Small Area Analysis of Hospitalization Rates Using SAS® Software

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ABSTRACT

The Kaiser Permanente Medical Care Program in Northern California, like other health care providers during the current period of rising medical costs, has a pressing need to manage its hospital utilization while maintaining a high quality of medical care. Small Area Analysis (SAA), which applies population-based statistical methods to compare hospitalization rates across hospital service areas, can be helpful in identifying high-variability medical diagnoses and procedures where utilization management may be effective.

The SAS System application described here produces detailed graphical reports for comparing hospital utilization rates for many diagnoses and procedures across different hospitals, time periods and populations. SAS/GRAPH® was chosen for the production of these reports because of its ability to produce a sequence of high quality customized graphs under control of the macro language.

INTRODUCTION

The Kaiser Permanente Health Care Program is one of the largest private health care delivery systems in the United States, serving over 2 million members in our Northern California Region alone, 6 million nationwide.

One of the earliest prepaid health care plans, Kaiser Permanente has often been seen as the most successful example of the Health Maintenance Organization (HMO), where its ability to control utilization while sustaining high quality of medical care has led to rapid and sustained growth throughout the postwar period.

In the present period however, Kaiser, like all other providers of medical care finds itself squeezed between the spiraling costs of providing health care and increasing resistance of individuals and institutions to pay more for their coverage. Under these conditions utilization management is becoming a crucial component of our organization's success.

Utilization management in its broadest sense can be defined as the attempt to understand and manage the relationship between resources expended by the health care provider and the production of health. In practice it usually has a more limited focus. In the work described here, the attention is on acute care hospital stays, and by implication, the rates of different types of surgical procedures performed on our members. Hospitalization and surgery are the most expensive medical interventions we provide, and in the case of surgery especially, unnecessary utilization may constitute bad medicine as well as bad business.

We emphasize, however, that quality of care must be a constant concern of utilization management efforts, and not be sacrificed to attempts at cost containment. Although utilization management is usually thought of in terms of controlling over-utilization, it has an equally important role in identifying and dealing with under-utilization of services.

How does one go about characterizing the rate and distribution of hospital use - surely the first step in managing utilization - in a system like ours, with upwards of 180,000 admissions at 16 hospitals per year? In light of the bewildering variety of things which can happen in a modern hospital, how can specific types of illnesses and procedures be singled out for closer study? In short - and this is the central theme of this talk - how can we go about turning all this data into information which is timely, concise and meaningful enough to be useful to medical practitioners, hospital administrators and corporate managers in managing hospital utilization?

SMALL AREA ANALYSIS

The general approach which we've taken at Northern California Kaiser's Division of Research depends on a method known as Small Area Analysis (SAA). SAA, in this context, is a statistical technique for comparing utilization rates such as hospital discharges across different areas, which may be hospital service areas, counties, states or even different countries.

When investigators began examining surgical procedure rates in this manner during the 1970’s, they discovered surprising, and in some cases shocking discrepancies in the rate at which certain surgery was being performed in different locals. John Wennberg and his colleagues, for instance, found that the likelihood of a woman receiving a hysterectomy sometime during her life varied from 20% to 70% depending on the hospital market in Maine in which she lived. Similarly, the lifetime chances of a prostatectomy for a man in Iowa man varied from 15% to higher than 60%. In Vermont the chances of a child holding onto his or her tonsils varied from 30-92%. What this meant is that patients with the same symptoms were liable to get radically different treatment depending on
where they happened to live. Differences this large could not be explained away by population differences or chance, and were believed to result from differences in physicians' styles of practicing medicine.

Large variations in physician practice patterns, of course, does not of itself say anything about the appropriate or "correct" level of hospital utilization. Interestingly enough, however, dissemination of the results of these kinds of studies to medical practitioners in the areas studied has sometimes resulted in a voluntary reduction in the rates of high-variability surgical procedures, without other interventions. This implies that "holding up a mirror" to health care providers by comparing their utilization rates to others, using SAA techniques, may become an effective component of utilization management.

APPLYING SAA TO KAISER PERMANENTE

For the past two years, working at Kaiser Permanente's Division of Research in Oakland, California, we have begun to apply SAA methods to hospitalization rates and average lengths of stay at our Northern California hospitals. As a prepaid "managed care" program, with no financial incentive to fill its hospital beds or perform unnecessary surgery, would Kaiser Permanente show similar patterns of variability in its hospitalization rates as other medical care systems?

Applying SAA methods to our hospitals was, at least conceptually, fairly straightforward. Computerized records of every hospital admission are saved into a DB2 database on our mainframe. Computerized membership files containing each member's age, sex and address allow us to approximate the population at risk of hospitalization for each of our medical centers. Using this data, we could compute an expected hospitalization rate for each of our medical centers, using a statistical technique called "Indirect Standardization". The expected rate for a given area, using this method, is the rate which would be expected if each individual of a particular age and sex living in the area had the same probability of being admitted to a hospital, as the Northern California Region average for people of that age and sex. The ratio of the admissions expected to the admissions actually observed for a given area, therefore, can be used as a summary measure of how much an area differs from the Regional average, after taking into account differing population characteristics. This statistic is usually referred to as the "Standardized Mortality Ratio (SMR)" in the epidemiological literature, but for this talk we'll refer it as the "Observed-to-Expected Ratio".

