MICHIGAN RURAL HOSPITALS: CHANGES IN SPECIALIZED AND OUTPATIENT SERVICES BETWEEN 1980 AND 1984

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DEDICATED TO

My parents, Mary and Albert Francoeur,
and my brother David
for their Love, Wisdom, and Great Patience.
I will always cherish you.

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MICHIGAN RURAL HOSPITALS: CHANGES IN SPECIALIZED AND OUTPATIENT SERVICES BETWEEN 1980 AND 1984

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A. INTRODUCTION

1. An Economic Framework

During the past two decades, the economic base of rural areas has deteriorated, causing the financial health of many rural hospitals to decline (Phillips et al., 1986).

In 1983, third party payors such as the Federal Medicare program and private insurance companies began limiting payments to hospitals in order to reduce health care costs; hospitals have reacted to these strong financial incentives by decreasing the length of inpatient stay for acute illnesses and through increased utilization of outpatient alternatives. This has created additional stresses on rural hospitals struggling to survive due especially to the reduced utilization of their inpatient acute care resources. Rural hospitals have sought to expand or undertake new long-term and outpatient services to compensate for lost revenues (Buada et al., 1986; Phillips et al., 1986).

Indeed, rural hospitals are described to a large extent by the perfect competition model which requires firms to accept the current market price for each standardized service offerred for sale. In some cases, a

rural hospital may exercise limited discretion in setting price, especially where the economies of scale in producing large supplies of a service result in lower costs per unit to the hospital. In any event, the equilibrium price in the market for each service occurs where supply and demand factors are equivalent. Firms strive to maximize profits (equal to the difference between total revenues and average total costs of production) by attempting to supply their services at this equilibrium price level. 1/

Although rural hospitals are usually price-takers, they are often monopoly suppliers of health services in their geographic areas (although some consumers may travel to urban hospitals perceived to provide better care or more specialized services). Unlike typical monopolies, rural hospitals do not obtain high profits as most are non-profit community hospitals. A sufficient revenue "surplus" is sought, however large numbers of struggling rural hospitals do not achieve this goal (Lutz, 1987; Burda, 1986). Rural hospitals in the worst financial health incur rising yearly debts due to a chronic problem where average total costs surpass total revenues.

2. Purpose of Study

This study aims to determine the extent to which Michigan rural hospitals decreased the total level of inpatient acute care services and changed the levels of

various specialized and outpatient services as well as associated ancillary inputs during the period from 1980 to 1984. It is expected that many of these services either increased over this period or remained stable since many hospitals may have decided to recoup lost revenues from inpatient acute care and/or to prevent additional revenue losses. In any event, many changes in these services are expected to be a response to challenges of financial survival.

The specialized and outpatient services in this study exclude inpatient acute care services. Specialized services are defined to comprise the major inpatient services in long-term care. Outpatient services comprise all major services provided on an outpatient basis. Ancillary inputs support, or might support, specialized and/or outpatient care. Note that important health professionals, such as allopathic physicians, are considered to be ancillary inputs. The variables that comprise or support specialized and outpatient services and the procedures to select them will be identified later.

Hospital size, rural location, and ownership type (private or county) may be important factors associated with changes in rural hospitals (Grim, 1986; personal conversation with David Seamon and Laura Redoutey, Michigan Hospital Association (MHA), 3/15/87). This study aims to identify which of these associated factors help explain the

extent of change in the variables representing specialized and outpatient services and associated ancillary inputs.

3. Background

In this study, rural hospitals are defined to be located in counties that are not part of Standard Metropolitan Statistical Areas (SMSAs), as determined by the Federal government.

Michigan rural hospitals reflect the national decline in rural inpatient admission rates (Buada, 1986; Burda, 1986). Table 1 reveals a nineteen percent drop in acute care patient days from 1980 to 1984. This reveals a decline in the provision of inpatient acute care services by rural hospitals. Several factors have contributed to this decline.

Change in a hospital service is defined in this study as the change in the level of that service from 1980 to 1984. Significant increase refers to a significant positive change in mean service level (based on all hospitals); significant decrease refers to a significant negative change in mean service level. As defined here, change in a service level includes those changes due to the redistribution of a constant level of resources among competing services as well as to those changes due to growth or decline in hospital size.

The literature and experts on the Michigan hospital

system convey that hospital size and distance to an urban area are likely to affect the extent of change in specialized and outpatient services provided by rural hospitals (Grim, 1986; personal conversation with David Seamon and Laura Redoutey, Michigan Hospital Association (MHA), 3/15/87). In this study, plots of the services have shown that the extent (and sometimes direction) of change with increasing hospital size usually varies with groupings of hospitals by size (small, medium, and large), as measured by the number of set-up beds. Thus, increasing hospital size within each grouping may often be associated with changes in service levels. The three distinct groupings of increases in hospital size were defined for use in statistical analyses.

Rural hospitals more accessible to urban areas may increase their chances for survival by strengthening affiliations with urban hospitals to achieve: networking and improved referrals of patients; greater specialization that would increase net income; improved access to technical assistance and resources from urban hospitals; and prevention of mergers and acquisitions from outside investors (Grim, 1986). Conversely, urban hospitals affiliated with rural hospitals may increase their marketing area for particular services and may find the cleaner and isolated rural environment preferrable in the treatment of chronic diseases such as AIDS, Alzheimer's

disease, and respiratory illness (Siegner, 1986). The more remote hospitals, however, may have fewer opportunities to increase service levels and to diversify into new areas. Many of these hospitals are predicted to close (Grim, 1986; Lutz, 1987).

The type of hospital ownership is another factor that may be associated with the extent of changes in hospital services. The Michigan Public Act 350 of 1913 does not allow county-owned hospitals to establish separate corporate entities or subsidiaries to absorb the liabilities associated with the expansion of hospital services; unlike privately-owned hospitals, county-owned hospitals are completely at risk in the expansion of hospital services. Hence, private hospitals are believed to have more opportunities to increase the levels of hospital services than do county hospitals (personal conversation at MHA, 3/15/87).

Other factors not considered by this study that may affect hospital decisions to change service levels include factors unique to each hospital such as management effectiveness, trustee politics, and union demands.

Rural hospitals often face reduced incentives and/or opportunities as compared to urban facilities with similar size and ownership characteristics because rural hospitals receive less Medicare reimbursement per patient for the same procedures (Lutz, 1987). Reimbursement inequities

between rural and urban hospitals were reduced in October 1986 from a level of twenty-one percent to fourteen percent (personal conversation at MHA, 3/15/87). 2/

4. Data Selection and Methodology

The Michigan Department of Public Health administers annual hospital surveys and compiles the data into accessible electronic form. The data for this study was obtained in this form from the Michigan Department of Public Health through use of the university mainframe computer. The data set was modified so that it could be downloaded onto the IBM AT microcomputer. The SPSS-PC statistical package was used for all data manipulations in this study.

This analysis is based on the eighty-seven Michigan rural hospitals in operation during both 1980 and 1984; two hospitals present during only one of these years were excluded.

a. Data Selection

The thirty-two variables that were selected indicate changes in outpatient services and inpatient long-term care. These variables indicate numbers of: (1) specific hospital personnel; (2) patient days; (3) admissions to specific service areas; and (4) specific procedures. Variables representing services provided by more than

twenty percent of Michigan rural hospitals during 1984 were selected. An additional selection procedure was employed to select the remaining variables deemed to represent potential important areas of change in Michigan rural hospitals. This procedure chose variables that revealled more than a sixteen percent difference over these two years in the number of hospitals providing the represented service.

The selected variables representing specialized services in inpatient long-term care were: alcohol admissions; psychiatric inpatient days; oncology admissions; number of long-term basic care patients; and number of long-term skilled care patients.

The selected variables representing outpatient services were: surgery outpatient visits; physical therapy outpatient visits; occupational therapy outpatient visits; laboratory outpatient procedures; home care visits; medicine outpatient visits; and psychiatric outpatient visits;

Respiratory therapy visits was considered to be in both categories.

The selected variables representing ancillary inputs were: number of staff allopathic physicians (MDs); number of staff osteopathic physicians (DOs); number of full-time pharmacists; number of part-time pharmacists (in full-time equivalents or FTEs); number of full-time pharmaceutical

technicians; number of part-time pharmaceutical technicians (FTEs); number of full-time dentists; number of EEG (electroencephalogram) procedures; number of EKG (electrocardiogram) procedures; number of ultrasound procedures; number of X-ray therapy procedures; number of radiation therapy procedures; and number of cobalt procedures. The selected variables representing ancillary inputs for outpatient services only were: CAT (computerized axial tomography) head scan-outpatient procedures; CAT body scan-outpatient procedures; peritoneal dialysis-outpatient visits; and pediatrics-outpatient visits.

The variables in the data set not chosen were: number of part-time dentists; rehabilitation patient days; number of drug abuse admissions; numbers of outpatient pediatric, rehabilitation, and obstetric patients; and number of therapeutic radiation procedures. It is possible that some of these unchosen variables represent important changes that occurred in specific hospitals, but this is beyond the scope of this study. Also, the variables for number of emergency room admissions and number of outpatient hemodialysis procedures were dropped because data was not available for 1980.

In the Appendix, a sample hospital survey form for 1983 reveals survey variables identical to those collected during 1980 and 1984 and comprises almost all of the

variables available in electronic form.

b. Methodology

Each statistical procedure discussed below was run for each of the thirty-two chosen variables. For each variable, separate regressions and correlation coefficients were run for three groupings of hospitals based on size (i.e. small, medium, and large hospitals). The methods used in this study of changes in rural hospital services are now summarized.

The Student's t-test was employed to measure the significance of the changes in the level of each service to determine the likelihood that these changes do not result from chance occurrences.

Multiple linear regressions of changes in services evidencing significant levels of change were run to test association with increasing hospital size within three hospital groupings, with extent of rurality, and with type of ownership. In a couple of services, regressions were improved by using changes in services relative to a measure of change for standard hospital inpatient services.

Using services showing change at a confidence level of ninety percent or greater, two types of calculations were performed. The average weighted percent change in total service level was determined for each service. The sum of these average weighted percent changes was then assessed to

provide a single index comprising all of these services.

