FINAL REPORT: EFFECTS OF RURAL HOSPITAL CLOSURE ON ACCESS TO CARE: DATA ANALYSIS

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EFFECTS OF RURAL HOSPITAL CLOSURE ON ACCESS TO CARE: DATA ANALYSIS

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ABSTRACT:

The purpose of this study was to examine the impact of rural hospital closure on access to and costs of medical care. State all-payers hospital discharge data were utilized to test the hypotheses that hospital market areas that experienced hospital closure would have lower admission rates, longer average length of stay and higher costs per admission than hospital market areas where hospitals remained open.

The sample for the study included fifteen market areas in nine states where hospitals closed between 1991-1994, as well as fifteen market areas where similar hospitals remained open. The comparison market areas were included to control for medical services utilization trends unrelated to closure. The sample size was limited to 30 because of the unavailability of all-payers data in many states where closure occurred.

Bivariate analysis revealed no effects of hospital closure on admission rates, average length of stay and average charge per admission. Admission rates and average length of stay decreased for both closure and comparison market areas. Average charge per admission increased in comparison areas and decreased in study areas; however, this difference in the direction of charges was not found to be statistically significant in bivariate analysis. The sample size used for the bivariate analysis did raise concerns regarding lack of adequate power to detect differences in the outcomes of interest. However, regression analysis using the individual admission as the unit of analysis also did not detect any effects of closure on lengths of stay or charges. No differences in results were identified for market areas that experienced closure and were at the farthest distance from their nearest neighboring hospital.

The results of this study must be taken in the context of its limitations, such as small sample size and uneven quality of the state all-payers data. These limitations may have affected the ability of the study to detect meaningful changes in the outcomes of interest. The study limitations primarily resulted from the unavailability of state all-payers data in many areas of the country and the problems that arose in trying to utilize the data. These problems included missing data for certain variables or hospitals and incompatibility of data across states because of a lack of uniformity in data collection and reporting. In addition, the outcomes used in this study (admission rates, hospital charges or lengths of stay) cannot adequately capture changes in access to care that may have led to decreases in health status and quality of life for populations living in areas where hospitals closed.

I. INTRODUCTION:

The fate of rural hospitals has been the subject of much debate over the last decade. During the 1980s nearly 10% of all US rural hospitals closed [Hart et al, 1991]. Although the rate of rural hospital closure has declined in the nineties, rural hospitals still continue to close, and questions remain about the impact of the closures on the residents previously utilizing their services.

The potential loss of access to hospital care may be more detrimental in rural areas where residents already have more chronic or serious illnesses, have higher injury-related mortality rates, are more likely to be uninsured and have longer travel times to medical care compared with residents in urban areas [GAO, 1991]. In addition, a greater proportion of the rural population is elderly, disabled, poor, and under eighteen, compared with urban areas. Rural hospital closure may be especially problematic for poor, elderly or disabled persons, who may lack transportation or be unable to travel long distances. A decrease in access to hospital care thus could result in poorer quality of care or higher costs for those previously utilizing the hospital that closed. Other potential repercussions of closure are access impediments for areas where the closed hospital served a high proportion of the medically underserved, loss of physicians, nurses and other vital medical professionals because of closure as well as reduced availability of emergency services.

Many studies have been performed to identify causes for the closure of many rural hospitals. The changes in Medicare reimbursement under the Prospective Payment System (PPS) have been blamed for closures by administrators, local leaders and physicians [Muus et al 1995, Hart et al

1991]. However, several studies have not identified PPS as a major contributor to closure [GAO 1991, Hadley et al 1991]. The General Accounting Office study, commissioned by Congress to study hospital closures, did however state that "Medicare may have contributed disproportionately to the financial distress that preceded closure in the smallest rural hospitals" [GAO, 1991]. The change to the PPS system may not have led directly to closure; however, PPS along with decreases in insurance reimbursement and more stringent monitoring of hospitalization by managed care and other insurers certainly contributed to more competitive markets. The situation of competitive markets has been cited as a factor in hospital closure [GAO, 1991]. The GAO study also found closure to be related to small size, low occupancy, for profit ownership, providing less complex medical services and weak economies. Other studies have identified additional factors to be related to hospital closure, such as lack of JCAHO accreditation, proximity to competitor facilities, and lack of differentiation in services [Mick and Morlock, 1990; Succi et al 1997].

The loss of a rural hospital may have repercussions beyond the critical concern of access. Often these rural hospitals serve as the organizational core for community health activities and social services such as home health care and services for the elderly. In addition, the hospital may be an integral element in recruitment of health professionals, such as physicians and physician extenders, which may suffer after the hospital closes [Weisgrau, 1995]. Rural hospitals also play an important role in sustaining the economic health of their host communities through employment of local residents and provision of one of the basic community services that is crucial to attract and retain other employers [Hart et al, 1991].

The purpose of this study was to explore the repercussions of hospital closure on access to and costs of medical care for the communities previously utilizing the hospitals that closed. State all-payers hospital discharge data were utilized to address questions of access and costs for all segments of the population. Identification and descriptions of any adverse effects of rural hospital closure are critical to future decisions concerning rural health policy.

II. BACKGROUND:

Some analysts view closure as an appropriate reduction in hospital capacity, while others see closure as the loss of necessary services and a threat to the health of the populations in the communities that are affected by closure. Determining how closure influences access to care is crucial to bringing some resolution to the question of whether closure reflects appropriate change or a decline in critical services [GAO, 1991].

A number of studies have been performed to address the substantive concerns of rural hospital closure. The methodology used in the studies varies from surveys and case studies of closure areas to employment of Medicare utilization data to look at effects of closure on Medicare recipients. Several surveys and case studies have documented serious concerns regarding access in closure communities. These effects appear to be greatest for the more vulnerable members of society, such as the elderly, poor, disabled, pregnant women and small children.