Another requirement for our work was to compute an overall measure of the hospital-to-hospital variability in hospitalization rates for our Region. We chose a statistic called the "Index of Dissimilarity (D')", which can be interpreted as the overall percentage decrease in hospital admissions which would be expected to occur if the areas with higher-than-average utilization rates were to come down to the Regional average rates. Conversely, D' can also be thought of as the additional hospitalizations which would be incurred if the areas below the Regional average were to come up to the expected rates. This measure has the desirable property that it allows us to easily estimate the financial impact of the observed variability in utilization, provided that we can cost out hospital stays.

We also examined differences in the "Average Length of Stay (ALOS)" for our hospitals. Again, statistical methods were developed to measure inter-hospital differences and overall variability within our Region, although we won't go into them here.

An important issue we faced concerned the appropriate categorization scheme for the types of hospital admissions we observed. Each of our computerized inpatient records contain one or more of what are called "ICD9" codes - an incredibly detailed coding scheme which attempts to describe exactly why the patient was in the hospital and what happened to them while they were there. To give you an idea of what these can be like, consider the ICD9 code E845: "injuries due to accidents involving spacecraft". Append a ".9" to the code and you have restricted it to accidents involving persons other than the spacecraft's occupants.

Fortunately there is a coding scheme in existence, derived from the ICD9 codes and available on our computerized records, which is at a more manageable level of aggregation. These are the "Diagnostic Related Groups (DRG's)" which are the basis of the Federal MediCare prospective payment system for hospital stays. By carefully pooling DRG's into clusters - (for instance, combining "complicated" and "uncomplicated" diagnoses into the same cluster) - we were able to develop a comparatively small number of categories (about 350) which would classify any hospital stay.

An important advantage of the SAA methods we used, incidentally, is that admission rates for medical care systems outside Kaiser Permanente could be put on the same standardized basis as our hospitals. The hospitalization rates for all of California, for example, could be compared to those of our Region.

Well, not to keep you in suspense any longer, when we applied the methods described above to our hospitals in Northern California Kaiser Permanente, we indeed found significant variability in hospitalization rates from hospital to hospital among certain types of admissions. What we see in Figure 1 is an example of the observed-to-expected ratios for hysterectomy rates for each of our hospitals in 1990, expressed as the percentage above or below the 1990 Kaiser regional average rate. The tall bar in the middle of the graph, for instance, represents an observed-to-expected ratio of 1.64, indicating that this Medical Center, labelled "KKK", had 64% more operations in 1990 than were expected based on Regional average rates, taking age into account. Similarly, the rate for medical center "HHH" was 20% below the Regional rate. The
asterisks next to the numbers indicate that the differences in rates are unlikely to have occurred by chance alone.

**DISCHARGE RATES FOR KP-NCR RESIDENCE AREAS, 1990**
**UTERINE & ADNEXA PROC FOR NON-MALIGNANCY (DRG's 356-359)**

Kaiser Northern California Regional discharge rates: 187 per 100,000 members

**Figure 1**

The inter-area variability should be apparent from this graph. An interesting comparison is illustrated by the lighter bar to the far right. This bar indicates that the rest of the state of California in 1989 (the most recent year for which data is available) had a hysterectomy rate 30% higher than the 1990 Kaiser Northern California Regional as a whole. So that although our Region has lower rates for this procedure than the outside world, specific hospitals within Kaiser exceed the California average. This in turn raises the possibility that physicians in our program vary more in their practice patterns than the conventional wisdom might suggest.

Although we've examined one procedure here in detail as an example, all of the 350 DRG clusters were subjected to this type of analysis, and many showed inter-area variability as great or greater than hysterectomy.

It's important to remember, however, that apparent inter-area differences in hospitalization rates may not be due to real differences in physician practice patterns. In fact, there are several other possible contributing factors:

- Coding and other data problems. In particular, a case's assignment to a specific DRG category depends on the interpretation of notes in a patient's medical chart, and there may well be systematic differences from hospital to hospital.

- Inter-area differences in population demographics. Although we adjust for age and sex, which are the most important demographic factors in hospitalization, other factors such as race or socioeconomic status, where they vary systematically between areas, may affect our results.

- Epidemiological inter-area differences. There may be different incidence of diseases in different areas, leading to differing utilization rates.

- Chance. Areas could differ in their utilization rates because of chance, although we try to control for this statistically.

Practice pattern differences can be inferred, in fact, only after these other factors have been ruled out as explanations for the observed differences.