Due to limitations in acceptable regression results regarding the interpretation of increasing hospital size within the three hospital groupings, correlation coefficients were calculated for changes in service levels with increasing hospital size (for each hospital size grouping) to determine the extent of the dominant positive or negative linear trend within the data. Cases with no changes in service level as hospital size increases were identified.

Limitations in acceptable regression results regarding rural location and ownership were addressed by separately testing the association of these variables with mean changes in service levels using the Student's t-test procedure.

This report discusses methodology in greater detail and focuses on the results thought to be of significance.

B. CHANGES IN THE LEVELS OF SPECIALIZED AND OUTPATIENT SERVICES

Are rural hospitals substituting lower-cost outpatient care for inpatient acute care? Such changes may be in response to third party payor incentives and demands. Increases in long-term care may also help recapture lost revenues from declining levels of inpatient acute care services. Significant increases in outpatient care and in

long-term care may require increases in allopathic and osteopathic physicians, in other personnel, and in specialized ancillary services.

This section focuses on changes in the levels of rural hospital services and ancillary inputs that are defined to be significant (i.e. at the confidence level of ninety percent or greater). The reader may employ a lower confidence level to determine which services/inputs evidence significant change (Table 1).

1. Specialized Services

Question 1: Did rural hospitals change the amounts of specialized services from 1980 to 1984?

Swing-beds (acute care beds that may be used for inpatient chronic and long-term care) were not a diversification option for Michigan rural hospitals from 1980 to 1984 since the change in licensed beds that could be used for long-term care was very small. This restraint may have encouraged some hospitals to increase home care services as revealled in Table 1. 3/

Insignificant increases were found in the amounts of long-term basic care, long-term skilled care, psychiatric inpatient days, and alcohol admissions.

Of particular interest is the dramatic decrease in the level of oncology admissions in rural hospitals from 1980

TABLE 1: Mean Hospital Service Levels and Significant Changes in Service Levels

COMMON SERVICE OR INPUT	NO. HOSPITALS (87 Total) 1980	1984	MEAN SERVICE LEVEL (All Hospitals) 1980	1984	SIGNIFICANCE OF CHANGE (All Hospitals)	AVERAGE PERCENT CHANGE IN TOTAL SERVICE LEVEL - WEIGHTED
No. Staff MDs	80	82	14	16	98.3	12
No. Staff DOs	62	66	2.6	3	99.5	17
No. Full-Time Pharmacists	60	62	1.7	1.9	96.7	9
No. Part-Time Pharmacists (FTE) $	23	18	0.12	0.11	14.7	
No. Full-Time Pharmaceutical Technicians	48	53	1.1	1.3	98.1	16
No. Part-Time Pharmaceutical Technicians (FTE) $	26	29	0.32	0.31	13.2	
Psychiatric Inpatient Days	10	12	2824	1496	72.2	
Oncology Admissions	33	1	99	8	100	-33
Surgery Outpatient Visits	76	80	263	622	99.7	
Diagnostic Radioisotope Procedures	27	33	358	366	10.0	
Physical Therapy Outpatient Visits	73	71	3015	3788	91.1	20
Occupational Therapy Outpatient Visits	7	14	28	63	93.6	19
Respiratory Therapy Visits	74	64	16760	16920	5.9	
No. EEG Procedures	34	40	94	85	66.2	
No. EKG Procedures	86	81	2364	2072	96.9	-12

$ - measured in full-time equivalent units.

TABLE 1. (cont'd.)

COMMON SERVICE OR INPUT	NO. HOSPITALS (87 Total) 1980	1984	MEAN SERVICE LEVEL (All Hospitals) 1980	1984	SIGNIFICANCE OF CHANGE (All Hospitals)	AVERAGE PERCENT CHANGE IN TOTAL SERVICE LEVEL - WEIGHTED
Outpatient Lab Procedures	83	83	26158	33345	99.9	25
Ultrasound Procedures	23	65	184	574	100	158
Medicine Outpatient Visits	3	14	232	231	0	
Acute Care Patient Days	87	87	17688	14300	100	-19
LESS COMMON SERVICE OR INPUT						
Long-Term Basic Care Admissions	12	14	1493	1257	67.1	
Home Care Visits	3	5	123	564	87.3	21
No. Full-Time Dentists	5	3	12	10	68.0	
Alcohol Admissions	4	3	17	13	56.4	
X-Ray Therapy Procedures	2	3	28	5	57.9	
Radiation Therapy Procedures	2	1	2	74	67.3	
Outpatient Psych. Visits	2	1	40	30	47.0	
CAT Head Scan - Outpatient Proc.	2	3	20	41	81.6	
CAT Body Scan - Outpatient Proc.	2	3	9	34	87.0	
Peritoneal Dialysis - Outpatient Visits	1	2	2	37	67.3	
Pediatrics - Outpatient Visits	3	2	159	93	78.6	
Cobalt Procedures	4	3	131	176	81.5	

to 1984 with thirty-three hospitals providing this service during 1980 compared to only one hospital in 1984. National interviews by National Research Corporation revealled that almost half of rural patients leave their communities for specialized care such as oncology (Jensen, 1985).

Thus, on the average Michigan rural hospitals provided similar levels of long-term care during 1980 to 1984 period, except for oncology admissions which declined dramatically.

2. Outpatient Services

Question 2: Did the level of outpatient services in rural hospitals increase from 1980 to 1984?

Table 1 reveals that the great majority of hospitals performed significantly higher mean levels of outpatient surgery and outpatient physical therapy during 1984 compared to 1980. Small numbers of hospitals conducted outpatient occupational therapy in both years; nevertheless, the overall hospital mean also increased significantly during 1984.

Note that a stable mean level for medicine outpatient visits is revealled in the two years; however, Table 1 shows that medicine outpatient visits were accepted by eleven additional hospitals during 1984 despite overall

insignificant change in service level. These eleven hospitals had diversified into outpatient medical services.

Three hospitals offerred home care services in 1980 and five hospitals provided this service in 1984. The mean service level during 1984 (564 visits) was more than four times the 1980 mean service level (123 visits), although this change was not quite significant.

Thus, on the average Michigan rural hospitals provided a significant increase in the overall level of outpatient services during 1984 compared to 1980.

3. Ancillary Inputs

Question 3: Did the numbers of allopathic and osteopathic physicians with admitting privileges increase in rural hospitals from 1980 to 1984?

On the average, the levels of allopathic and osteopathic physicians in Michigan rural hospitals increased significantly from 1980 to 1984. This result is consistent with the national trend that rural hospitals are increasing the numbers of primary care physicians on staff and encouraging specialists to visit periodically; this may be in part to attract rural patients seeking care in urban areas (Super, 1987).

Question 4: Did the level of other specialized ancillary inputs increase in rural hospitals from 1980 to 1984?

This question spans a large number of variables listed in Table 1. During 1984, full-time dentists, part-time pharmacists, and part-time pharmaceutical technicians were employed by fewer hospitals and at lower mean levels compared to 1980, although these declines were not significant.

Increases in the number of hospitals employing full-time pharmacists and full-time pharmaceutical technicians and significant increases in the mean levels were observed for both services.

Ultrasound revealled dramatic increases in the number of providing hospitals and in the mean service level.

The same number of hospitals provided outpatient laboratory services during 1980 and 1984 but at a significantly increased mean level during 1984.

The increases in the mean levels for outpatient CAT head scan, outpatient CAT body scan, and cobalt procedures were not quite significant.

The great majority of hospitals offerred EKG procedures during both years, although fewer hospitals provided this service during 1984. Significant decreases are observed in the mean level for EKG procedures.

Respiratory therapy, diagnostic radioisotope, radiation therapy, X-ray therapy, and EEG procedures showed little change. Interesting trends, however, are revealled in respiratory therapy and EEG procedures. In Table 1, note the stable mean level for respiratory therapy over both years; however, concentration in provision is evidenced since ten fewer hospitals provided this service in 1984. A similar analysis can be made for EEG procedures, revealling a dispersion in services (i.e. a higher number of providing hospitals and a lower mean in 1984).

In summary, a significant decrease has occurred in only one ancillary input (EKG procedures) out of five ancillary inputs that revealled significant changes in service levels. Eight other ancillary services did not evidence significant change. Hence, less than one-third (four) of the observed ancillary inputs that support, or might support, specialized and outpatient services have increased significantly in Michigan rural hospitals from 1980 to 1984; all but one (EKG procedures, which declined) of the nine remaining ancillary inputs were provided at similar levels during both years.

C. FACTORS ASSOCIATED WITH CHANGES IN SERVICE LEVELS

1. Analytic Model

Multiple linear regressions of changes in rural hospital services evidencing significant levels of change (as determined by the analysis shown in Table 1) were run to test association with increasing hospital size within three hospital groupings, with level of rurality, and with county or private ownership. One series of regressions was run to explain changes in rural hospital services and a second series (discussed below) was run to explain relative changes in rural hospital services.

Of the data collected in both years, hospital size, as measured by the number of set-up beds, is the only quantifiable and continuous variable which is stable over both years that might be associated with the extent of change in various services.

Plots of the services in this study have shown that the extent (and sometimes direction) of change varies with groupings of hospitals by size (small, medium, and large), as measured by the number of set-up beds. To explain the extent of change occurring at different hospital sizes, the rural hospitals were divided into three groups based on the number of set-up beds as follows: small hospitals with forty-nine or less beds; medium hospitals with fifty to

ninety-nine beds; and large hospitals with over 100 set-up beds. Four of the eighty-seven hospitals were dropped from all linear regressions because fluctuations in the number of beds from 1980 to 1984 caused each hospital to fall into two size categories.

Distance to the nearest urban hospital and type of ownership (county or private) are potentially important factors in diversification decisions (Grim, 1986; personal conversation at MHA, 3/15/87). These factors were tested as dummy variables. The data bases provided indications as to type of ownership for each hospital. Rural hospitals more than two counties away from an urban county (thirty-six hospitals) were classified as "remote." The remaining forty-seven hospitals were classified as "rural." Note that the significance of rural and remote location in each regression is a function of this definition. A listing of "remote" and "rural" counties in Michigan is provided in the Appendix.

For any service A, the regression model for each hospital size grouping is:

change in service A (1984 level - 1980 level) =

$$a + b(size) + c(D)(rural) + e(d)(county)$$

where size = size1 for small hospitals
= size2 for medium hospitals
= size3 for large hospitals
D = 0 if hospital is remote
D = 1 if hospital is rural
d = 0 if hospital is private
d = 1 if hospital is county-owned

Each regression was conducted for one of the three hospital size groups and included the associated factors of hospital location and ownership.

