as the standard for assessing the validity of HCFA's hospital mortality analyses. HCFA's decision to analyze the generic screen results separately in each state addresses the inconsistency in the application of the screens across states, but not the likelihood of low reliability within states, the possibility of bias as well as random error in generic screen results, and the limited range of potential quality problems considered by the screens. Given these questions, considerable care should be employed in drawing inferences about the validity of HCFA's analytical approach from patterns of correlation coefficients relating hospital rates of PRO-confirmed quality problems based on generic screens to the residual mortality rates reported in its hospital mortality analyses.

The Severity Validation Study

HCFA's second validation study will employ more reliable measures and more consistent data collection methods, but is focused on the much narrower question of what difference clinical information on patient severity would make for HCFA's hospital mortality results. Its contract with MediQual to abstract the data for the 44,500 cases in the sample provides for both standardized procedures to collect detailed information on specific clinical findings and monitoring to ensure that the data are complete and accurate. Therefore, the main questions raised by this study concern HCFA's planned approach to analyze these data and the relationship of these results to the larger issue of validity.

The central issue addressed by this study is whether results reported in HCFA's hospital mortality analyses would change appreciably if additional clinical information on patient severity were added to the regression equations that HCFA uses to estimate expected mortality. However, the HCFA staff conducting this analysis do not plan to follow the same analytical procedures in the validation study as those used in the 1988 hospital mortality analyses. Instead of calculating expected mortality rates through 17 separate regression equations and inferring hospital performance from the residual of expected and observed mortality, they will estimate hospital performance through separate "index" variables

[10]A study of a nationally representative sample of Medicare patients found that poor-quality care more often involved a lack of needed tests than a failure to act on abnormal lab results. (The Health Data Institute, National DRG Validation Study (Lexington, Mass.: Nov. 1987), pp. 83-85.)

for each individual hospital.[11] With an index variable for each hospital entered into one logistic regression equation encompassing the entire sample of patients, the analysis can assess more directly the effect on patient mortality that derives from treatment in one hospital as opposed to another. Essentially, this approach distinguishes between hospital-related differences and other, unexplained variation in patient mortality, which are combined in the residual mortality rates reported in the full-scale hospital mortality analyses.

HCFA staff have considered using hospital index variables in the full-scale analyses. However, the agency's computers currently do not have the capacity to process the number of index variables that would be required. If HCFA's hospital mortality analyses therefore continue to focus on residual mortality, a different approach based on hospital index variables—even if offering statistical benefits—would seem less appropriate for validation purposes than a more exact replication of the analytical approach being validated.

A second issue derives from HCFA's decision not to compare its approach to available alternative approaches. Without such comparisons, HCFA staff will have to assess the reasonableness of any differences between their two models (with and without the clinical data abstracted from medical records) on a fairly arbitrary basis. Were HCFA staff to evaluate its chosen approach relative to others, they could directly compare the various approaches in terms of how large a difference was observed between the model that included the abstracted clinical information and the model without that information.[12] The analytical approach demonstrating the smallest difference would presumably have the most effective adjustment for patient severity.

[11]The coefficients for the index variables will indicate the extent to which the mortality of patients treated in each hospital differed from patient mortality in all the other hospitals, after taking account of the other patient risk factors such as age, sex, and comorbidities. There will be 87 different index variables, one for each of the hospitals in the study. For each of the 44,500 patient records included in the analysis, the index variable representing the hospital where that patient was treated will be coded "1" and the 86 other index variables will be coded "0." The regression equation will then analyze these data and calculate a separate coefficient for each one of 86 index variables (the results for the 87th hospital in the regression equation are fixed by those for the first 86).

[12]For each analytical approach (HCFA's current approach and one or more alternatives), two regression equations could be estimated using the severity validation study data set. In each case, the two equations would be identical except that one would include clinical data abstracted from medical records and the other would not. Analysts could then observe how much the coefficients for the 86 hospital index variables changed when the clinical data elements were dropped from the equation. Essentially, this procedure would replicate for one or more alternative approaches the analysis HCFA plans to conduct for its chosen approach.