A survey of mayors of towns that had experienced closure of their sole community hospital found these mayors to perceive a loss of quality of life and health status, especially for the elderly, low income and disabled residents [Hart et al, 1991]. A study performed by Bindman et al 1990, compared inpatients from a public hospital in California that closed to inpatients from a similar hospital that remained open. Patients were surveyed soon after hospital closure and a year later to look at issues of access to medical care. The percentage of patients from the closed hospital without a regular provider of care doubled in the year after closure. These patients experienced an increase in pain, an increase in waiting times for medical services, a significant decline in health perception and a decrease in medication compliance as compared to patients from the open hospital who did not experience similar difficulties [Bindman et al 1990].

A study done in North Dakota also looked at the impact of a single hospital closure however

did not include a control group. In the year after closure residents living in the county where the small rural hospital was located were randomly selected for a survey. Results of the survey showed that 75% of residents believed the loss of the hospital would affect them, half said diminished access to emergency care was a problem for them, and 17% said they or a family member had decided not to seek needed medical attention on one or more occasion because of inconvenience [Muus et al 1995].

A component of the in-depth study of hospital closure performed by the General Accounting Office was a case study of 11 closure areas. This case study also identified significant concerns regarding access to hospital services especially for the medically fragile and those requiring emergency or obstetrical services.

These surveys and case studies indicate potentially serious effects of closure on access, the studies must, however, be considered in the context of their limitations. Surveys are subject to bias because of the possibility that those who will take the time to respond to the survey may be different from those who do not respond. Those that do perceive problems with access may be more likely to respond to the survey than those who do not, therefore exaggerating results of access problems. In addition, the generalizability of results of case studies to other areas is limited. As the study only examines one specific region, results may not be applicable to other areas or types of hospitals.

Additional studies have looked at travel time, distance to the nearest hospital, and services provided by hospitals as proxies for access to medical care. These studies did not measure actual patient use of medical services. Results regarding distance to the nearest hospital have been mixed. Samuels, Choi and Cunningham 1991, in a study of hospitals that closed in 1989 reported a mean travel time between closed hospitals and their closest neighboring hospital of 18.7 minutes and concluded from this that access was not significantly impaired by closure [Samuel et al, 1991].

A study of the 1990 nationwide closures also looked at travel time but added a travel distance measure. A computer software program was used to estimate the distances and travel time to the nearest hospital rather than using interviews with ambulance drivers as Samuels did [Fleming et al 1995]. The study also looked at the availability of specific services at the closure hospitals and the nearest neighboring hospitals to further measure the effects of closure on access. This study found a longer average travel time, 30.2 minutes, than had Samuel and an average distance of 25.7 miles to the closest hospital. Forty percent of the areas had longer than a 30 minute travel time with the longest being 110 minutes. These long travel times, while offering no proof of barriers to access, could create a situation where the most fragile, vulnerable patients, such as the elderly, disabled, and poor, have more difficulty in managing this burden. The study also found that the hospitals closest to closure hospital areas provided a broader scope of services than the hospital that closed. The authors concluded that the hospital closures "resulted in a tradeoff between breadth of services and rapid access for emergency conditions" [Fleming et al 1995].

A PROPAC commissioned study that examined the effects of distance, travel time and medical resource availability as proxies for access found no overall detrimental outcomes of hospital closure. However, analyses of specific areas revealed that residents in the mountain region did have significant travel time to obtain hospital services [Marder et al 1991]. The residents in the closure counties had to travel as much as three times longer than patients in the control counties. The control counties were counties that never had a hospital. They also had fewer health resources, such as health departments, physicians and nursing homes available to them.

Studies have also used the availability of physician services as a proxy for measuring access. Physician supply is potentially jeopardized by hospital closure if physicians lose access to the only available facility in the area through its closure. They then must decide between relocating or traveling to admit their patients to other hospitals. A study of Texas hospitals that closed from 1985-90 found little impact on availability and distance to critical hospital services but did find some evidence of a reduction of physician availability in the counties where closure occurred

[McKay, 1995]. A study by Hart and colleagues found indications of a relationship between hospital closure and physician supply [Hart et al 1991]. They found that although the supply of physicians in rural areas rose by 21.6% in the 80s, towns that lost their sole community hospital had a decrease of 12.8% in the number of physicians during the decade. Although rural areas experienced some decline in population during this time, the decrease in physicians was five times the loss in population. Of the 132 rural towns that experienced closure of their only hospital, 49% had fewer physicians practicing than they had 2 years prior to closure and only 23% saw any gains in their physician supply. The study also identified a relationship between distance to nearest hospital or urban area and physician supply. Hospitals within 20 miles of the nearest hospital experienced little change in physician supply whereas those greater than 20 miles from the nearest hospital had a 25.4% decrease in physicians. In addition, hospitals located in counties contiguous to Metropolitan Areas experienced negligible losses in their physicians, while the counties that were not adjacent to Metropolitan Areas experienced a reduction of over 20% in physician supply. This distance association raises concerns of access to medical services, particularly for those that are the least likely to be able to travel to seek physician and hospital care.

It is not clear to what extent changes in access can be measured through the use of proxies, such as distance to nearest hospital or availability of health care services. Study results showing an increase in travel time or decrease in physician supply imply, but cannot prove that access has been reduced. Another issue of study design that must be considered when examining hospital closure is how the hospital's market area will be defined. County is frequently utilized as the market area for the hospitals. County is often not the optimal choice for market area definition as the hospital may be close to county lines and draw from other neighboring counties for patients. Use of county as the market area may not only exclude patients from neighboring counties but also might erroneously include residents in the market area that actually utilize other hospitals. Market area determination is crucial to the study of closure on access, as use of the wrong population based on conveniently existing geographical boundaries could mask effects of the closure [Goody, *Health Services Research*, 1993].