Of all independent variables that comprise each regression, hospital size levels were expected to contribute the most important information to the regression because they are the only continuous independent variables. Within each hospital grouping, the hospital size levels were plotted against each dependent variable representing change in service level to identify situations where the regression line fits the data but indicates no or little change in service levels as hospital size increases (low values for slope, correlation coefficient, and R-squared statistic).

Such situations were distinguished from plots where the data patterns are quite nonlinear yet also reveal low R-squared values. R-squared values, ranging from zero (no fit to the data) to one (exact fit to the data), reveal the total variation in change explained by one or more independent variables, such as the hospital size variable.

All hospitals providing a particular service were included in the corresponding regression. An exception was made for the regression representing changes in full-time pharmacists in medium hospitals (Figure 2) by excluding medium hospitals which employ full-time pharmacists but reveal no change. In this service, the majority of medium

hospitals revealled no change in the employment of full-time pharmacists. Inclusion of these medium hospitals resulted in a regression line that did not fit the data reasonably well (R-squared = 0.14; a reasonable fit to the data is defined to occur if R-squared equals 0.20 or greater). Exclusion of these medium hospitals resulted in the chosen regression line which does fit the data reasonably well (R-squared = 0.27). This regression line explains only the positive and negative changes in full-time pharmacists in medium hospitals; it does not reflect all medium hospitals providing this service nor does it characterize the importance of this change in full-time pharmacists employed by medium hospitals.

A second series of multiple regressions was run for each service to explain relative change. Relative change assesses the change in any given service relative to a measure of change for standard hospital inpatient services. The selected measure for the latter variable was percent change in acute care patient days. This measure, an indication of yearly inpatient flow, should be sensitive to changes in total standard inpatient services.

Relative change between 1980 and 1984 is defined as:

$$\text{Relative Change in Service A} = -\frac{[\text{change in service A}]}{[\text{percent change in inpatient acute care days (1980 base)}]}$$

This measure is assumed to reflect the importance of a service change to a rural hospital since the service change is divided by the percent change in inpatient acute care days. Usually, increase in a service is compared to the percent decrease in inpatient acute care days. The relative change ratio increases as a service becomes more important.

Note that percent change, rather than absolute change, in inpatient acute care days was chosen as the divider. This was necessary to reflect the importance of the change in inpatient days. To illustrate, we let a large hospital and a small hospital reduce inpatient acute care by the same number of days. This is less important to the large hospital because a significantly smaller percent change in inpatient acute care days results compared to the percent change in the small hospital.

In testing for relative change, only the regression lines for small hospital employment of full-time pharmacists and full-time pharmaceutical technicians (Figures 6 and 7) revealled improved fit to the data in comparison with the original regressions.

The exclusion of medium hospitals showing no change in the employment of full-time pharmacists from the respective regression was explained earlier in this section during the discussion of the first series of regressions. Similarly, small hospitals showing no relative change in the

employment of full-time pharmacists were excluded from the respective regression in order to attain a reasonable linear fit to the data (R-squared was improved from 0.04 to 0.47). Nine out of twenty-six small hospitals employing full-time pharmacists showed no relative change. This regression of relative change does not reflect all small hospitals providing this service nor does it characterize the importance of this relative change. It characterizes the relative changes that were made in terms of hospital size, location, and ownership.

In many or all of the regressions conducted for this study, interpretations regarding the significance of the location and ownership variables and their contribution to the regressions (as determined by the R-squared statistic) may be underrated. In particular, it is likely that even in services where county hospitals do evidence significantly different levels of change in comparison to privately owned hospitals, significant variable coefficients (approximately equal to two or greater by convention) were not obtained in many regressions since county hospitals comprise only one-seventh of the total rural hospital population. In order to significantly affect any given regression, changes in the county hospitals falling within the appropriate hospital size grouping would need to be rather high. In any event, the interactive effects between the location and ownership

dummy variables are biased. 4/

Two procedures were used to supplement the regressions and to overcome some of the limitations posed by many of them. In each service, the extent of the dominant positive or negative change with increasing hospital size is assessed in each hospital size grouping by calculating the correlation coefficient; cases where there are no changes in service level as hospital size increases are identified (note 5; Table 3). The effects of location and ownership were evaluated using the Student's t-test procedure to substitute for the unacceptable regression results of most services and to account for bias in accepted regressions if insignificant dummy variables are shown to actually be significant (Table 4). These procedures will be discussed later.

2. Index of Change

Ideally, weighting factors would be included in these regressions to assess the relative importance of each service to the net revenue of each hospital. Potential improvements in the regression models may occur by multiplying, within each hospital, the level of significant change in any service A by:

$$\frac{\text{(net 1984 revenues from service A)}}{\text{(total net 1984 hospital revenues)}}$$

Unfortunately, data were not available to either construct

revenue-weighted indexes for services showing significant changes or to construct a single revenue-weighted index to reflect total significant change in all services. 5/

Instead, weighted average percent change indices were calculated for each service/input showing significant change (i.e. at the ninety percent level of significance or greater); these indices are based on the proportion of rural hospitals (out of eighty-seven total) that provide the respective service/input (Table 1). Information from the table is used to calculate the average weighted percent change which is:

$$(A / 87) * (B / C) * 100$$

where A = number of rural hospitals providing service or input in 1980 or 1984, whichever is greater
B = net change in total service or input level from 1980 to 1984
C = 1980 total service or input level in rural hospitals

To illustrate, the variables for average weighted percent change in total service level for allopathic physicians (MDs) are:

A = number of rural hospitals employing MDs in 1980 or 1984, whichever is greater
B = net change in number of MDs employed from 1980 to 1984
C = 1980 total number of employed MDs in rural hospitals

This construct is desirable since it: a) lacks units of measurement, permitting its summation across all services showing significant change in order to yield a

single index; and b) weights the change by the fraction of hospitals providing the service. The importance of each service in the entire population of Michigan rural hospitals is reflected.

The sum of the weighted values for all services showing significant change yields a single index. In order to obtain an index of average weighted percent change in all services/inputs showing significant change from 1980 to 1984, the sum of the weightings must equal one; thus, the final index is obtained by dividing the sum of the weighted values for all services by the sum of the weightings.

The value of this index is 27.3 percent. Thus, on the average Michigan rural hospitals have experienced slightly more than a one-fourth increase in a variety of services. This measure includes the weighted negative change in acute care patient days to indicate the decrease in inpatient acute care. Note that Table 1 reveals negative average weighted percent changes for only three services: oncology admissions; number of EKG procedures; and acute care patient days.

This is necessarily a conservative estimate of change in total service level in the "average" Michigan rural hospital since total percent changes in services exhibiting nonsignificant levels of change (less than ninety percent significance) were not included.

3. Effects of Size, Location, and Ownership Type On Service Level Changes

   a. Results From Multiple Regression and Correlation Procedures

Hypothesis 1: Hospital size has not influenced service level changes from 1980 to 1984.

Unfortunately, the index of change cannot be used in our analytic model. Note that the importance of each service to an individual hospital is not known; thus, in the respective regression, the unweighted change in service level is used for each rural hospital providing a service, as discussed above.

The regression results were assessed before considering to calculate correlation coefficients (for additional information regarding hospital size) and before considering to employ the Student's t-test procedure (for additional information regarding location and ownership type). The discussion of regression results is based on the data from Table 2 and refers to plots of change as hospital size increases within specific hospital groupings (Figures 1 through 7).

Some services/inputs showed reasonable linear changes (i.e. R-squared of 0.20 or greater) with increasing hospital size for certain hospital size groupings; where significant, the location and ownership dummy variables

TABLE 2: Results of Multiple Linear Regressions of Changes in Service/Input Levels

SERVICE/INPUT (HOSPITAL SIZE CATEGORY)	R-SQUARE (STANDARD ERROR OF REGRESSION)	INDEPENDENT VARIABLES: COEFFICIENT (STANDARD ERROR) T-STATISTIC		
		SIZE	RURAL	COUNTY
No. Staff DOs (Large)	0.38 (2.00)	-0.013 (0.005) -2.794 *	-0.179 (0.996) -0.180	-2.388 (1.165) -2.050 *
No. Full-Time Pharmacists (Medium) @	0.27 (1.00)	0.029 (0.019) 1.476 *	0.039 (0.797) 0.049	1.416 (1.257) 1.127
Oncology Admissions (Small)	0.23 (45.33)	-1.968 (0.857) -2.295 *	31.464 (18.209) 1.728 *	16.668 (48.052) 0.347
Surgery Outpatient Visits (Small)	0.30 (161.41)	8.305 (3.053) 2.721 *	60.158 (64.832) 0.928	49.413 (171.089) 0.289
Physical Therapy Outpatient Visits (Small)	0.27 (915.26)	31.180 (17.310) 1.801 *	655.137 (367.618) 1.782 *	109.299 (970.132) 0.113
No. Full-Time Pharmacists (Small) @ $	0.47 (2.06)	-0.168 (0.050) -3.371 *	1.507 (1.143) 1.319	-2.872 (2.207) -1.301
No. Full-Time Pharmac. Tech. (Small) $	0.21 (2.30)	-0.018 (0.045) -0.395	1.970 (0.969) 2.034 *	0.016 (0.021) 0.743

* - significant or close to significant value at ninety percent confidence level.

@ - includes only hospitals showing change in input levels.

$ - relative change measure used.

also contributed to the R-squared statistic. These services/inputs were: number of osteopathic physicians in large hospitals (size3) (R-squared = 0.38); number of full-time pharmacists in medium hospitals (size2) (R-squared = 0.27); oncology admissions in small hospitals (size1) (R-squared = 0.23); outpatient surgery procedures in small hospitals (R-squared = 0.30); and outpatient physical therapy procedures in small hospitals (R-squared = 0.27) (Figures 1 - 5).

In large hospitals, the extent of increase in the number of osteopathic physicians diminished with size, particularly in county hospitals, from 1980 through 1984; hospital location was not a statistically significant factor (Figure 1).