A more fundamental question concerns the relationship of the study's results and the overall validity of HCFA's approach. Certainly, the potential effects of variations in patient severity among hospitals need to be considered in assessing the validity of HCFA's approach to hospital mortality analyses. However, a determination that such variations do not affect the results generated by a given analytical procedure would not in itself establish the validity of that approach. There could be other sources of distortion in linking hospital outcomes with quality of care. Without an independent verification that the hospitals identified in the mortality analyses as having unusually high and low residual mortality rates also had relatively high and low rates of quality problems, respectively, there is no way of knowing conclusively that the mortality analyses provide a valid indication of the quality of care received in those hospitals.

The Structural Variables Study

The relationships found in this study between residual mortality and various structural characteristics should enhance our understanding of HCFA's residual mortality measure by describing its distribution among different subgroups of hospitals. However, the contribution of this study is likely to be secondary to that of the other two validation efforts. This is because it does not directly address either the core issue of validation—effective identification of hospitals with quality problems—or the potential impact of inadequate severity adjustment.

Overall Assessment

A judgment of the adequacy of these validation studies depends on the scope and definitiveness expected of them. The stated objectives of the HCFA staff members responsible for these studies are relatively modest. Their highest priority is to either dispel or confirm the concern that hospital mortality analyses based on the patient data available in computerized files do not adequately adjust for variation in the severity of patients treated in different hospitals. In addition, they would like some information on the congruence of these hospital assessments with the quality judgments currently being made by PROs and those inferred from hospital structural characteristics, even as they acknowledge that both generic screen results and structural variables may have serious practical or conceptual limitations as indicators of quality of care. These staff members believe that such efforts will provide a reasonable test of the appropriateness of HCFA's annual hospital mortality analyses using its current analytical approach. They see no need to determine whether available alternative approaches to mortality analyses might produce better results.

The three validation studies that HCFA has initiated will provide a much sounder basis for evaluating the results of its hospital mortality analyses than was possible for last year's release. Nonetheless, the limitations of these studies militate against making a definitive judgment that HCFA either should or should not continue these analyses as currently designed. The validation studies represent the beginning of an effort to collect the sort of evidence needed to address the issue of validity, not only for the hospital mortality analyses but also for other patient outcome analyses. A much stronger case can ultimately be made if HCFA finds or develops more consistent and comprehensive indicators of quality of care to use in validation studies and if it explicitly and systematically compares the performance of different available analytical alternatives.

Assessing the Effect of Inaccurate Data

Nature of the Problem

Scattered evidence from a range of approaches for analyzing hospital mortality leads us to suspect that the results may be distorted by inaccurate or missing data.[1] Accurate diagnostic data can be especially important in adjusting hospital mortality rates for patient severity. HCFA has not collected and reported information on the extent of missing and inaccurate entries for the data elements used in its analyses of Medicare patient outcomes. Yet, research conducted about ten years ago demonstrated that substantial inaccuracies existed in the Medicare data files, particularly for diagnostic data.[2] It is possible that the accuracy of these data may have improved now that the amount of hospital payments under Medicare's prospective payment system depends in large part on patient diagnoses. However, a more recent study based on a nationally representative sample of Medicare patients indicates that a substantial level of inaccuracy remains.[3] Once the nature and scope of these data inaccuracies are established, HCFA can begin to assess their effect on the results of its hospital mortality analyses.

Prior GAO Recommendation

We recommended in our June report that HCFA determine through medical record reviews of a nationally representative sample of Medicare patients the extent of missing and inaccurate data for those data elements it used in its patient outcome analyses. The results of such assessments should be publicly reported and corrective action taken for those data elements that are crucial for reliable outcome analyses. Meanwhile, all analyses of Medicare mortality rates should include an explanation that their findings could be in error by an unknown amount due to potential data inaccuracies.