Methods have been identified to address this incongruence between county of the hospital and what the actual market area may be. These methods generally involve use of patient level data to identify which hospital the majority of patients in a zip code are utilizing. These high use zip codes are determined and a market area is constructed for the hospitals of interest. A study by Goody looked at the differences in market areas determined by use of county and use of zip code patient origin data [Goody, *Inquiry*, 1993]. The geographic region defined as the market area varied dramatically between county and zip code definitions. The market area was found to be, on average, approximately twice as large when the county was used rather than the zip code. The zip code based market areas also included zip codes that were not in the same county as the hospitals. In order to determine the overlap between the alternate market definitions, zip codes that were contained in both zip code based and county based market areas were identified. The overlap between zip code and county based market areas was only 42% of the zip codes.

Several studies have used a zip code market area definition to study the impact of closures on access. In the late 80s, the General Accounting Office was commissioned by Congress to study reasons for hospital closure and the resulting impact on access. GAO researchers studied hospitals that closed in 1986 and used Medicare data to define the market areas of the closed hospitals and to study the impact of closure on admissions and costs. The study was limited to information on Medicare beneficiaries because of the unavailability of national all-payers data. The extent to which Medicare beneficiary patterns of use reflect that of the general population is questionable [GAO, 1991]. Closure hospital market areas were defined as zip codes that had the highest use of the closed hospital. Zip codes with progressively lower use were added until at least 75% of the hospital's patients came from the included zip

codes. GAO researchers looked at two years prior and one year post closure. Closure market areas experienced a decrease in hospital admissions after closure; however, rates of admission were higher than the national average prior to closure and remained higher than the national average despite the drop in admissions after closure. The study also evaluated the effects of closure on costs, hypothesizing that the expenditures would rise because of use of more costly hospitals after closure. The results, however, showed that although a trend toward use of more costly hospitals (urban hospitals and rural referral centers) was identified, this was no greater than the trend to use higher cost hospitals found in national averages.

Despite the lack of aggregate findings of reduced access, the GAO study did identify specific market areas where access was a concern. Their analysis found that about a third of the rural closures may have created or worsened access problems for the most vulnerable in their areas. These conclusions stemmed from several indicators including long travel times to the nearest hospital, hospitals that served a high proportion of medically underserved and indigent patients, and areas that had a decline in admissions during the study years that dropped their admission rates below national averages. This study received criticism for failing to standardize for potential age and sex differences between closure areas and the national rate [Rosenbach et al 1995]. Another potential limitation of the study was the use of only one year of data post closure. Often the year after closure is a tumultuous one with professionals and market area residents attempting to adapt to the change. Although measuring access indicators during the first year post closure is important to assessing the initial impact of closure, it is also valuable to study these indicators at a later time such as two years post closure. This would allow time for the upheaval created by closure to stabilize somewhat so that more long term effects can be assessed.

A more recent study by Rosenbach and Dayhoff used a market area definition similar to the definition used in the GAO study in order to compare areas where hospitals closed to areas where hospitals remained open and areas that never had hospitals. The study compared admissions rates, physician utilization patterns, mortality, and beneficiary costs before and after hospital closure. Two comparison groups were selected for each closed hospital to attempt to control for effects that could have occurred independent of hospital closure, such as secular trends for decreases in admissions. Study results show a significant decrease in admission rates in the years following closure; however, admission rates still remained higher than in comparison areas. This finding led authors to suspect that perhaps the threshold for admissions was low prior to closure and the decrease in the admission rate was actually a decrease in unnecessary admissions. No impact on mortality or physician utilization was observed. An interesting finding from the study was that patients in closure market areas did utilize more expensive urban hospitals during the post closure time. This was offset by the decrease in admissions so did not result in overall increases in costs during the study period [Rosenbach et al 1995]. One considerable limitation of this study is a small sample size of 11 hospitals. This small number restricts the power of the study to detect changes or find significant results.

A study performed by Welch and colleagues in 1993 compared the costs of hospital care for rural and urban residents. Study results indicated that patients from more distant areas have higher costs than local patients treated at urban referral centers in Washington State. Several explanatory possibilities are given for this result. One explanation is the distance decay model that patients with more severe illnesses are more likely to travel for care; however, this seems unlikely as severity of illness was adjusted for in the analysis. Another possible explanation is that distance may create barriers to discharge, such as transportation, lack of home health care or other essential supportive services, therefore delaying discharge and increasing costs [Welch et al, 1993]. This finding may have financial repercussions for closures if indeed rural patients incur higher costs when seen at urban referral centers.

Many methodolgic issues have been identified from previous studies that could have influenced

their results. Some of these are potentially mutable while others are expected repercussions of doing research on the behavior of populations that cannot be under the control of the researcher. One immutable problem is the inability to randomize hospitals or market areas to closed or open groups in order to increase the certainty of similarity between groups. Another significant problem is the inability to directly measure the effects of closure on access. Barring an assessment of all individuals in the market area of a hospital before and after closure to identify problems in obtaining care and the resulting impact on health status and quality of life, all measures used to identify barriers to access resulting from hospital closure are proxies of access. These measures have the potential to underestimate impacts of closure. Health status is extremely difficult to measure as there are no national morbidity indexes, so other measures, such as admission rates, costs, readmission rates, lengths of stay, etc. must serve as proxies when using aggregated data. Case studies or surveys are able to get direct health status information from patients; however, these study designs suffer from limitations outlined above such as bias due to who responds to the study, lack of generalizability to other areas, and containing primarily subjective data.

This study will attempt to rectify, where possible, the multiple problems identified in previous studies. This was done by use of the zip code rather than county to define the market areas for closure and comparison hospitals; the use of two years prior and two years post closure to more accurately capture baseline utilization and utilization once some stabilization has occurred; use of comparison hospital market areas matched to the closure hospitals on important characteristics; and a sample size of 30 closure hospitals and their matches. State all-payers data were used, rather than just Medicare data, to broaden the questions regarding the effects of closure to other vulnerable populations, such as the indigent, uninsured, pregnant women and children. Data regarding Non-Medicare patients have been difficult and often impossible to obtain as no national all-payers database exists. State legislatures and organizations are responsible for making decisions of what data are collected and how it is utilized. In many states no data have been collected or the data is incomplete. In several states where the state hospital association has collected all payers data, the use of these data are restricted to participating hospitals.