In medium hospitals, the number of full-time pharmacists increased with size, although this trend is barely significant (t-statistic = 1.5; significance requires the t-statistic to be near two or greater); location and ownership are not statistically significant factors (Figure 2). As described above, this regression comprises only hospitals that revealled changes in the number of full-time pharmacists employed (fourteen out of thirty-four hospitals). The importance of this change in the population of Michigan rural hospitals providing this ancillary input is unclear.

Table 1 reveals a drastic drop in the number of

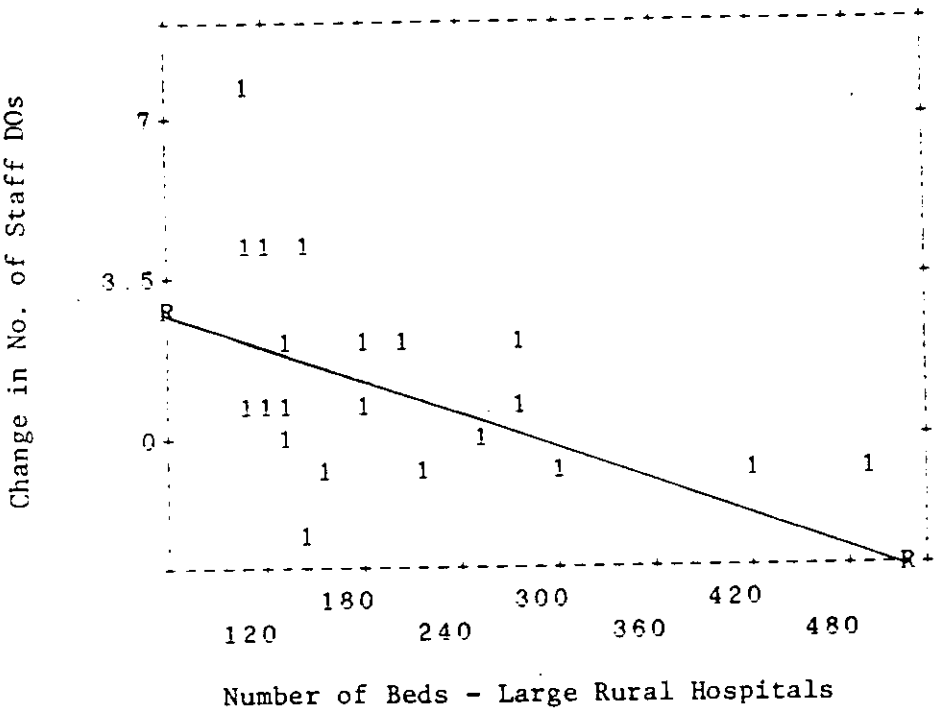

Figure 1: Plot of Change in Number of Osteopathic Physicians with Size of Large Rural Hospitals

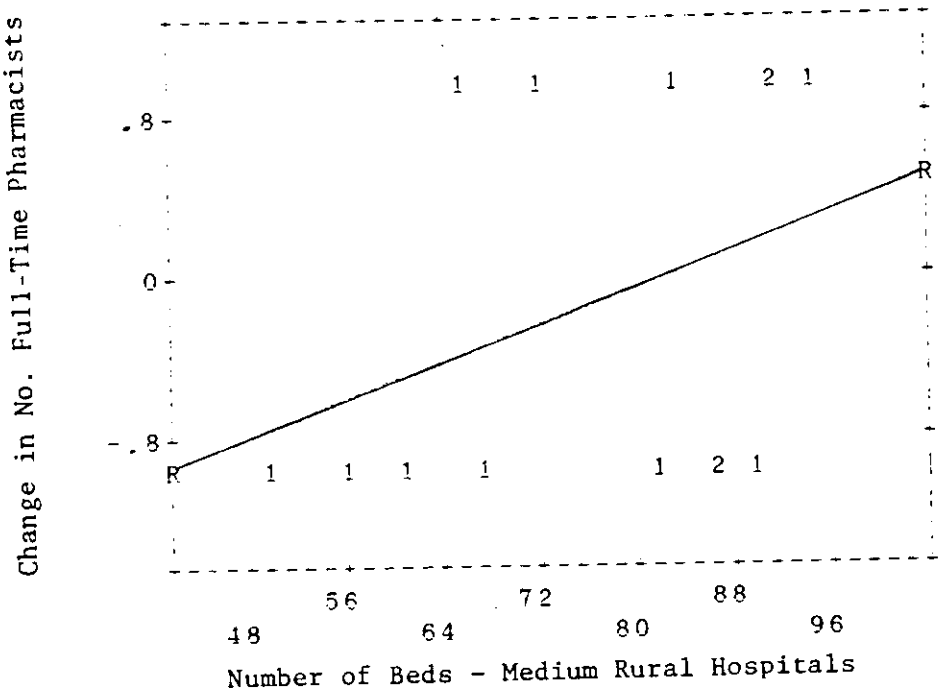

Figure 2: Plot of Change in Number of Full-Time Pharmacists with Size of Medium Rural Hospitals

Michigan rural hospitals admitting oncology patients (thirty-three during 1980; one during 1984). The remaining rural hospital in 1984 was a large hospital. Figure 3 reveals the changes in oncology services over this period that were provided by small rural hospitals. The number of 1984 oncology admissions in small hospitals either remained at zero at all size ranges or had decreased to a greater extent with increasing size to equal zero in 1984. The extent of decrease in the number of oncology admissions tended to be greater for remote hospitals.

In small hospitals, the number of outpatient surgery procedures increased significantly with size, as revealled by Figure 4. The ownership and location variables, respectively "county" and "rural," are not statistically significant. Since the great majority of rural hospitals provided outpatient surgery during both years (see Table 1), service area disincentives faced by county and remote hospitals were less weighty or inoperative in the provision of outpatient surgery.

The plot in Figure 5 reveals that in small hospitals outpatient physical therapy procedures increased with size (although the data spread from the regression line tends to be wide). Hospital size and location are close to significant (R-squared = 1.5 for both variables). Thus, the extent of increase in the outpatient physical therapy procedures of small hospitals reveals <u>some</u> positive

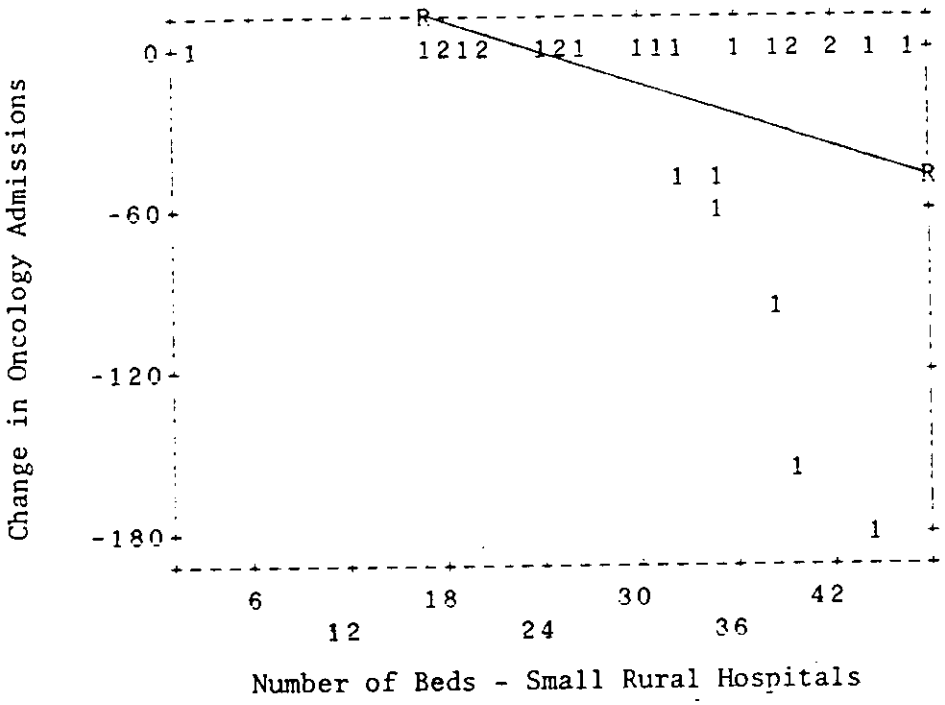

Figure 3: Plot of Change in Oncology Admissions with Size of Small Rural Hospitals

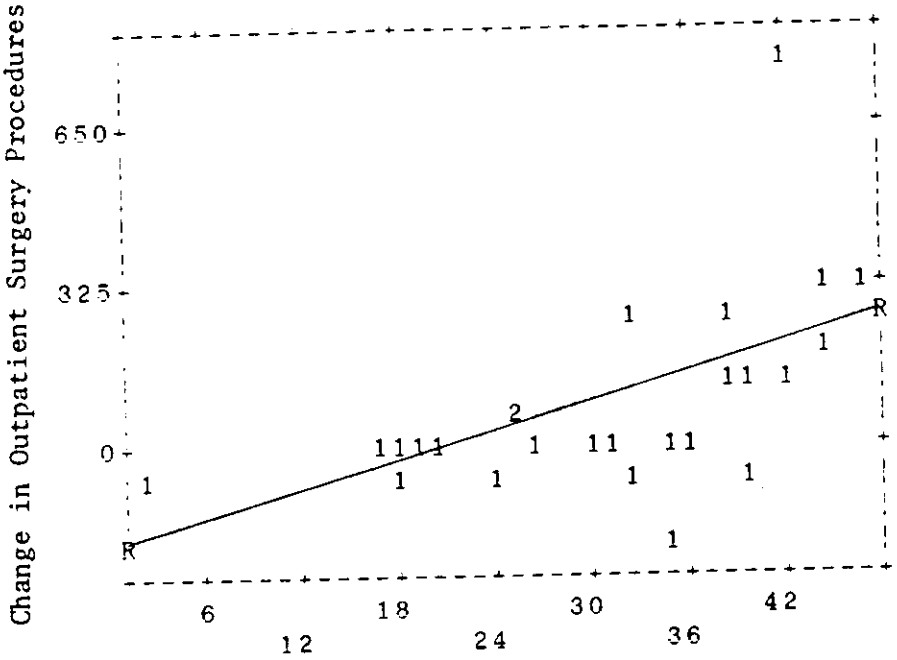

Figure 4: Plot of Change in Outpatient Surgery Procedures with Size of Small Rural Hospitals