[1] Medicare: Improved Patient Outcome Analyses Could Enhance Quality Assessment (GAO/PEMD-88-23, June 1988), pp. 92-93.

[2] Institute of Medicine, Reliability of Medicare Hospital Discharge Records (Washington, D.C.: National Academy of Sciences, Nov. 1977), pp. 23-24.

[3] This study was conducted by the Health Data Institute for the Department of Health and Human Services' Office of the Inspector General. It found that 21 percent of the 7,050 cases in its random sample of Medicare patients had sufficient inaccuracies in their recorded diagnostic and procedure codes to cause a change in diagnosis-related group (DRG) assignment. (See David Hsia et al., "Accuracy of Diagnostic Coding for Medicare Patients Under the Prospective-Payment System," The New England Journal of Medicine, vol. 318, no. 6 (Feb. 11, 1988), pp. 353-354, and The Health Data Institute, National DRG Validation Study, pp. 36-52.) The 21-percent figure probably underestimates the magnitude of diagnostic data inaccuracies relevant to the use of those data for patient severity adjustment. Because DRGs frequently consolidate a wide range of clinical conditions, many diagnostic coding errors that would distort an adjustment for patient severity could exist without affecting the DRG assignment.

Relevant Changes in the 1988 Approach

HCFA staff responsible for the hospital mortality analyses have conducted some explorations of data quality, but have not initiated the comprehensive, nationally representative study we recommended. The HCFA explorations have uncovered a variety of potential problems, ranging from apparent variations among states in the accuracy of deaths reported to the Social Security Administration to inaccuracies in the assignment of certain principal diagnoses. HCFA has resolved some problems with its own bill-processing procedures by making programming changes for the 1988 analyses, but it has not addressed the data problems that derive from inaccuracies in the information reported to HCFA.

HCFA is developing a separate data base that will provide more comprehensive information on a subset of Medicare patients. The Uniform Clinical Data Set is designed to provide consistent abstraction of clinical information for all cases reviewed by the PROs, which currently represent about a quarter of all Medicare hospital patients. Moreover, by assembling detailed information on specific clinical findings, analysts will not need to rely as much on diagnostic codes, which until now have been the only clinical data on patients available for analysis in computerized files. HCFA staff consider diagnoses, however accurately reported, inherently less indicative of patient condition than data on patient symptoms and relevant laboratory test results.

GAO Analysis of HCFA's Changes

The limited inquiries that HCFA staff have conducted concerning questions of data quality cannot provide reliable estimates of the magnitude of data accuracy problems. Consequently, the issues raised by our earlier report regarding the effect of inaccurate data on hospital mortality analyses remain unresolved. However, HCFA's data explorations do reinforce the need to establish the accuracy of specific data elements used in the hospital mortality analyses.

Even when the Uniform Clinical Data Set is fully implemented, HCFA plans to abstract data for only a fraction of Medicare hospital patients—those actually reviewed by PROs. According to HCFA staff, this will preclude using the Uniform Clinical Data Set for the type of comprehensive hospital mortality analyses currently conducted by HCFA, although some more limited analyses would be feasible. Future hospital mortality analyses will therefore continue to rely on the existing billing data from the Medicare Statistical System that are routinely collected for all Medicare patients. Consequently, the systematic study of data accuracy that we recommended would still be called for. HCFA staff members have expressed concern about the potential cost of such a study.

However, the Institute of Medicine study on precisely this topic indicates that sophisticated sampling methods can generate reliable estimates of data inaccuracies with a relatively limited data-gathering effort.

The HCFA staff responsible for the mortality analyses prefer to regard potential data problems as an issue separate from the validity of the analytical approach. They believe that use of the approach will itself create the incentive to enforce accurate reporting of data. Nevertheless, the results reported from an analysis of hospital mortality are no less vulnerable to distortion from deficient data than from inadequate severity adjustment. As long as data quality problems could substantially affect those results, they should be taken into account in order for an analytical approach that uses those data to have validity.