III. RESEARCH QUESTION AND HYPOTHESES:

Research Question:

What was the impact of rural hospital closures on the utilization and costs of hospital care for populations living within the service areas of the closed hospitals?

Hypotheses:

The following hypotheses were developed to address the research question. The concepts of access, utilization and cost of care were operationalized using the hospital discharge outcomes of admission rates, average lengths of stay, and average charges per admission. These variables are used as indicators of significant changes taking place in hospital market areas after the closure of rural hospitals. A hypothesized effect of distance is included with each hypothesis, as the distance to the nearest hospital is thought to mediate the impact of hospital closure on the dependent variables.

Hypothesis 1: In the years following hospital closure, admission rates will be lower for residents in service areas where hospitals closed, compared to admission rates of matched service areas where hospitals remained open.

Rationale: Residents of rural areas will have difficulty accessing hospital care in areas where hospitals closed. They may not seek care for conditions that are not emergencies and may also substitute self care or outpatient care if available for hospital care because they experience barriers such as travel time, financial resources, difficulty in traveling.

Effects of Distance: Barriers to admission will increase as distance to the nearest hospital increases, therefore hospital admissions will be expected to decline as distance increases.

Hypothesis 2: The average length of stay will be greater for patients residing in service areas where hospitals closed in the years following the closures, compared to lengths of stay for residents in areas where hospitals remained open.

Rationale: Residents in rural areas where hospital closure has occurred may have difficulty accessing hospital care. This may result in their being more severely ill when finally admitted to a hospital and therefore having longer lengths of stay.

Effect of Distance: Barriers to care will increase with distance so lengths of stay will increase as distance increases.

Hypothesis 3: In service areas where a rural hospital closed, the total charges per admission will rise after adjustment for inflation, compared with similar areas where hospitals remain open.

Rationale: Since residents living in closure areas may decide to go to more expensive urban hospitals, the average cost per admission will rise.

Effect of Distance: In closure areas, total charges per admission may rise as distance to the nearest hospital increases because the distance may create additional barriers to assessing care that could lead to residents being more severely ill on admission.

IV. METHODS AND ANALYSIS

STUDY DESIGN:

A longitudinal analysis with a matched comparison group was used to study the effects of hospital closure on the utilization and cost of care for residents living in the market areas.

SAMPLE:

Hospital closures were identified for the years 1991 through 1994. The 1994 cutoff was chosen to ensure that hospital discharge data would be available for two years after closure. Several sources were used to identify and verify hospitals that closed because of the dynamic nature of these closures. Hospitals can close temporarily, change names or ownership which may lead to their erroneously being labeled as permanently closed. An article by Burda and colleagues, 1989, regarding the American Hospital Association's 1988 closure list demonstrated how several hospitals on this list had reopened. In order to study the effects of closure on access, it is obviously essential to study hospitals that actually closed. To alleviate this potential problem a cross referencing system was developed for verification of closures for the purpose of this study.

Hospital closure lists from the years of interest were obtained from the American Hospital Association, The Health Care Financing Agency and the Office of the Inspector General. These three lists were compared and the hospitals on all three lists were included as closed hospitals. For any hospitals where information conflicts were detected, local health providers in the closure area were contacted to verify hospital closure status. After hospitals were matched to comparison hospitals further closure verification was done by calling the state hospital associations in all states where closure occurred and asking for verification of the closure of the hospital, the date of closure and the open status of the comparison hospitals. If the state hospital associations did not have this information, the state Medical Facility Licensure Departments were contacted to obtain the necessary information.

The closure identifying process produced 18 acute care hospitals that closed between 1991-1994 in states that collected state all-payers hospital discharge data for those years. A group of 18 comparison hospitals was selected in order to control for trends in hospital utilization and expenditure patterns not related to hospital closure. The final sample size for the study was 30, 15 closed and 15 comparison hospitals; 3 of the original 18 closure hospitals and their matches had to be dropped because of insufficient data. These hospitals represent 9 states with a concentration in the west and Midwest of the U.S. (See Figures 1-4 for hospital characteristics) Hospitals were matched on three characteristics; state in which the hospital was located, size, and distance to nearest facility. Distance to the nearest hospital was chosen as a match characteristic because of the hypothesis that the distance to the closest neighboring hospital affects the influence of closure on utilization. For instance, residents at greater distance

from the nearest hospital would be predicted to have greater difficulty in accessing services. The use of the distance variable for matching as well as its use in the analysis to look at how access is affected by increasing distance from the nearest hospital appears to be unique to this study. The distance to the nearest hospital was constructed using the ZIP code reported in the 1989 American Hospital Association Survey of Hospitals. These reported zip codes were linked with a Claritas Data Systems data file containing location information about Zip Codes. The MapInfo system was then utilized to calculate the distance to the nearest hospital. Comparison hospital candidates were identified through the 1989 AHA hospital survey. Five potential matches were selected for each hospital with the exception of a few hospitals where four match candidates were selected, as a fifth appropriate match was not available. A random number table was generated and used to select the control hospitals.

DATA SOURCES:

- American Hospital Association's Report, *Hospital Closures 1980 -1993 A Statistical Profile*.
- Health Care Financing Agency - List of Terminated Hospitals from 1991-1994.
- Office of the Inspector General Hospital Annual Hospital Closure Report - 1991-1994.

MARKET AREA DEFINITION:

A market area was defined for each closed and comparison hospital using state all-payers hospital discharge data. To be considered part of a hospital's market area a zip code had to contribute at least 30% of its hospital admissions to that hospital. This method of market area definition, which is referred to as a relevance index, measures the proportion of total admissions by residents of an area to a particular medical facility [Simpson et al, 1994]. The level of 30% was chosen because of the results of simulations performed on rural hospital closure data. These simulations identified 30% as the most logical compromise between specificity and sensitivity of market area definitions.