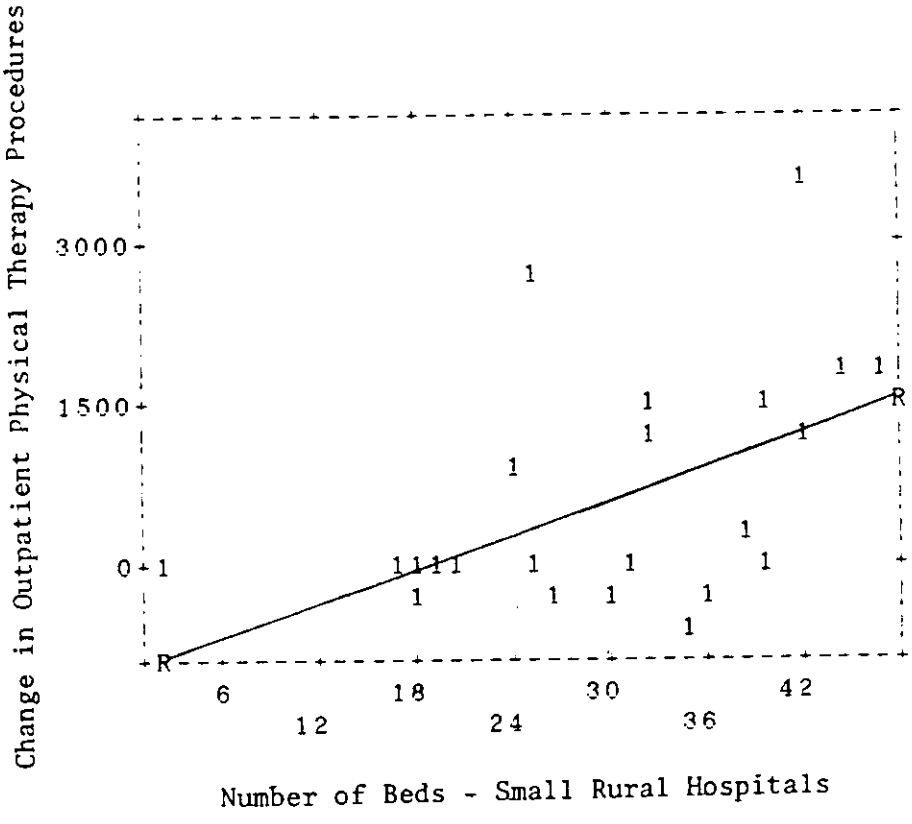

Figure 5: Plot of Change in Outpatient Physical Therapy Procedures with Size of Small Rural Hospitals

relation to size and proximity to urban area(s).

In the regressions for relative change (Figures 6 and 7), relative decreases were revealled in small hospitals from 1980 to 1984 in the employment of both full-time pharmacists (R-squared = 0.47) and full-time pharmaceutical technicians (R-squared = 0.41). The relative change decreased significantly with hospital size (t-test statistic equals -3.4 and -2.7 respectively); the variables representing ownership (county) and location (rural) were not statistically significant. As described above, the regression for the employment of full-time pharmacists in small hospitals only comprises hospitals that revealled changes in this ancillary input (eighteen out of twenty-eight hospitals). The importance of this change in the population of Michigan rural hospitals providing this ancillary input is unclear.

The focus is shifted from relative changes to changes in the levels of these two variables. For both variables, Table 1 reveals slightly increased mean service levels and significant increases in service levels when all rural hospitals are considered. In the plots of change in full-time pharmacists and pharmaceutical technicians with increasing hospital size, almost every small hospital that revealled nonzero changes in these ancillary inputs showed similar service level decreases in both plots (less than -0.8 change and about -0.9 change, respectively). Thus,

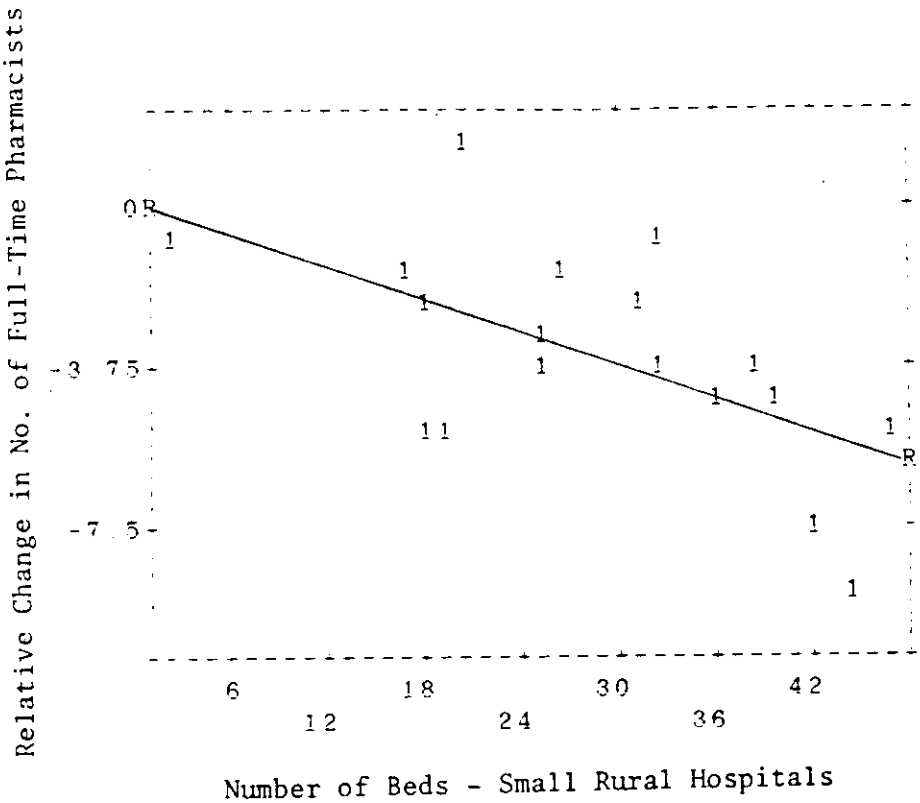

Figure 6: Plot of Relative Change in Number of Full-Time Pharmacists with Size of Small Rural Hospitals

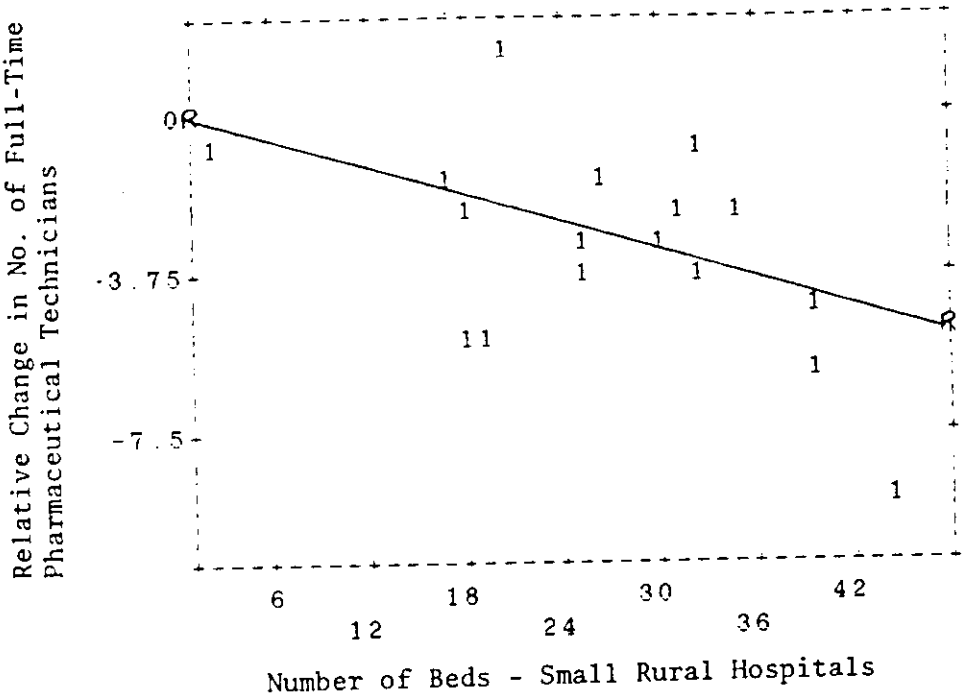

Figure 7: Plot of Relative Change in Number of Full-Time Pharmaceutical Technicians with Size of Small Rural Hospitals

medium and large rural hospitals contributed almost exclusively to the positive mean input levels and to the increases in these ancillary inputs.

Little or no changes in ancillary input levels as hospital size increases occurred in plots for the number of allopathic physicians employed by medium hospitals; and for the number of osteopathic physicians employed by small hospitals. In response to Question 3 (above), it was determined that on the average, the levels of allopathic (MDs) and osteopathic (DOs) physicians in Michigan rural hospitals increased significantly from 1980 to 1984. Thus, most of the increase in allopathic physicians (MDs) from 1980 to 1984 occurred in small and large hospitals while most of the increase in osteopathic physicians (DOs) over this period occurred in medium and large hospitals.

Little or no changes in service/input levels as hospital size increases are also revealled for outpatient surgery procedures provided by large hospitals; outpatient occupational therapy visits accepted by medium hospitals; EKG procedures provided by medium hospitals; EKG procedures provided by large hospitals; and outpatient laboratory procedures provided by small hospitals. It can be inferred that most of the increase in outpatient surgery procedures occurred in small and medium hospitals; most of the decline in EKG procedures occurred in small hospitals; and most of the increase in outpatient laboratory procedures occurred

in medium and large hospitals.

Table 3 reveals low correlation coefficients for all of these plots which show little or no changes in service/input levels with increasing hospital size and distinguishes them from nonlinear plots with low correlation coefficients. Despite any nonlinear trends in the data, the higher the absolute value of a correlation coefficient (to a maximum of one) in Table 3, the greater is the extent of the dominant positive or negative linear trend within the data. 6/ Hence, the correlation coefficients show the extent of the dominant positive or negative linear change with increasing hospital size for each hospital size grouping.

Within each hospital size grouping from 1980 to 1984, significant increases occurred in some services as hospital size increases while no changes or significant decreases occurred in other services as hospital size increases.

Since multiple regressions for most services evidencing significant levels of change were not acceptable due to data nonlinearities, the importance of these dummy variables could not be assessed in most cases.

