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Health care planning and optimal distribution of hospitals in the State of Iowa

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Health care planning and optimal distribution of hospitals in the State of Iowa

by

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CHAPTER I. INTRODUCTION

The concern of Man for health is probably as old as Man himself. Health care as a dignified profession is also as ancient as civilization. Health care professions were, and still are, reluctant to provide their services in a commercial form. Efforts have been made to convince the public that the health and well-being of patients is the sole objective of health care providers and is not based on economic motives. But provision of health care services has evolved into an industry which is large enough to be worthy of attention and complex enough to induce the tendency of people tc avoid it.

The nature of the health care industry gives peculiarities not common in other industries. Some of these characteristics which contribute mainly to the size and complexity of problems in the industry are noted below.

Market

Generally larger[1] hospitals have control over the supply

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[1]By definition: Small-sized hospitals, 100 beds or fewer; moderate-sized, 100-399 beds; large-sized, 400 beds or more.

of health care services in a certain area. They act as the leader and others have to follow in order to survive. There is also an upward trend in the number of large community hospitals, leading to more centralized control of the industry.

> ...small hospitals accounted for 22.2 percent of community hospital beds in 1965 but only 15.8 in 1976. Beds in large hospitals comprised slightly more than one-fourth (25.2 percent) of the community hospitals in 1965 and almost one-third (32.8 percent) in 1976.... (6)

The State of Iowa also has a similar situation. During 1976, 17 percent of the hospitals in Iowa admitted 51.8 percent of patients. This number of hospitals (23 out of 135) encompasses 48.9 percent of the total bed capacity throughout the state. (2)

Entry to and departure from this industry cannot easily be achieved. Practically, so far, only the existing institutions have been able to afford expansion and curtailment of the extent of their services to match the needs of the community. There has been no significant change in the number of hospitals during the last 12 years, although the number of hospital beds has changed drastically. From 1965 to 1976, the number of beds dropped from 1,704,000 to 1,434,000, a decrease of 15.7 percent, while the number of hospitals changed from 7123 to 7082, a decrease of .58 percent. (2)

Until now, the health care industry has generally enjoyed self-regulatory status. Regulatory agencies have done little more than maintain the status quo, merely preventing the situation from becoming worse. The scarcity of skilled professionals, the labor and capital intensity of its operation, and social and political attachment to the issues make entry and departure from this industry a difficult problem. There has always been a shortage of physicians, nurses, and other health professionals. Educational institutions are not ready to respond to an increase in demand for such professionals. Physicians, the most indispensable part of hospitals, do not have the mobility or interest in moving from one community to another.

Regarding demand, consumers of health care do not have any bargaining power or opportunity for shopping around before purchasing the service they need. This factor has been the center of attention by consumer advocates and government agencies.

> The nation's health care industry is the subject of a close look from the Justice Department's Antitrust Division, it was announced June 17 by Assistant Attorney General.... He pointed out that hospital and medical services are not considered competitive because beneficiaries rarely shop around when care is needed....(4)

> ...the AMA's ban on physician advertising violates antitrust laws, according to the Federal Trade Commission....(10)

In some instances, competition between health care providers leads to higher prices. To be competitive and attract more skilled professionals and highly specialized physicians, hospitals have to purchase more expensive equipment and acquire more facilities which may not be economically justified. In fact, users have little (if any) choice over the selection of providers. Usually, even in some emergency cases, no patient will be admitted to a hospital unless he/she has been referred by one of the hospital's staff physicians. Thus, the physicians associated with a hospital actually control admission, discharge, distribution of patients, the types of services to be offered, and the equipment to be used.

Moreover, executive and administrative officers in a hospital usually have neither the expertise nor the authority to challenge the necessity of requests made by medical staff for expansion or diversification of services. So, contrary to most other sectors of the economy, consumers are advised to utilize a commodity to an extent that is beyond their control. The suppliers are also forced to operate at a certain level which may or may not be economically feasible. As a result, consumers and providers (patients and hospitals) are isolated from each other by physicians and little feedback is exchanged.