VARIABLES USED IN THE ANALYSIS:

Outcome Variables: This study includes the tests of the three hypotheses previously listed. The three outcome variables derived from these hypotheses are admission rates, average lengths of stay, and average charges per admission. Lengths of stay of less than 24 hours were not used in the analysis as these admissions may reflect outpatient care and emergency room visits that are not reported consistently across states. The population of the zip code market areas was used as the denominator to calculate admission rates. The population statistics were obtained from the Claritas Data System as the Census data were missing data for several zip codes that were needed for the study. The census yearly projections for the population in counties where closed and comparison market areas were located showed that over 70% of market areas were predicted to experience at least marginal growth. Because this growth in population could affect the accuracy of the calculated rates for admissions and therefore bias results, corrections were made for population growth. The population number in each market area was adjusted by the percent growth that had occurred in the county between the before closure period and the after closure period. County population was used for the adjustment rather than zip code because county projections for every year were available through the census. Hospital charges were modified to account for inflation by using the consumer price index to adjust the charges to the before closure time period.

Explanatory Variables: The primary policy relevant explanatory variables for this analysis are closure status and time from closure. Time from closure was dichotomized into the time one to two years prior to closure and the time one to two years after closure. The time one to two years before closure is referred to as the before closure period in this analysis and started at two years prior to the month and year of closure and ended one year prior to the month and year of closure. The time one to two years following closure is referred to as the after closure period and began one year after the month and year of closure and ended at two years after the month and year of closure.

Control Variables: Demographic information from the zip code market areas was analyzed to identify any aggregate differences between closed and comparison market areas. Variables were to be included in the analysis if they were found to be significantly different by t-tests in control and comparison market area groups.

Demographics of Market Areas: The US Census data from 1990 were utilized to compare the demographics of the study market areas. Information on age, education, race, ethnicity and poverty status was obtained and combined for the zip codes in each market area (see Table 1 for a summary of census statistics). Information on the total population in the year 1990 was obtained from the census data and Claritas Data systems. Comparison of these two sources identified six areas where zip code information was missing in the census data. In five of the market areas the population in the missing zip codes was less than 10% of the total area population. However, in one area 20% of the total area population was included in the missing zip codes. Because of the missing zip code information in the census data, the Claritas Data System total population numbers were used as the total populations for the areas as well as the denominators for calculating admission rates. However, because the Claritas Data System does not contain demographic information, the census data were used to compare population demographics for closed and comparison market areas.

The total population for the comparison areas (218,329) is over twice the population of closed areas (93,842). This finding is difficult to interpret; it could be due in part to a smaller scope of closure hospitals that contributed to their closure, or the difference could reflect a gradual closing process that had already begun several years prior to closure. Market areas were calculated using hospital discharge data for a twelve month period beginning two years prior to closure and ending one year prior to closure. Consequently, some hospitals may have already experienced a decline in admissions that resulted in the market areas being defined as smaller than they would have been if they had been defined in an earlier period. The size difference between closure and comparison market areas may also reflect poorer reporting of admissions by hospitals that were struggling or in the process of closing.

The closure and comparison areas were similar in terms of overall age distribution. Just over a quarter of residents were under eighteen, nearly 60% were between 18-64, and close to 15% were 65 and older. T-tests of the percentages in each category for all closed hospital areas and all comparison hospital areas show no significance difference at an aggregate level. However, there was considerable variability between the market pairs with some areas having a much greater population over 65 and others having a much younger population.

On average, the control group residents had a slightly higher level of education than did the closed area residents. Among the closed area residents, 33% had no high school education and 30% had a college degree, as compared with 25% of residents of the control areas who had no high school degree and 38% with a college degree. However, the means for the closed and comparison market areas were not found to be statistically significant.

The distributions of race and ethnicity also differed for the closed and control market areas. The closure areas had a lower percentage of residents that were white and a higher percentage that were Hispanic, African American or Native American. However, these differences, like that of education, were not found to be significant when t-tests were performed. In addition, the differences between closure and control areas on race and ethnicity primarily reflect large differences in a few areas. For instance, in one Western closure area nearly 50% of the population was Hispanic, whereas in the matched comparison hospital area only 4% of the population was Hispanic.

The population proportion below the poverty line was 18% for closure areas and 13% for comparison areas. Eleven out of the sixteen closure areas had a higher poverty rate than their matched comparison areas. However, this difference was not found to be statistically significant. The proportion of those over age 65 who were

living in poverty was fairly similar in the closed and comparison areas.

Although differences in demographic characteristics were detected between closed and comparison zip code market areas, these differences were not found to be statistically significant. A larger sample size of hospitals would be to needed to assess whether the differences reflect random variation or if there is a trend of closure occurring in rural areas with higher poverty rates and higher proportions of minority residents.

DATA ANALYSIS:

The data obtained from the states were standardized and compiled into a common format so that analysis at an aggregate level could be performed. T-tests were used to examine whether admission rates, average length of stay and average charge per admission were significantly different in the before and after closure periods for the closed and comparison areas. The t-tests were performed as an initial analysis to see if the outcomes of interest changed following the hospital closures. The outcome of average charge per admission was examined in eighteen of the thirty closed and comparison areas. The remaining twelve areas were located in states where charge data were unavailable.