HCFA Statistical Methodology for Calculating Expected Mortality Rates in Its 1987 and 1988 Hospital Mortality Analyses

1. Patients were divided among 17 diagnostic categories according to their ICD-9-CM principal diagnosis classification (see appendix II).

2. For each patient group (diagnostic category), a separate logistic regression equation was estimated, using the data recorded for every hospital admission in HCFA's Medicare Provider Analysis and Review (MEDPAR) file. Each equation included the same five independent variables: age, sex, number of prior hospitalizations, whether or not the patient was transferred from another hospital, and the presence of up to four chronic comorbidities (from a list of eight specified comorbidities). The dependent variable was individual patient mortality, coded as alive or dead 30 days after admission.

3. For each patient group analyzed, the regression equations generated coefficients for each of the independent variables. These measured the association of that particular risk factor with patient mortality, controlling for the effects of the other factors in the equation. Applying these coefficients to the characteristics of each individual patient (age, sex, comorbidities, and so forth) permitted analysts to compute the probability of death for that specific patient.

4. The number of expected deaths for a hospital, either overall or in specific diagnostic categories, was calculated by aggregating the individual probabilities of death for all the patients in that group. Dividing the number of expected deaths by the number of patients treated produced an expected mortality rate.

Comparison of HCFA 1987 and 1988 Diagnostic Categories

	1987 Mortality Analyses		1988 Mortality Analyses	
Risk group	**Diagnostic category**	**Principal diagnoses (ICD-9-CM codes)**	**Diagnostic category**	**Principal diagnoses (ICD-9-CM codes)**
High	Cancer	141-160, 162-172, 174-209	Cancer	141, 147, 150-151, 156-159, 162.2-164, 171.5, 171.8-171.9, 172.8, 179, 180.9, 183, 189.0, 191, 192.2, 195, 196.1-196.2, 196.8, 197.0-197.2, 197.4-197.8, 198.0-198.1, 198.3-198.8, 199-208
	Stroke	430-432, 434, 436	Stroke	430-432, 433.0, 434, 436
	Severe acute heart disease	410, 427.1, 427.4, 427.5, 441.0, 441.1, 441.3, 441.5, 441.9, 785.51	Severe acute heart disease	410, 415, 421.0, 421.9, 423.0-423.2, 427.4, 427.5, 441.0, 441.1, 441.3, 441.5, 444.1, 447.2, 785.5
	Severe chronic heart disease	398.91, 402.01, 402.11, 402.91, 425, 428, 518.4	Severe chronic heart disease	397, 398.91, 416, 425.0, 425.2-425.4, 426.89, 428, 429.5-429.9, 441.2, 442.2, 453.2
	Gastrointestinal catastrophes	551, 557, 560.0, 560.2-560.9, 570, 572-572.7, 573.4, 567, 578.0, 578.9	Gastrointestinal catastrophes	452, 453.0, 456.0, 456.20, 530.4, 530.8, 531.1-531.2, 531.5-531.6, 532.1-532.2, 532.5-532.6, 533.1-533.2, 533.5-533.6, 534.1-534.2, 534.5-534.6, 551, 557.0, 558.2, 560.0-560.2, 560.89, 567, 569.83, 570, 571.2, 571.5-571.6, 572.2-572.4, 572.8
	Metabolic and electrolyte disorders	250.01-250.4, 251.0, 251.1, 255.4, 276	Metabolic and electrolyte disorders	250.2-250.3, 260-263, 273, 275.4, 276.0, 276.2, 276.4-276.5, 277.3
	Pulmonary disease	415.1, 416.0, 480-483, 485-516, 518-519, except 516.1 and 518.4	Pulmonary disease	481, 482.0-482.1, 482.3-482.9, 485-486, 500-505, 507, 508.0, 510, 511.1-511.9, 512-516.0, 518.0-518.1, 518.4, 518.5, 519.2-519.3
	Renal disease	580-590 except 580.81 and 590.81	Renal disease	453.3, 584-586
	Sepsis	3.1, 20.2, 22.3, 36.2, 36.3, 36.89, 36.9, 38.0, 38.1, 38.2, 38.3, 38.40-38.44, 38.49, 38.8, 38.9, 54.5, 790.7	Infectious disease	18, 27.0, 36, 38, 40, 46-48, 49.0-49.1, 54, 60, 70.0, 70.2, 70.4, 70.6, 112, 116-117, 136.3, 320.0-320.3, 320.8-320.9
	Severe trauma	806, 808.43, 808.53, 820, 821, 828, 850.2, 850.4, 851.1-851.7, 852, 839.0-839.5, 860-867, 887, 897, 900.0, 901-904, 926, 927.0, 928.0, 929.0, 942.3, 942.4, 942.5, 946.3-946.9, 947.1-947.9, 948.2-948.9, 952, 958.0, 958.1, 958.4, 958.5	Severe trauma	806.0-806.1, 807.4, 851-853, 861.0-861.1, 861.3, 864, 868-869, 875.1, 901-902, 933.1, 934, 946.3-946.5, 948.4-948.9, 958.4