Reimbursement System

Because of the Third Party Payment System, patients have limited information about the cost of services they have received. During 1976, personal health care expenditures amounted to $120.4 billion, or $551.50 per capita. The share taken by the third party (government and private insurance companies) was about $81.3 billion or 67.5 percent of the total cost. For hospital care, this ratio is even higher, with 91.1 percent of the cost covered by some kind of third party payment, as shown in Table 1.(34)

Table 1. Percentage distribution of per capita hospital care expenditure, by the source of fund. FY 1976.

Annual hospital care cost per capita: $254.		
Source:		
Public	54.9%	Third Party Payments
Philanthropy & industry	1.2%	
Private health insurance	35.1%	
Direct payment	8.9%	

Being directly responsible for only a small portion of the cost of medical care is one of the causes of consumers' apathy and insensibility to the rising costs of health care.

Ownership and Objective

A significant number of the health care institutions are owned and managed by non-profit organizations, such as

churches or city, state or federal government. There are 6449 short-term hospitals in the United States, of which only 715 or 11 percent are owned by investors and are for profit. During 1976, these 715 hospitals treated less than 7.4 percent of the total number of patients.(6) In Iowa, there are two general short-term hospitals, which treated 0.4 percent of all patients.(6) The non-profit concept does not necessarily imply that the hospitals are not self sufficient. But it does imply that there are no stockholders to receive dividends at the end of the year. By virtue of the association of hospitals with non-profit organizations, some individuals, who have less expertise than sincerity and good will, may gain positions on the Board of Trustees. This also immunizes them from scrutiny which might be useful for improving their hospital's efficiency or lowering the cost. However, that immunity has been challenged by some major financiers of health care such as insurance companies and government agencies in charge of publicly funded health programs.

Public Attitude Toward Health

Health has been viewed as a "sacred" feature of life and not a material or exchangeable commodity. There are some services, called "public goods," such as knowledge, safety, and clean air. Once these have been provided, their use is

widespread and cannot be limited to a certain group. Of course, some individuals may be deprived of enjoying these services because of mental or physical limitations or their socio-economical status. But health care services are offered without judging the eligibility of individuals or imposing any selection process on them. Everyone is offered the service to the fullest extent and on a first come, first served basis. Recently, access to health care services has been viewed as the rights of individuals and laws providing equal access to those services as society's responsibility have been enacted. Emotional, religious, and political attachment to this problem are obstacles in objectively allocating health care resources.

With all its uniqueness, in the view of economists, health professionals, and all concerned Americans, the problem of health care delivery has three incompatible elements: quality or effectiveness, reasonable cost, and equity of access by every individual. Although all are aware of such problems, one should not expect the parties involved to share the same understanding of these problems.

Quality

In the minds of uninformed individuals, there is little difference between the quality and quantity of health care. Overuse of services in many instances is an indication of this attitude. The patient's expectation of the hospital is

that it utilize all of the discovered knowledge in medicine to cure a certain ailment. During the last three years, the number of laboratory tests per admission has gone up drastically.(12) It is hard to believe that the quality of care has improved proportionately. From 1974 to 1976 in Iowa, there was an increase of 4.8 percent and 19.5 percent for annual inpatient and outpatient visits per capita, respectively.(6,7) Can it thus be concluded that Iowans have become less healthy or more concerned about their health?

Health is a psychological state of mind as well as a physical state of body. Non-medical tasks carried out by hospital staff may be equally important as medical tasks in improving the health of the patients. In these days, the implied definition of health care is the development of potential characteristics and the removal of diseases at the same time. Nonetheless, people have different conceptions of the quality of health and health care. Some of the objective criteria which can be used in measuring the quality of health care services are as follow:

a. The mortality rate of infants and children.
b. The exepcted life span at birth.
c. The number of inpatient admissions per population per year.
d. The major causes of death for adults and for each age group.

e. The rate of complication in treatments which leads to re-admission of patients.

f. The ratio of resources spent on preventive medicine and on curing diseases.