Differences between the before and after time periods in all market areas were calculated for the three variables of interest: admission rates, average lengths of stay, and average charges per admission. These differences were aggregated for closed and control market areas so that comparisons could be made. This method of taking the difference between the before and after periods for each market area and aggregating them to the closed and comparison areas was used in order to control for baseline differences on the outcomes of interest between closure and comparison market areas. If only the differences between closed and comparison areas on outcomes of interest in the after period were examined, then any differences detected may reflect baseline differences between closed and comparison areas rather than repercussions of closure. The aggregated differences in the before and after period on admission rates, average lengths of stay and average charge per admission were then compared between closure and control market areas by the use of t-tests. The differences in admission rates, average length of stay and average charges per admission were analyzed separately for medical, surgical, newborn, obstetric and psychiatric admissions. Age categories and payer source were also analyzed separately. These subanalyses were performed in order to detect any differences by age group, payer source or type of admission in the effects of closure on the outcomes of interest.

Linear regression, with adjustments for correlation between observations in the market areas, was used to evaluate the effects of closure on lengths of stay and charges as well as to examine the influence of distance to the nearest hospital on outcomes. The unit of observation in this analysis was the individual admission rather than the market area. Admission rates were not analyzed through regression analysis because they could not be examined at an individual level. The admission was used as the unit of analysis in order to provide adequate power to detect differences between the study and control areas. Use of the admission as the unit of analysis introduces the problem of correlation among observations within a market area. Failure to control for clustering can result in biased standard errors and possible overestimation of the statistical significance of variables. Potential error correlation was corrected by using the robust and cluster commands in the STATA software. Regression with the robust option in STATA adjusts for correlation by using Huber White methods to calculate the robust standard errors. Use of the cluster option allows relaxing of the assumption of independence within the market areas (STATA 5.0, 1997).

Semi-logarithmic models for estimating length of stay and charges were used in order to correct for the skewed distribution of the variables. Independent variables included in the estimation were: whether the hospital was located at the farthest distance from the nearest hospital, whether the admission occurred during the before or after period, whether the admission was from a closed or comparison market area, age, type of admission, and multiple interaction terms for clo-

sure status, time period and type of admission. (See the Appendix for the regression equation.) The distance variable was created by using the distance quartile that was the farthest from the nearest hospital and comparing it to the reference group of the other three quartiles. All the hospitals in the farthest quartile were greater than 17 miles from an adjacent hospital.

V. RESULTS:

Bivariate analysis: No significant differences were found in the unadjusted analysis that examined the effects of closure on admission rates, average lengths of stay and charge per admission (See table 2 for these results). For both the closure and control groups, admission rates and lengths of stay decreased over time. However, average charge per admission increased slightly for the study areas and decreased slightly for the control areas.

When admissions were examined by payer source, Medicare, Medicaid, and private insurance, no significant differences were found in the before and after periods for admission rates, average length of stay and average charge per admission for the study and control areas. In addition, no significant differences were detected between the before and after periods on outcomes of interest when admissions were examined by service areas including medical, surgical, pediatric, newborn, and obstetrics. This was true for both the study and control areas indicating that different populations and types of admission did not show differences between the before and after periods for either study and control areas. Admission rates decreased and the lengths of stay either stayed virtually the same or decreased for most service areas in both the closure and comparison market areas. The trends for average charge per admission varied by service areas with some decreasing and others increasing. For example, average charge per admission showed an increase for newborn and obstetric admissions in both the study and control areas, however, as stated above these differences were not statistically significant.

Comparing differences in admission rates, average lengths of stay and average charge per admission between the time prior to closure and time subsequent to closure, we found no variation by study versus control. T-tests demonstrated that the differences between the before and after periods were not significantly different for the study and control areas for admission rates, average length of stay and average charge per admission. However, the average charge per admission decreased from the before closure period to the after closure period by $262 for closure areas and increased by $414 for control market areas. This result is difficult to interpret because of the small number of market areas reporting hospital charges. Six of the fifteen market areas where hospitals closed and six of the fifteen market areas where hospitals remained open were not used in this analysis because charges were unavailable in state databases. It is impossible to know if the difference between the closure and control areas would have remained as disparate if more observations were available.

The results of the regression analysis on the logged length of stay and logged charges were similar to the unadjusted results that indicated no effect of closure on the lengths of stay or charges. This model included an interaction term of closure status and time from closure. The nonsignificant findings on the interaction variable of closure status and time from closure in the lengths of stay and charges regression models indicated that admissions that occurred in the time period after closure, that were in market areas where closure occurred, did not have lengths of stay or charges that were significantly different from those market areas that did not experience closure. As expected, the regression analysis did identify that lengths of stay were shorter in the after period for both closure and comparison market areas. This result is consistent with the national trend for a decrease in lengths of stay. Regression analysis did not detect a significant difference for charges per admission in the after period for either closed or comparison market areas.

Regression analysis was used to investigate the effect of distance from the closure hospital to an adjacent hospital on lengths of stay and charges. The regression model included variables that controlled for the influence of age and type

of admission. The admissions from the closure market areas that were the farthest from an adjacent hospital were hypothesized to have the longest lengths of stay and higher charges in the post-closure period. The distance variable was dichotomized with one category including the market areas in the quartile farthest from an adjacent hospital and the other category including the remaining three quartiles. Interaction terms between the distance, closure status and time period variables did not find an effect of distance on hospital lengths of stay or charges in the post-closure period.

VI. DISCUSSION:

This study provides little support for the hypotheses that hospital closure influenced the outcomes of interest: admission rates, average length of stay and average charge per admission. Some differences were found in the before and after periods for both closed and comparison areas, indicating that in general hospital admission rates and lengths of stay decreased over time. However, the average charge per admission increased in comparison areas and decreased in closure areas. This difference in the direction of charges and the fact that it was not found to be statistically significant, may reflect the smaller number of market areas (only eighteen out of thirty study and comparison areas had data on charges) that were available for this analysis.

Failure to detect significant differences in the patterns of admission rates, average lengths of stay and average charges between study and control market areas may indicate that closure did not influence hospital utilization. However, these results must be viewed with caution because of the small sample size when admissions are aggregated to the market areas. In the regression analysis the individual admission was the unit of analysis. The lengths of stay analysis had 74,365 observations. This analysis had adequate power to detect differences between closure and comparison area admissions, yet also failed to show that closure significantly influenced the average length of stay. The regression analysis of charges had less observations, 42062, because of market areas where charges were unavailable. This sample size was adequate to detect differences between the admissions in closure and comparison market areas yet also did not find an effect of closure.