(continued)

	1987 Mortality Analyses		1988 Mortality Analyses	
Risk group	**Diagnostic category**	**Principal diagnoses (ICD-9-CM codes)**	**Diagnostic category**	**Principal diagnoses (ICD-9-CM codes)**
Low	Opthalmologic disease	360-379	Neuropsychiatric and sensory disease	290-292, 293.1-293.9, 294-309, 311-319, 331.1-331.6, 331.8-331.9, 332-334.3, 334.5-334.9, 337.0, 337.2-337.9, 340, 342-343, 344.2-344.9, 345.0-345.2, 345.4-345.9, 346-347, 348.0, 350-357.0, 357.5-358.0, 358.2-358.9, 360-389
	Gynecologic disease	617-629	Gynecologic disease	614-627 (excluding 619.1)
	Low-risk heart disease	393-398.90, 398.92-402.00, 402.02-402.10, 402.12-402.90, 402.92-409, 411-415.0, 415.2-415.9, 416.1-424, 426-427.0, 427.2-427.3, 427.6-427.9, 429	Low-risk heart disease	390, 393, 401, 402.00, 402.10, 402.90, 405, 411.1-411.8, 413-414, 417, 420.9, 422.9, 425.1, 426.1-426.7, 426.81, 427.0, 427.2-427.3, 427.6, 427.8-427.9, 429.4, 433.1-433.9, 435, 437.2, 442.0-442.1, 442.3-442.9, 447.0-447.1, 447.3-447.9, 448, 451, 453.1, 453.8-453.9, 454-455, 456.3-456.6, 457.0-457.1, 457.9, 458.0
	Gastrointestinal disease	530-550, 552-556, 558-559, 560.1, 561-566, 568-569, 571, 572.8-573.0, 573.3, 573.5-576, 577.1-577.9, 578.1-578.8, 579	Gastrointestinal disease	520-527, 528.2, 528.4-528.9, 529, 530.0-530.3, 530.5-530.7, 530.9, 531.3, 531.7-531.9, 532.3, 532.7-532.9, 533.3, 533.7-533.9, 534.3, 534.7-534.9, 535-536, 537.1-537.2, 537.5-537.6, 537.81, 537.9, 540-543, 550, 552, 558.1, 558.9, 562-566, 568, 569.0-569.2, 569.4-569.6, 569.9, 571.8-571.9, 574.00, 574.10, 574.20, 574.30, 574.40, 574.50, 575.0-575.3, 575.5-575.6, 575.9, 576.0, 576.9, 577.1, 577.9, 579
	Urologic disease	593-609	Urologic disease	582-583, 588-589, 590.1, 590.8-590.9, 592, 594-595, 596.0, 596.2-596.5, 596.7-596.9, 597-598, 599.1-599.9, 600-606, 607.0-607.1, 607.3-607.9, 608.0-608.3, 608.8-608.9