**GRAPHICAL REPORTS**

After we had completed our analyses, we needed to develop a reporting format for our results. We rejected the usual expedient of churning out page after mind-numbing page of columns of numbers, and opted for a graphical presentation. We were presenting comparisons, after all, and what could be more natural than bar graphs? Graphics, properly presented, could allow our clients an intuitive grasp of the magnitudes involved, with a minimum of eye strain.

But was such a report practical? Up to this point our experience with graphics had consisted of producing a dozen or so slides to illustrate a talk or a journal article; here we were contemplating producing about 500 individual graphs, all artfully arranged on pages in groups for each admission type and medical center.

A prototype using SAS/GRAPH gave us a qualified "yes" as an answer; yes, you could produce the graphs in finite time, providing that you could set up a program which would pull in data for each graph, scale and label each graph appropriately, and arrange the graphs on a printed page, all without user intervention. (The last requirement is crucial when you consider that the complete run takes about 14 hours to execute on a 386 25-megahertz PC).

We should say a word here about why we chose SAS/GRAPH for this task. The SAS System is the most widely used software in our department, because of its strong data management and statistical features. SAS/GRAPH, on the other hand, while it has many wonderful properties, has rarely been described as user-friendly. In our application, with all the required annotation and complex page layout, we were almost in the realm of desktop publishing.
But when we examined other graphical and page layout software on the market, we came up against serious limitations in their ability to cycle through a lot of data and push out multiple graphs under macro control. This, however, is SAS's strong suit. With SAS we were able to exert exact control over the scaling and labelling of each graph and customize it to the data. Let's face it, for all its faults, SAS/GRAPH is an industrial strength product.

Without getting into too much detail we'd like to point out the main features of the report we came up with. We first present an enlarged version of the first of three individual graph which make up the panels of the report. Each of the bars in Figure 2 represent the observed-to-expected ratios, times a hundred, of a given population's transurethral prostatectomy ("TURP") hospital discharge rate, using the Northern California Region of Kaiser Permanente during 1990 as the standard. The left-most cluster of bars represents a specific KP hospital, (here disguised as Hospital FFF), during 1988, 1989 and 1990. So that this hospital in 1990, for instance, had a rate 22% greater than the 1990 KP Regional average, after adjustment for age and sex. Similarly, the middle cluster of bars represents 3 years of rates for the KP region as a whole (the 1990 bar here, as the standard, is always 100%), while the right-most bars indicate that the rest of the state of California was substantially higher in discharges - 61% and 47% for 1988 and 1989 respectively, than the KP standard. Asterisks on the bars once again indicate a statistically significant difference. Note as well that the rates seem to be falling over time for all three populations. The footnote to this graph estimates the number of hospital days associated with the difference in hospitalization rate between the individual Medical Center and the Region as a whole.

A similar graph (Figure 3) is used to describe the average length of stay for TURP's. Again we have three clusters of bars for comparing the individual hospital, the region as a whole and the rest of California for up to three different years.

We choose a Venn diagram (remember Venn diagrams?) to show the number of cases contributing to the two bar graphs (Figure 4). We hoped that this would be helpful in avoiding the confusion that sometimes results from the fact that our discharge rates are based on the residence area of the patient, i.e. where they live; while the average length of stay is based on the hospital to which they were admitted.
Finally the complete page looks like Figure 5. This shows the utilization picture for hospital "FFP" for two different surgical procedures: the TURP graphs we've already looked at on the top panel, and hysterectomy on the bottom. Subtitles for each of the two panels specify the name and DRG's included in the category of diagnosis or procedure, as well as the 1990 KP regional rate which is organization manages utilization. We can, however, list some of the areas where we hope and expect it to have an impact:

- "Hold up a mirror" to health care practitioners by allowing them to easily compare their utilization patterns to others. This can promote valuable discussions within peer groups about the appropriate criteria for the decision to hospitalize or perform surgery.

- Focus the utilization management process on possible "problem" categories of service. SAA can be used as a screening tool to reduce the enormous number of diagnoses and procedures, for further study.

- Suggest areas for outcome research.

- Reveal time trends in local, Regional and State utilization rates.

- Enhance visibility of research in organization.

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**Figure 5**

used as the standard for the discharge rate graph. The Venn diagram with the hospitalization counts is placed in the middle of the panel to visually and conceptually tie together the other two graphs.

A complete set of these panels for one medical center constitutes a kind of utilization profile for the hospital, summarizing a considerable amount of information.

**POTENTIAL IMPACT ON ORGANIZATION**

As the work we have described here is fairly new in the Kaiser medical care program, it is too soon to point to concrete effects our research has had on the way our
SUMMARY

In closing we would like to reiterate a theme which you will surely hear many times during this conference: good information is the key to the successful operation of any enterprise, and health care is no exception. Today we have discussed how one method of turning data into information, small area analysis of hospitalization rates, has the potential of improving our organization. Thank you for your time and attention.

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