No effect of distance on hospital utilization patterns was identified. Admissions from the closure market areas located the farthest from their closest neighboring hospital did not experience longer lengths of stay and higher charges compared with those closer to the nearest hospital. This result suggests that alternatives were found prior to closure and that distance is not a deterrent in regions where rural hospitals close.

Study Limitations:

Several limitations of the study have been identified. One problem that studies of this kind experience is the use of proxies, such as hospital admissions, lengths of stay or average charges, to evaluate the effects of closure on access and costs of medical care. These measures may fail to capture an accurate picture of the impact of closure of a rural hospital on the health of the community that it served. The use of hospital discharge data aggregated to market areas prevents the examination of the health seeking behavior and barriers to care for individuals over time. The examination of readmissions for patients is not possible, as the variable is not available in most state databases. The use of only hospital discharge data may miss pertinent information about utilization of other sources care. Alternative care sites, such as outpatient medical and surgical services, have been theorized to serve as substitutes for inpatient care. However, this result was not found in the Rosenbach and colleagues study that examined utilization of both inpatient and outpatient care in market areas of closure and comparison hospitals (Rosenbach et al, 1995).

The sample size of this study is another potential limitation. Although 77 closed hospitals were identified for the years of interest only 18 were in states that had state hospital discharge databases. Three additional closed hospitals had to be eliminated from the analysis because of insufficient data. The analysis of the outcomes of admission rates, average length of stay, and total charges per admissions that were aggregated to

the market area may have suffered from a lack of power to detect differences between closure and comparison areas due to the sample size. However, regression analyses of lengths of stay and charges per admission were performed at an individual admission level, therefore should have had adequate power to detect changes between closure and comparison market areas.

The generalizability of the study is somewhat restricted because of the concentration of the hospitals in the Midwest and West. The states represented by this study primarily represented the West and Midwest because of data availability. Although many closures occurred in the southeastern part of the country only one closure in this area occurred in a state where data were available for the years needed.

The quality and consistency of state hospital discharge data are additional potential limitations of this rural hospital closure study. The Agency for Health Care Policy and Research (AHCPR) reviewed the data quality of 12 state discharge databases for 1991. Five of these states provided information that was utilized in this study. Edit checks were run to search for out of range or invalid values and consistency between data elements at the discharge level. These edit checks found low error rates and inconsistencies as well as low incidence of missing values for key variables except for race and type of admission. These variables were not utilized in this study because of their questionable quality in statewide databases.

The AHCPR state data review notes differences between states on how data were collected and coded. This is an inherent problem in using data collected by different sources in different formats. Variables, such as discharge status and payer type, that differed between states were standardized as much as possible for the purpose of this analysis, but inconsistencies may remain despite these efforts. The control hospitals were chosen from the state in which each closure originated so the data issues would be the same within the state. Therefore, the deleterious effect of data inconsistencies would be somewhat abated.

An additional limitation of the state hospital discharge data is the potential loss of admissions for a market area because residents are crossing state borders to obtain care. An analysis was done to identify areas where border crossing could have occurred. This analysis identified five market areas where border crossing for care may be an issue. In two areas, this was resolved by using data from the bordering states that had been purchased to look at closures within that state. Additional data were purchased from the bordering state of one closure area, as border crossing was highly probable because of the short distance to the border and presence of hospitals in that neighboring state that were fairly close to the border. In two areas, data from the bordering state were not available. In both of these situations the nearest hospital and the next nearest hospital were both located in the state where the closure occurred not in the bordering state. Because of the location of closer hospitals within state, it appeared that significant border crossing was not very probable.

A further study concern was that hospitals that were struggling or in the process of closing may not have reported their admissions to the data collecting agency in their state as accurately as the comparison hospitals. This potential difference in the accuracy of reporting could have affected the market area definition and contributed to the finding that closed hospital market areas were smaller than comparison hospital market areas. Market areas were defined using the hospital utilization information from one year prior to the year before closure. That year was selected rather than the year prior to closure to attempt to avoid the problem of inaccurate reporting or hospitals that closed slowly over time. However, it is possible that the using the year earlier than the year before closure still may not have been far enough before closure to avoid some of the instability created by the closure of the hospital. Conversely, it is also possible that the market area populations of the closed areas are smaller because the hospital, even prior to the closure process, was seeing a smaller number of patients than the comparison areas.

Finally, changes in the population of closure or comparison market areas could have introduced bias to the analysis of admission rates. The market

area populations were adjusted from the before period to the after period by using the census population projections. However, as these were only projections there is a possibility that they were not accurate in some areas. If a population change was not adequately projected then admission rates for the after period would not be correct because the denominator would not accurately reflect the true population in the market areas.

VII CONCLUSIONS AND POLICY IMPLICATIONS:

This study of rural hospital closures identified no adverse effects of closure on costs of care, lengths of stay or admission rates in market areas experiencing closure. The results of this study are consistent with the results of previous studies that used hospital discharge data for Medicare recipients to examine repercussions of hospital closure. The use of state all-payers hospital discharge data appears unique to this study and allowed for the examination of outcomes of interest for all populations in the closure market areas rather than among beneficiaries with Medicare. Results for younger, non-disabled populations indicate that outcomes of charges, admission rates and length of stay were also not adversely affected for these populations.

The results of this study must be taken in the context of its limitations, such as small sample size and quality of the state all-payers data. These limitations may have affected the ability of the study to detect meaningful changes in the outcomes of interest. The study limitations primarily stemmed from the unavailability of state all-payers data in many areas of the country and the problems in trying to utilize the data. These problems included missing data for certain variables or hospitals and incompatibility of data across states because of a lack of uniformity in data collection and reporting. Future studies of the effects of closure on access and costs may not experience limitations of the same magnitude because of the improvements in data collection methodology that appear to taking place in many areas and the addition of new states that are collecting discharge data.