TABLE 3: Correlation of Changes in Services With Rural Hospital Size

SERVICE/INPUT SHOWING SIGNIFICANT CHANGE	SMALL HOSPITAL (SIZE 1)	MEDIUM HOSPITAL (SIZE 2)	LARGE HOSPITAL (SIZE 3)
No. Staff MDs	.02 (c)	.09 (b)	-.36
No. Staff DOs	.10 (b)	.33	-.50
No. Full-Time Pharmacists	-.55 (a)	.38	.23 (c)
No. Full-Time Pharmac. Tech.	-.49 (a)	.28	.23 (c)
Oncology Admissions	-.36	-.24	.17
Hemodialysis Outpatient Visits			
Surgery Outpatient Visits	.54	.25	-.14 (b)
Physical Therapy Outpatient Visits	.45	-.28 (c)	.12 (c)
Occupational Therapy Outpatient Visits	.35	.22 (b)	.26
No. EKG Procedures	-.27	-.05 (b)	-.13 (b)
Outpatient Lab Procedures	-.11 (b)	-.05 (c)	.23 (c)
Ultrasound Procedures	.21 (c)	.01 (c)	-.15 (c)
Acute Care Patient Days	-.20	-.01 (c)	.19 (c)

(a) - relative change measure used.

(b) - no or little change in service/input level as hospital size increases.

(c) - nonlinear data pattern with low correlation coefficient.

b. Results From Student T-Tests Comparing Service Level Changes

Hypothesis 2: Rural hospitals and more remote hospitals show statistically similar changes in service levels between 1980 and 1984.

In order to overcome some of the above limitations in analysis, the effects of location and ownership were evaluated separately, using the Student's t-test procedure. 7/

Table 4 reveals that in some hospital services/inputs there are statistically significant differences between the mean changes in "rural" and "remote" hospitals from 1980 to 1984. 8/

"Rural" hospitals on the average show greater decreases in acute care patient days and smaller increases in outpatient surgery than "remote" hospitals (Table 4). /9

On the average, "rural" hospitals show decreases while "remote" hospitals show increases in the full-time employment of pharmacists.

In outpatient surgery and outpatient physical therapy services, the mean increase in "remote" hospitals is less than the mean increase in "rural" hospitals. 10/

TABLE 4: Mean Changes in Service Levels From 1980 to 1984 by Location and Ownership Categories for Hospitals Providing the Service in Either 1980 or 1984

SERVICE/INPUT SHOWING SIGNIFICANT CHANGE	LOCATION			OWNERSHIP		
	RURAL (max. 47 hospitals)	REMOTE (max. 36 hospitals)	PROBABILITY OF SIGNIF. DIFFERENCE $	COUNTY (max. 12 hospitals)	PRIVATE (max. 71 hospitals)	PROBABILITY OF SIGNIF. DIFFERENCE $
No. Staff MDs	2.1	1.5	.27	2.22	1.78	.17
No. Staff DOs	.39	.55	.21	-.22	.58	.81
No. Full-Time Pharmacists	-.48	.12	.76	-.33	-.22	.22
No. Full-Time Pharmac. Tech.	-.33	-.23	.22	.25	-.38	.84
Oncology Admiss.	-95	-79	.28	-62	-93	.52
Hemodialysis Outpatient Visits						
Surgery Outpatient Visits	235	527	.70	1132	227	.74
Physical Therapy Outpatient Visits	1237	297	.73	153	946	.69
Occupational Therapy Outpatient Visits	34	37	.07	35.2	35.1	.005
No. EKG Procedures	-280	-335	.15	-169	-327	.44
Outpatient Lab Procedures	8264	5554	.50	4235	7610	.41
Home Care Visits	9563	4831	.40	0	7670	@
Ultrasound Proc.	416	351	.52	415	384	.21
Acute Care Patient Days	-3591	-3027	.51	-4749	-3110	.85

@ - no variance available for independent sample t-test. Nevertheless, in this case, the probability of significant difference would be high.

$ - see note 8.

Hypothesis 3: Private rural hospitals and county-owned rural hospitals evidence statistically similar changes in service levels between 1980 and 1984.

County rural hospitals reveal decreases while private rural hospitals show increases in the full-time employment of osteopathic physicians (DOs) (Table 4).

Conversely, private rural hospitals reveal decreases in the full-time employment of pharmaceutical technicians while county rural hospitals show increases in this area.

County rural hospitals on the average reveal much greater increases than private rural hospitals in outpatient surgery procedures. Incidentally, inpatient acute care days dropped further in county rural hospitals than in private rural hospitals. Evidently, the restrictions on county hospitals imposed by the Michigan Public Act of 1913 do not restrict diversification in outpatient surgery procedures and may even incite additional diversification in this area to compensate for the lack of diversification in other services.

Increases in outpatient physical therapy occurred to a much greater extent on the average in private rural hospitals compared to county rural hospitals.

No county hospitals provided home care services from 1980 to 1984 while five private rural hospitals diversified

in this area.

Thus, private rural hospitals reveal statistically higher mean increases in some services than county rural hospitals while county rural hospitals reveal statistically higher mean increases in other services.

D. CONCLUSIONS

Acute care inpatient days have declined dramatically in Michigan rural hospitals from 1980 to 1984. Did these rural hospitals increase service levels in other activities, especially outpatient services, to recoup lost revenues from inpatient acute care? While significant increases were found in many hospital services and inputs, the lack of a proper revenue-weighting procedure prevents determination of whether increases in net revenues from outpatient care compensated for lost revenues, and projected lost revenues, from inpatient care. It is possible that increases in outpatient services were not conducted as compensation for decreases and projected decreases in inpatient acute care, especially since limited reimbursements were implemented late during the period of analysis (i.e. beginning in 1984).

To summarize, this study found that from 1980 to 1984 changes in service levels in Michigan rural hospitals were characterized by the following:

1. Michigan rural hospitals provided similar levels of long-term care from 1980 to 1984, except for oncology admissions which declined dramatically. The variables tested were: long-term basic care,

long-term skilled care, psychiatric inpatient days, and alcohol admissions. There was a drastic drop in the number of Michigan rural hospitals admitting oncology patients (thirty-three during 1980; one during 1984). The extent of decrease in the number of oncology admissions tended to be greater for "remote" hospitals. (Tables 1 and 2, Figure 3)

2. Michigan rural hospitals provided a significant increase in the overall level of outpatient services during 1984 compared to 1980. The great majority of hospitals performed significantly higher mean levels of outpatient surgery and outpatient physical therapy during 1984 compared to 1980.

In small hospitals, the number of outpatient surgery procedures increased significantly with size; location (rural or remote) and ownership (private or county) are not significant. Little or no changes in service levels as hospital size increases are revealled for outpatient surgery procedures provided by large hospitals; thus, most of the increase occurred in small and medium hospitals.

The extent of increase in the outpatient physical

therapy visits of small hospitals reveals some positive relation (i.e. close to significant change) to size and proximity to urban areas (SMSA counties).

The mean level of outpatient occupational therapy procedures also rose significantly. Little or no changes in service levels as hospital size increases are revealled for outpatient occupational therapy visits accepted by medium hospitals.

Outpatient medicine was provided by eleven additional hospitals during 1984 despite overall insignificant change in service level. The level of home care visits increased by more than a factor of four by 1984, although only five hospitals provided this service. (Tables 1 - 3, Figures 4 and 5)

3. <u>The levels of allopathic and osteopathic physicians in Michigan rural hospitals increased significantly from 1980 to 1984</u>. In large hospitals, the extent of increase in the number of osteopathic physicians diminished with size, particularly in county hospitals; hospital location was not significant. Little or no changes in input levels as hospital

size increases are revealled for the number of allopathic physicians provided by medium hospitals and for the number of osteopathic physicians provided by small hospitals. Most of the increase in allopathic physicians (MDs) from 1980 to 1984 occurred in small and large hospitals while most of the increase in osteopathic physicians (DOs) over this period occurred in medium and large hospitals. (Tables 1 - 3, Figure 1)

4. Less than one-third (four) of the observed ancillary inputs that support, or might support, specialized and outpatient services have increased significantly in Michigan rural hospitals from 1980 to 1984.

From 1980 to 1984, there were significant increases in full-time pharmacists and full-time pharmaceutical technicians; there were insignificant declines in full-time dentists, part-time pharmacists, and part-time pharmaceutical technicians.

In medium hospitals, the number of full-time pharmacists increased with size, although this trend is barely significant; location (rural or remote)

and ownership (private or county) are not significant. The importance of this change in the population of Michigan rural hospitals providing this input is unclear because this regression comprises only hospitals that revealled changes in the number of full-time pharmacists employed.

Medium and large rural hospitals contributed almost exclusively to the positive mean input levels and to the increases in full-time pharmacists and pharmaceutical technicians.

In the regressions for relative change, relative decreases were revealled in small hospitals from 1980 to 1984 in the employment of both full-time pharmacists and full-time pharmaceutical technicians as hospital size increases; ownership and location were not significant. The importance of this change in the population of Michigan rural hospitals providing this ancillary input is unclear because only hospitals that revealled changes in this input were used in the regression.

Ultrasound procedures showed a dramatic increase from 1980 to 1984. There was a significant increase in outpatient laboratory procedures which were

provided by the vast majority of rural hospitals. Little or no changes in input levels as hospital size increases was revealled for outpatient laboratory procedures provided by small hospitals; hence, most of the increase occurred in medium and large hospitals.

The increases in the mean levels for outpatient CAT head scan, outpatient CAT body scan, and cobalt procedures were not quite significant. (Tables 1 - 3, Figure 2)

5. <u>All but one (number of EKG procedures, which declined) of the nine remaining ancillary services were provided at similar levels during both years</u>.

Little or no changes in input levels as hospital size increases were revealled for EKG procedures provided by medium and large hospitals; thus, most of the decrease in EKG procedures occurred in small hospitals.

Respiratory therapy, diagnostic radioisotope procedures, radiation therapy, x-ray therapy, and EEG procedures showed little change from 1980 to

1984. Concentration among rural hospitals of respiratory therapy procedures and dispersion in EEG services among rural hospitals were revealled. (Tables 1 and 3)

6. The sum of the values for all services showing significant change from 1980 to 1984 yields an average weighted percent change in total service level for all of these services equal to 27.3 percent. Thus, on the average rural hospitals have experienced slightly more than a one-fourth increase in a variety of services. Negative average weighted percent changes occurred in only three services (oncology admissions, number of EKG procedures, and acute care patient days) (Table 1).