Although most of this data either is readily available or can be obtained, extensive effort is needed to remedy the undesirable situations.

Reasonable cost

The rising cost of health care has been the focus of attention by social scientists, economists, legislators, and consumer advocates. Federal and state governments as the major financiers of these services rally public support for imposing strict regulation on this industry. A review of the national health expenditure and its trend, which is shown in Table 2 justifies such concern.

Table 2. Aggregate and per capita national health expenditure, by source of funds, selected FY 1960-1976. (34)

Fiscal Year	Total (millions)	Per Capita	Source: Private, Percent of Total	Source: Public, Percent of Total
1960	$25856	$141.63	75.3	24.7
1965	38892	197.75	75.5	24.5
1966	42109	211.56	74.3	25.7
1967	47879	237.93	66.9	33.1
1968	53765	264.37	62.7	37.3
1969	60617	295.20	62.2	37.8
1970	69201	333.57	63.3	36.7
1971	77162	368.25	62.7	37.3
1972	86687	409.71	61.4	38.6
1973	95383	447.31	61.6	38.4
1974	106321	495.01	61.0	39.0
1975	122231	564.35	58.4	41.6
1976	139312	637.97	57.8	42.2

Hospitals and medical associations also have launched their own counter-rally, passing the blame onto other factors not in their control and warning the public of the consequences of interference by public and regulatory agencies. Hospital associations try to link the increase in costs to improvement in the quality of health care and general inflation factors over which they have no control.

> Recently released data from the AHA's two new statistical indexes support the AHA's contention that inflation in the hospital industry is not accurately shown by the hospital service charge

> component of the Consumer Price Index (CPI). The two indexes, the Hospital Cost Index and the Hospital Intensity Index, measure the cost to hospitals of purchased goods and services used in rendering hospital care (the HCI) and increases in the intensity of hospital services (HII)....(13)

Expecting the cost of health care to rise at the same rate as other commodities and services does not sound realistic. Yet in order to have a too expensive health care system, one may have to sacrifice education, good nutrition, peace of mind, and other aspects of life which in turn contribute to improving health. Moreover, the existence of an expensive health care system does not necessarily bring about healthier people. One of the causes of rising costs for health care delivery is the maldistribution of its limited resources. The health program for the elderly is an example of this case.

> Nationally, the over 65 were hospitalized at a rate significantly above that of younger people in 1974 and accounted for 25% of all recorded hospital days. This is not entirely due to medical problems. Because many third-party reimbursement systems require a hospital stay prior to coverage of long term care, it is possible that some elderly patients are in the hospital to qualify for nursing home admission. In addition, services of home health agencies, or other community supports, may not be available, thus requiring the individual to remain in the hospital longer than would otherwise be necessary....(60)

This situation is a matter for expansion of health care institutions in a direction which does not coincide with the needs of the rest of society.

> It is estimated that 2.5 million elders nationally are without care to postpone or prevent institutionalization....(60)

On the other hand, nationally, hospital occupancy rates dropped from 86% in 1950 to 76% in 1976. During the same period, the total investment per hospital bed rose from $8132 to $44,650. Further, labor intensity of the hospital operation also has changed drastically from .73 FTE per bed in 1950 to 2.17 FTE in 1976.(6) In the State of Iowa, the number of hospital beds per capita and admissions per capita has gone up, while the occupancy rate has declined.

Changes in hospital bed per capita, admission, and occupancy rate over a selected period of time are shown in Table 3.

Table 3. Iowa community hospitals statistics over time.[1]

Year	Beds	Bed/ 1000 Pop.	Admission/ 1000 Pop.	Occupancy Rate %	Average Length of Stay
1964	12174	4.31	151	74.6	7.8
1968	14562	5.15	162	75.4	8.9
1970	15333	5.42	170	72.5	8.4
1972	15883	5.51	167	66.5	8.1
1974	16523	5.78	184	68.1	7.8
1975	16840	5.89	188	68.0	7.8
1976	16758	5.84	192	67.9	7.6
% Change 1964-76	+37.6%	35.5%	+27%	-9%	-2.6%

[1]Source: Iowa Health Systems Agency. Draft, Health Systems Plan, August 1977. Compiled from Hospital Statistics 1977 Edition, AHA and Population Estimates Report, Government Documents.