The findings from this study partially support those identified by a case study, also performed by these authors [Reif et al, working paper, 1998] that was done to supplement this hospital closure study. The case study involved interviews of health professionals in six areas that experienced closure and six matched comparison areas. These interviews identified few long term effects of closure for the general population, with the exception of one frontier area where the nearest hospital is 30 miles from the hospital that closed. The health professionals in that area are seeking to reopen that hospital because of long travel times for emergency services and other acute medical care. This study using hospital discharge data did not identify the hospital market areas at farthest distance from the nearest hospital to be adversely affected in terms of hospital charges or lengths of stay. The measures of hospital charges or length of stay, however, would not capture changes in health status not requiring acute care and changes in quality of life or satisfaction with medical care that may be experienced by persons in communities where hospital closure occurs.

The case study also identified closure repercussions for vulnerable populations, such as the elderly, disabled and pregnant women, that primarily centered on problems in securing transportation and enduring long travel times. These problems, however, may not result in differences of the magnitude that would be detectable in the outcomes of length of stay and charges that were utilized in this study.

Future analysis of the data used for this study will examine very specific outcomes that could be expected to be affected by hospital closure, such as pregnancy and newborn complications and mortality rates for specific ambulatory sensitive conditions. These outcomes primarily focus on the experience of vulnerable populations in order to evaluate whether these specific populations are negatively impacted by hospital closure.

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Table I. Demographic Characteristics of Closed and Comparison Hospital Areas

Demographic Characteristic	Closed Hospital Areas	Comparison Hospital Areas	Results of t-test of the significance of the difference in rates
Total population	93,842	218,329	
% White, NonHispanic	79.97	89.86	Not significant (NS)
% Black NonHispanic	10.03	2.50	NS
% Native American NonHispanic	.84	1.35	NS
% Asian NonHispanic	.39	.46	NS
% Hispanic	8.72	5.77	NS
% Age below 18	26.65	27.40	NS
% Age 18-64	58.16	57.08	NS
% Age 65 and over	15.19	15.52	NS
% No high school degree	32.54	25.83	NS
% High school only	37.20	37.43	NS
% Any college	30.26	36.74	NS
% Poverty, whole population	17.76	13.28	NS
% Poverty, over 65	15.87	13.54	NS

N = 30 (15 closed hospital areas and 15 matched comparison areas)

Table 2: Outcomes of Interest Aggregated at the Study and Control Level

	CLOSURE STATUS	BEFORE PERIOD	AFTER PERIOD	DIFFERENCE
Admissions	Closed	.040	.034	.006
	Control	.060	.053	.007
Average Length of Stay	Closed	5.06	4.77	.290
	Control	4.89	4.66	.230
Average Charge Per Admission	Closed	5877.08	5614.36	262.72
	Control	5452.11	5866.13	-414.02

APPENDIX:

REGRESSION EQUATIONS:

$LnLos = b_0 + b_1 after + b_2 study + b_4 farthest + b_5 age + b_6 surgery + b_7 ob + b_8 psych + b_9 newborn + b_{10} study*after + b_{11} furthest*after + b_{12} furthest*study + b_{13} furthest*study*after + b_{14} surgery*after + b_{15} ob*after + b_{16} newborn*after + b_{17} psych*after + b_{18} surgery*after*study + b_{19} ob*after*study + b_{20} psych*after*study + b_{21} newborn*after*study$

The same regression equation was used to estimate the natural log of total charges

Variable Definition:

Lnlos = natural log of length of stay
after = 0 if in the time before closure and 1 if admission occurred in the time after closure
study = 0 if comparison market area and 1 if study market area
surgery = surgery admissions
ob = obstetric admissions
psych = psychiatric admission
newborn = newborn admissions
medicine admissions were the omitted category

CHARACTERISTICS OF CLOSED HOSPITALS

Figure 1: Regions where hospital closures were located

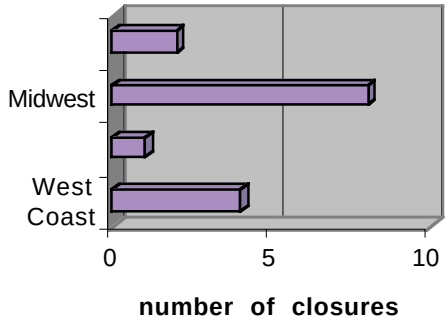

Figure 2: Distance to the nearest hospital from closed hospitals

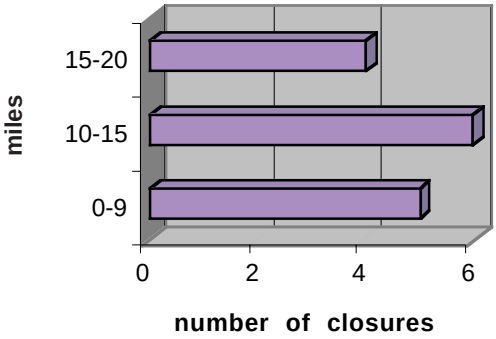

Figure 3: Number of staffed beds at the closed hospitals

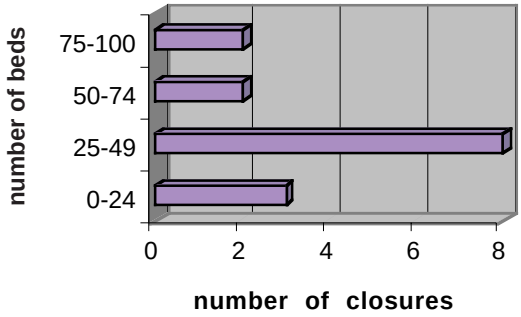

Figure 4: Ownership of closed hospitals