7. In some service/input areas, significant differences from 1980 to 1984 exist between mean changes in service levels of rural hospitals when classified by location (i.e. "rural" and "remote" hospitals).

"Rural" hospitals on the average showed greater decreases in acute care patient days and smaller increases in outpatient surgery procedures than

"remote" hospitals. On the average, rural hospitals revealled decreases while remote hospitals showed increases in the full-time employment of pharmacists. In outpatient surgery and outpatient physical therapy services, the mean increase in remote hospitals was less than the mean increase in rural hospitals. (Table 4)

8. <u>In some service/input areas, significant differences from 1980 to 1984 exist between mean changes in service levels of rural hospitals when classified by ownership (i.e. "county" and "private" hospitals)</u>.

"County" hospitals showed decreases while "private" hospitals revealled increases in the full-time employment of osteopathic physicians (DOs). Conversely, private hospitals showed decreases in the full-time employment of pharmaceutical technicians while county hospitals revealled increases in this area.

County hospitals on the average showed much greater increases than private hospitals in outpatient surgery procedures. Inpatient acute care days showed greater decreases on the average in county

hospitals compared to private hospitals.

Increases in outpatient physical therapy occurred to a much greater extent on the average in private hospitals compared to county hospitals. No county hospitals and five private hospitals provided home care services from 1980 to 1984. (Table 4)

E. NOTES

1/ Strictly speaking, Michigan hospitals operate on a nonprofit basis (personal conversation with David Seamon and Laura Redoutey, Michigan Hospital Association (MHA), 3/15/87). Hence, it should be stated that they attempt to maximize net returns rather than profits.

2/ Survey data from 1985 to 1987 might show greater changes in some services, especially since Medicare reimbursements to rural hospitals were increased six percent during October 1986.

3/ This restraint probably helped slow the growth in Medicare and Medicaid government expenditures.

4/ An improvement would be to weight the changes in each of the twelve county hospitals and in each private hospital equally. For services provided by the majority of rural hospitals, regressions including the twelve county hospitals and a similar number of randomly selected private hospitals would be expected to improve the significance of location and ownership variables and linear fit in those services where the regression line provides reasonable linear fit to the changes in service levels (i.e. R-squared value of 0.20 or greater). This process might be repeated for each service to determine the reliability of conclusions.

However, there is no indication that there are many services where the regression line would reasonably reflect changes in service levels. As mentioned in the text, the continuous variable of hospital size is expected to contribute the most important information to the regression. When all rural hospitals were considered, nonlinear relationships were revealled in regressions for most of the significant services when they were plotted with hospital size. This occurred despite attempts at logarithmic and quadratic transformations to create linear relationships conducive to multiple linear regression.

5/ There is an alternative to the relative change approach in assessing the importance of a service to each rural hospital. In services where change is related to size, an income weighting factor might increase the absolute values of the correlation (Table 3; refer to note 6) between changes in each service and each hospital size category. This improvement (or any change for that matter)

would affect the interaction of the hospital size variables with the location and ownership dummy variables; in some cases (which show linear data relationships) this could result in significant contributions to the regressions by one or both dummy variables which were insignificant in the regressions not weighted by income.

On the average, about half of rural hospital patients are Medicare beneficiaries (Lutz, 1987). The average Medicare reimbursement rates to rural hospitals for particular service/input categories (e.g. outpatient surgery visits) could be used to create income weighting factors in the absence of revenue data for these categories.

6/ The Pearson correlation coefficient is used to quantify the strength of the linear relationship between two variables. It is defined as:

$$r = [\ \Sigma\ (Xi - \bar{X})\ (Yi - \bar{Y})] \ /\ [(N - 1)\ Sx\ Sy]$$

where Xi = value of X for case i
$\bar{X}$ = mean of X
Yi = value of Y for case i
$\bar{Y}$ = mean of Y
N = number of cases
Sx = standard deviation of X
Sy = standard deviation of Y

When all points fall exactly on a line, the absolute value of r equals one. Values near or equal to zero reveal little or no linear relationship. r is positive when the fitted line has a positive slope and r is negative when the fitted line has a negative slope.

7/ It is assumed that normal distributions, with respect to size, of "rural" and "remote" hospitals are present for each service; this may not be plausible regarding county and private hospitals since only twelve county hospitals exist.

Also, the levels of degrees of freedom used in the Student's t-test procedure were adjusted to reflect differences in the number of cases compared.

8/ In Table 4, the significant probability levels listed within the location and ownership categories are lower than the levels used in Table 1 because unequal numbers of cases were compared in each statistical analysis. This is especially true in the ownership category; only twelve out of eighty-three Michigan rural hospitals are county-owned.

Shared-services between hospitals are especially common in the "remote" hospitals of Michigan's Upper Peninsula (Michigan Hospital Association, 3/28/86). The numbers of allopathic and osteopathic physicians reported by these hospitals may be inflationary because the surveys did not measure the employment of these providers on a part-time or hourly basis. Hence, shared and full-time physicians are weighted equally.

9/ An explanation for this might be that rural patients accessible to urban areas tend to seek care at larger and more specialized urban or suburban hospitals (Phillips et al., 1986).

10/ Perhaps "remote" hospitals have diversified less in these areas than "rural" hospitals due to less competition for patients and/or to greater difficulties networking and cross-referring patients with urban hospitals for more specialized care.

APPENDIX

FACILITY NUMBER:

MICHIGAN DEPARTMENT OF PUBLIC HEALTH
BUREAU OF HEALTH FACILITIES
DIVISION OF HEALTH FACILITY PLANNING AND CONSTRUCTION

HOSPITALS REPORT
MICHIGAN 1983

COUNTY:
FACIL SRV AREA #:
HEALTH SRV AREA #:

TYPE OF SRV: GENERAL MED/SURG
TYPE OF OWNERSHIP: VET. ADM
STATE LICENSED: NO

12-MONTH REPORT: YES
BEGINNING DATE: 10-01-82
ENDING DATE: 09-30-83

PATIENT CENSUS:

02-01-83	186
08-01-83	179
11-01-83	209
08-01-84	192

MED/SURG. SRV AGE 65+:

NO. PATIENTS	N/A
NO. DAYS OF CARE	N/A

BIRTH & NURSERY CARE:

LIVE BIRTHS	-
STILL BIRTHS	-
NO. MOTHERS	-
NO. BASSINETS	-
NEWBORN DAYS OF CARE	-

EMERGENCY DEPARTMENT:

NO. PATIENT VISITS	-
NO. ADMISSIONS VIA ED	-

ED PHYSICIAN ARRANGEMENT:
1.NONE:NO EMRGY DEPT

SATELLITE CLINICS: NO

TOTAL INPATIENT SERVICES

TYPE OF SERVICE	SERV. PROVID.	DAYS OF CARE	ADMISSIONS	DISCHARGES	BEDS SET-UP	LIC. BEDS	AVG. DAILY CENSUS	OCC. RATE (%)	AVG. LENGTH OF STAY
MEDICAL/SURG.	YES	49020	5233	5254	201	-	134.30	66.8	9.33
PEDIATRICS	NO	-	-	-	-	-	-	-	-
OBSTETRICS	NO	-	-	-	-	-	-	-	-
TOTAL (MS-PED-OB)	YES	49020	5233	5254	201	-	134.30	66.8	9.33
REHABILITATION	NO	-	-	-	-	-	-	-	-
LONGTERM - SKILLED	YES	13425	168	167	40	-			
LONGTERM - BASIC	NO	-	-	-	-	-			
LONGTERM - OTHER	NO	-	-	-	-	-			
LONGTERM - MR	NO	-	-	-	-	-			
LONGTERM - MI	NO	-	-	-	-	-			
TUBERCULOSIS	NO	-	-	-	-	-	-	-	-
PSYCHIATRIC	NO	-	-	-	-	-	-	-	-
GRAND TOTAL	YES	62445	5401	5421	241	-			

INPATIENT SERVICES IN SPECIAL CARE UNITS
(THESE DATA ARE ALSO REPORTED AS PART OF THE TOTAL INPATIENT SERVICES ABOVE)

SUB. ABUSE - ALC	NO	-	-	-	-	-	-	-
SUB. ABUSE - DRUG	NO	-	-	-	-	-	-	-
INTENSIVE CARE	MIXED	1145	N/A	364	6	3.14	52.3	3.15
CARDIAC CARE	NO	-	-	-	-	-	-	-
BURN TREATMENT	NO	-	-	-	-	-	-	-
NEONATAL - ICU	NO	-	-	-	-	-	-	-
SPEC. NEWBORN NURS	NO	-	-	-	-	-	-	-
MATERNAL - ICU	NO	-	-	-	-	-	-	-
ONCOLOGY	NO	-	-	-	-	-	-	-
SELF CARE	NO	-	-	-	-	-	-	-
NEUROLOGY	NO	-	-	-	-	-	-	-
OTHER SPEC. UNITS	NO							

FACILITY NUMBER:

MICHIGAN DEPARTMENT OF PUBLIC HEALTH
BUREAU OF HEALTH FACILITIES
DIVISION OF HEALTH FACILITY PLANNING AND CONSTRUCTION

FACILITIES INVENTORY REPORT - HOSPITALS (CONTINUED)
MICHIGAN 1983

COUNTY:
FACIL SRV AREA #:
HEALTH SRV AREA #:

ACTIVE PHYSICIAN STAFF (WITH ADMITTING PRIVILEGES)

M.D.S ON STAFF	19
D.O.S ON STAFF	-
PODIATRISTS ON STAFF	-

STAFF SPECIALTIES

GENERAL PRACTICE	YES
FAMILY PRACTICE	YES
ALLERGY	NO
CARDIOVASCULAR DISEASES	YES
DERMATOLOGY	NO
GASTROENTEROLOGY	NO
INTERNAL MEDICINE	YES
PEDIATRICS	NO
PULMONARY DISEASES	YES
GENERAL SURGERY	YES
NEUROLOGICAL SURG.	NO
PEDIATRIC SURG.	NO
ORTHOPEDIC SURG.	YES
PLASTIC SURGERY	NO
COLON & RECTAL SURG.	NO
THORACIC SURGERY	NO
OBSTETRICS/GYNECOLOGY	NO
OPHTHALMOLOGY	YES
OTOLARYNGOLOGY	YES
UROLOGY	YES
DENTISTRY	YES
ORAL SURGERY	YES
ANESTHESIOLOGY	NO
NEUROLOGY	NO
PSYCHIATRY	YES
PATHOLOGY	YES
RADIOLOGY	YES
ONCOLOGY	NO
NEPHROLOGY	YES
OTHER	YES