(continued)

	1987 Mortality Analyses		1988 Mortality Analyses	
Risk group	**Diagnostic category**	**Principal diagnoses (ICD-9-CM codes)**	**Diagnostic category**	**Principal diagnoses (ICD-9-CM codes)**
	Orthopedic conditions	712-739, 810-819, 822-827, 829-838, 840-848	Musculoskeletal and cutaneous conditions	680-686, 690-698, 700-706, 707.1-707.9, 708-709, 710, 710.2-710.9, 714.0-714.4, 714.89, 714.9, 715-744, 746-758, 800.0, 800.5, 801.0, 801.5, 802, 805, 806.2-806.9, 807.00-807.06, 807.1-807.3, 807.5-807.6, 808-819, 822-838, 839.1-839.9, 840-848, 850, 854.00-854.04, 854.06-854.09, 861.2, 862, 867.1, 867.3-867.9, 870-874, 875.0, 876-887, 890-897, 905-929
Medium	All other conditions		All other conditions	

Analysis of Changes Made in Shift to the 1988 Diagnostic Categories

Risk group	Diagnostic category	Year	Mortality rates[a]	Change index[b]	Percent of cases
High	Cancer	1987	0.0–54.5	.51	7.4
		1988	0.0–54.5		3.8
	Stroke	1987	13.7–52.2	1.00	3.3
		1988	13.7–52.2		3.3
	Severe acute heart disease	1987	8.9–79.2	.83	3.6
		1988	9.9–79.2		3.8
	Severe chronic heart disease	1987	3.3–27.5	.90	5.8
		1988	8.3–27.5		5.4
	Gastrointestinal catastrophes	1987	6.5–80.4	.16	2.1
		1988	9.0–80.4		0.8
	Metabolic and electrolyte disorders	1987	1.5–27.3	.65	2.1
		1988	0.0–27.3		1.6
	Pulmonary disease	1987	0.0–35.1	.55	8.6
		1988	10.0–35.1		5.0
	Renal disease	1987	0.0–35.9	.59	1.1
		1988	12.3–35.9		0.6
	Sepsis Infectious disease	1987	10.3–35.3	.91	0.9
		1988	9.5–46.7		1.0
	Severe trauma	1987	0.0–72.7	.04	2.3
		1988	4.6–100.0		0.2
Low	Ophthalmologic disease Neuropsychiatric and sensory disease	1987	0.0–4.6	.23	1.5
		1988	0.0–16.7		6.3
	Gynecologic disease	1987	0.0–8.3	.93	0.7
		1988	0.0–6.7		0.7
	Low-risk heart disease	1987	0.0–23.3	.66	9.9
		1988	0.0–15.7		12.7
	Gastrointestinal disease	1987	0.0–60.0	.70	8.8
		1988	0.0–10.5		6.5
	Urologic disease	1987	0.0–11.0	.55	4.2
		1988	0.0–7.2		3.7
	Orthopedic conditions Musculoskeletal and cutaneous conditions	1987	0.0–14.3	.67	5.7
		1988	0.0–15.4		8.6
Medium	All other conditions	1987	0.0–100.0	.40	32.0
		1988	0.0–67.4		36.0