HOSPITAL EMPLOYED STAFF, WEEK PRIOR TO 08-01-84

OCCUPATIONAL CLASSES	FULL TIME	PART TIME	P.T. HOURS
ADMINISTRATORS	1	-	-
INTERNS & RESIDENTS	-	-	-
OTHER PHYSICIANS	20	2	N/A
DENTISTS	2	-	-
REGISTERED NURSES	62	22	N/A
LIC. PRACT. NURSES	54	20	N/A
NURSES AIDES	N/A	N/A	N/A
MED. RECORD ADMIN	1	-	-
LIC. PHARMACISTS	3	-	-
PHARM. TECHNICIANS	1	2	N/A
MEDICAL TECHNOLOGISTS	5	1	N/A
OTHER LAB. PERSONNEL	6	-	-
DIETITIANS & DIET. TECH	4	-	-
RAD TECHNOLOGISTS	4	2	N/A
OTHER RAD PERSONNEL	1	-	-
OCC. THERAPISTS (O.T.)	-	-	-
O.T. ASSISTANTS	-	-	-
PHY. THERAPISTS (P.T.)	2	-	-
P.T. ASSISTANTS	1	1	N/A
RECREATIONAL THERAPISTS	-	1	N/A
RESPIRATORY THERAPISTS	3	2	N/A
SOCIAL WORKERS	4	-	-
OTHER HLTH. PERSONNEL	18	3	N/A
NON-HLTH. PERSONNEL	160	30	N/A
TOTAL EMPLOYED STAFF	352	86	N/A

HOSPITAL EXPENSES

PAYROLL EXPENSES	$9341243
NON-PAYROLL EXP.	$5591991
TOTAL EXPENSES	$14933234

SPECIAL, ANCILLARY SERVICES

TYPE OF SERVICE	SERV. PROVID.	OPERATIONS PROC.,OR PAT.VISITS
SURGERY - INPATIENT	YES	1051 *
SURGERY - OUTPATIENT	YES	105 *
ORGAN TRANSPLANTS	NO	- *
OPEN HEART SURG - TOTAL	NO	- *
OPEN HEART SURG. - PED.	NO	- *
OPEN HEART SURG. - ADULT	NO	- *
CARDIAC CATH. - PED.	NO	- **
CARDIAC CATH. - ADULT	NO	- **
ENDOSCOPY	YES	735 **
DIAGNOSTIC X-RAY - INP	YES	7154 **
DIAGNOSTIC X-RAY - OUTP	YES	4508 **
DIAGNOSTIC RADIOISOTOPE	YES	3365 **
ULTRASOUND	YES	219 **
CT HEAD SCAN - INP	NO	- **
CT BODY SCAN - INP	NO	- **
CT HEAD SCAN - OUTP	NO	- **
CT BODY SCAN - OUTP	NO	- **
X-RAY THERAPY	NO	- ***
THERAPEUTIC RADIOISOTOPE	NO	- ***
RADIATION THERAPY	NO	- ***
COBALT THERAPY	NO	- ***
RADIUM THERAPY	NO	- ***
ELECTROENCEPHALOGRAMS	NO	- **
ELECTROCARDIOGRAMS	YES	5246 **
LABORATORY - INP	YES	240000 **
LABORATORY - OUTP	YES	N/A **
HEMODIALYSIS - INP	YES	N/A ***
HEMODIALYSIS - OUTP	YES	882 ***
PERITONEAL DIALYSIS-INP	YES	N/A ***
PERITONEAL DIALYSIS-OUTP	YES	N/A ***
PHYSICAL THERAPY-INP	YES	19151 ***
PHYSICAL THERAPY-OUTP	YES	2043 ***
OCC. THERAPY - INP	NO	- ***
OCC. THERAPY - OUTP	NO	- ***
RESPIRATORY THERAPY	YES	25547 ***
SPEECH PATHOLOGY	YES	3219 ***
AUDIOLOGY SERVICES	YES	N/A ***
HOME CARE SERVICES	NO	- ***
FAMILY PLANNING	NO	- ***

* OPERATIONS
** PROCEDURES
*** PATIENT VISITS

FACILITY NUMBER:

MICHIGAN DEPARTMENT OF PUBLIC HEALTH
BUREAU OF HEALTH FACILITIES
DIVISION OF HEALTH FACILITY PLANNING AND CONSTRUCTION

FACILITIES INVENTORY REPORT - HOSPITALS (CONTINUED)
MICHIGAN 1983

COUNTY:
FACIL SRV AREA #:
HEALTH SRV AREA #:

ORGANIZED OUTPATIENT CLINICS

TYPE OF SERVICE	SERV. PROVID.	PAT. VISITS
O/P MEDICAL	YES	N/A
O/P SURGICAL	YES	N/A
O/P PEDIATRIC	NO	-
O/P OBSTETRICAL	NO	-
O/P REHABILITATION	NO	-
O/P PSYCHIATRIC	NO	-
O/P ALL OTHER TYPES	YES	N/A
O/P ALL SERVICES	YES	23043

OTHER SPECIAL, ANCILLARY SERVICES

POST OPERATION RECOVERY	YES
PHARMACY - FULL TIME	YES
PHARMACY - PART TIME	NO
HISTOPATHOLOGY LAB	YES
ORGAN BANK	NO
BLOOD BANK	YES
PREMATURE NURSERY	NO
GENETIC COUNSELING	NO
PREADMISSION TEST	NO
PSYCHIATRIC - PARTIAL	YES
PSYCHIATRIC - EMERGENCY	NO
PSYCHI.-FOSTER/HOME CARE	NO
PSYCHIATRIC - CONSULT.	YES
CLINIC. PSYCHOLOGY	NO
DRUG ABUSE - OUTP.	NO
CHEMOTHERAPY	YES
SOCIAL WORK	YES
DENTAL SERVICES	YES
PODIATRIC SERVICES	NO
PARAMEDICAL TRNG PROGRAM	NO
PATIENT EDUCATION	YES
VOLUNTEER SERVICES	YES
HOSPITAL AUXILIARY	NO
CHAPLAINCY PROGRAM	YES
HOSPICE HOME CARE	NO
HOSPICE INPATIENT	YES
HOSPICE OUTPATIENT	NO

SERVICES REFERRED TO OTHER FACILITIES

TYPE OF SERVICE	NUMBER OF REFERRALS
BURN TREATMENT	N/A
MATERNAL - ICU	-
NEONATAL - ICU	-
SPEC. NEWBORN NURS	-
CT HEAD OR BODY	N/A
ULTRASOUND	-
OPEN HEART SURG.	N/A
ORGAN TRANSPLANTS	N/A
CARDIAC CATH.	N/A

LEASED, PURCHASED, SHARED SERVICES

ANESTHESIOLOGY	NO
PATHOLOGY	NO
MEDICAL RECORDS	NO
RADIOLOGY	NO
PHYSICAL THERAPY	NO
OCCUPATIONAL THERAPY	NO
BLOOD BANK	NO
DATA PROCESSING	NO
DIETITIAN	NO
EMERGENCY ROOM PHYSICIAN	NO
CARDIOPULMONARY PERSONNEL	NO
MANAGEMENT	NO
LAUNDRY	NO
OTHER	PURCHASED

SURGERY ROOMS

TOTAL OPERATING ROOMS	4
NO. USED IP ONLY	4
NO. USED OP ONLY	-
ENDOSCOPY ONLY ROOMS	1

UNSCHEDULED CT SCANS

TYPE OF SERVICE	NUMBER OF PROCEDURES
HEAD SCANS	-
BODY SCANS	-

DIAGNOSTIC IMAGING

RAD./FLUOROSCOPIC ROOMS	3
PORT. X-RAY UNITS	3
RAD. HLTH. PHYSICISTS	-
SPC DIAG RAD PROC.:TOTAL	327
CEREBRAL ANG./ARTER	-
ANGIOGRAMS/ARTERIOGRAMS	23
RADIO . BRAIN SCANS	256
PNEUMOENCEPHALOGRAMS	-
OTHER SPC DIAG. RADIO.	48

SPEC. EQUIPMENT INSTALLED IN 1983

RAD. THERAPY EQUIP.	NO
NUC. MED. EQUIP.	YES
SPEC. DIAG RAD EQUIP.	NO
CARD CATH. EQUIP.	NO

SPEC. EQUIPMENT REMOVED IN 1983

RAD. THERAPY EQUIP.	NO
NUC. MED. EQUIP.	YES
SPEC. DIAG RAD EQUIP.	NO
CARD CATH. EQUIP.	NO

CONSTRUCTION

COMPLETED 1983 - BEDS	NO
ANCILLARY UNITS	YES
IN PROGRESS - BEDS	NO
ANCILLARY UNITS	NO
CONSTRUCTION PLANNED	YES

LISTING OF MICHIGAN COUNTIES WITH "RURAL" AND "REMOTE" HOSPITALS

"Rural" hospitals, as defined in the text, are in the following twenty-nine counties:

Allegan; Arnenac; Barry; Branch; Cass; Clare; Gladwin; Gratiot; Hillsdale; Huron; Ionia; Iosco; Isabella; Lake; Lenawee; Mason; Mecosta; Missaukee; Montcalm; Newaygo; Oceana; Ogemaw; Osceola; Roscommon; St. Joseph; Sanilac; Shiawassee; Tuscola; Van Buren.

"Remote" hospitals, as defined in the text, are in the following twenty-six counties:

Alger; Baraga; Benzie; Charlevoix; Cheboygan; Chippewa; Crawford; Delta; Dickinson; Emmet, Gogebic; Grand Traverse; Houghton; Iron; Kalkaska; Leelanau; Luce; Mackinac; Manistee; Marquette; Menominee; Ontonagon; Ostego; Presque Isle; Schoolcraft; Wexford.

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BIBLIOGRAPHY

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