Principal diagnosis mortality rates at ten-percentile intervals[c]								
10th	20th	30th	40th	50th	60th	70th	80th	90th
3.7	6.1	6.7	8.9	14.4	20.0	23.3	29.2	39.9
15.0	18.8	20.0	21.0	25.0	29.0	33.1	39.9	42.6
16.2	16.2	16.2	16.2	17.5	19.8	19.8	19.8	42.9
16.2	16.2	16.2	16.2	17.5	19.8	19.8	19.8	42.9
9.9	9.9	21.4	21.4	27.6	28.6	28.6	36.5	36.5
9.9	14.7	21.4	21.4	26.0	28.6	28.6	36.5	36.5
14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	15.1
14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	15.1
6.5	9.5	9.5	9.5	10.8	10.8	10.8	11.2	15.8
11.2	12.5	15.0	20.3	20.8	24.1	24.1	25.7	46.9
5.5	9.2	14.7	16.7	16.7	16.7	16.7	16.7	16.7
16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	20.1
2.2	6.7	9.3	11.7	14.5	16.7	16.7	16.7	20.0
12.8	14.5	16.7	16.7	16.7	16.7	16.7	18.2	25.2
4.3	4.8	4.8	9.7	12.3	12.3	13.5	33.7	35.9
12.3	12.3	12.3	12.3	24.1	33.7	34.9	35.9	35.9
14.1	14.1	22.0	28.7	28.7	29.5	35.3	35.3	35.3
14.1	14.1	22.0	27.9	28.7	29.2	35.3	35.3	35.3
4.9	5.2	5.2	5.9	5.9	6.7	6.7	6.7	7.5
6.4	11.8	12.5	13.9	16.1	16.1	21.1	27.8	45.4
0.0	0.0	0.0	0.3	0.3	0.4	0.4	0.4	0.5
0.0	0.2	0.3	0.4	0.6	1.1	1.5	3.0	4.4
0.0	0.0	0.3	0.3	0.3	0.3	0.3	0.6	0.7
0.0	0.0	0.3	0.3	0.3	0.3	0.3	0.6	0.7
2.0	2.0	2.8	3.2	3.2	3.8	3.8	4.4	6.6
1.6	2.0	2.0	2.1	2.8	3.2	3.2	3.8	4.4
0.6	1.8	2.2	2.7	2.8	2.9	3.7	5.9	7.3
0.4	1.8	1.8	2.4	2.7	2.8	2.8	2.9	3.7
1.0	1.0	1.0	1.0	1.0	3.2	8.0	8.3	8.3
0.6	0.8	1.0	1.0	1.0	1.0	1.0	2.8	4.7
0.0	0.2	0.4	0.5	0.6	1.0	1.3	2.2	3.3
0.0	0.4	0.5	0.9	1.2	2.2	2.7	3.2	4.3
0.5	1.2	1.9	2.2	3.2	3.5	4.4	5.6	9.2
1.2	2.2	3.3	4.3	5.3	6.5	7.4	8.9	10.8

[c]These represent the range of 30-day postadmission mortality rates corresponding to the principal diagnosis codes assigned to the categories as shown in appendix II. Upper and lower range values reflect the outcome of a minimum of 50 cases, with at least one principal diagnosis having 15 or more cases. Data on the mortality rates of the principal diagnoses were provided by Michael Pine and Associates. They derive from a merger of 5-percent samples of all Medicare hospitalizations in 1985 and 1986, for a total of 1,008,231 cases divided among 6,137 principal diagnoses.

[b]An index showing the degree of commonality between diagnostic categories in the two years: (a-b)/(a+c) where a = total number of patients in the 1987 category, b = number of patients dropped from 1987 category in 1988, and c = number of patients added to category in 1988. This represents the proportion of patients included in the category in either year that remain in the category in both years.

[a]In each diagnostic category, principal diagnoses were sorted in order of increasing mortality rates. The figures presented here represent the mortailty rate of the principal diagnosis for those cases at the 10th to 90th percentile of total cases within each diagnostic category.

Major Contributors to This Report

Program Evaluation and Methodology Division

Lois-ellin Datta, Associate Director (202-275-1370)
Linda Demlo, Group Director
Eric Peterson, Project Manager
Martha Ann Carey, Project Staff
Phillip Kapler, Project Staff
Liz Scullin, Writer-Editor