In conjunction with these changes, the cost per patient day has been increasing over time. In Table 4, these changes are shown.

Table 4. Increase in cost per patient day nationally and on state level over time.[1]

	1974 (July)	1976 (July)	% Increase 1976 Over 1974
Iowa	$ 88	$132	50.0%
Region 6	92	132	43.4%
U.S.	108	143	32.4%

[1]Source: Iowa Health Systems Agency. Draft, Health Systems Plan, August 1977.

The main components of these changes are utilization increase and quality improvement, population growth, and price increase. A study conducted by the Social Security Administration identifies the magnitude of each factor, as shown in Table 5.

Table 5. Factors affecting increase in personal health care expenditures, FY 1965-1975.[1]

Utilization increase and quality improvement	38.3%
Population growth	8.7%
Price increase	53.0%

[1]Source: Social Security Bulletin, February, 1976.

It may be noted even in government vocabulary, "Utilization Increase" and "Quality Improvement" are used interchangeably.

As to cost, there is little agreement among the parties involved over the issue of "Reasonable Cost." There is no other commodity or service which can be compared with health care. Individuals' perception and appraisal of health care is based on their socio-economic, education, religious background as well as some subjective measures. In spite of these, the majority of Americans disagree with the rate of increase in the cost of health care.

> Two thirds of the American public is unwilling to pay 10 to 15 percent more for hospital care, even if guaranteed better quality service and more personal attention, according to a recent Louis Harris survey conducted for the Federation of American hospitals....(14)

But as long as the cost is not directly reimbursed by people, their dissatisfaction over increasing costs does not reflect in their consumption behavior.

Equity in access

Delivery of health care services is a two-facet problem, both parts of which have to be viewed simultaneously.

a) Healthy people are essential for the progress, independence, and quality of life in a society. Healthy people live longer, are more productive, and can provide greater benefit for themselves and their society by their efforts than unhealthy people can. Thus, spending on health is a sound investment which pays off. This investment has to be analysed in a

business-like manner and its consumption should be treated as is the consumption of any other commodity. Expenditures should be allowed in so far as its marginal cost is less than the marginal profit gained by the society. In that aspect each society, based on its limitations and circumstances, needs to derive a target level of care which should be delivered to its residents. But no attempt has been made so far to establish an objective level of care for the society, and no health program has been broad enough to encompass the program on the national level. Either programs have been created by the spirit of the moment or the needs of all areas have not been viewed as equally important.

b) After dealing with the economic side of the problem, then one should deal with its social parts. What would the situation be of those who cannot or will not be productive, regardless of the amount of care they may receive? How can health services be distributed among children, adults, and the elderly? What is society's responsibility for those who are suffering from self-inflicted unhealthy conditions, such as alcoholism and drug addiction?

These are some of the unresolved problems which one may face in health planniing and distribution of health services. Although, according to recent laws, equal access to health care services is envisioned as the right of individuals, there is little assurance that equal access produces the same level of health for different individuals.

Consider the number of hospital beds per capita in a community as a measure of accessibility to health care services. In order to investigate the affect of this index, the following analysis was made of the number of hospital beds per capita and the number of admissions per capita during 1976 for 45 states and the District of Columbia, it was found that there is a linear relation between these two indices, as shown in Figure 1. The value of R-square for this relationship is .85.

As can be seen from this numerical analysis, the more hospital beds available, the more people will be hospitalized. There is no evidence for the belief that those states with a lower bed ratio and consequently a lower admission rate are healthier or less healthier than others. Since physicians have a vested interest in hospitals' high occupancy rate, and are the ones who recommend hospitalization, this may be one of the factors contributing to a higher admission rate.

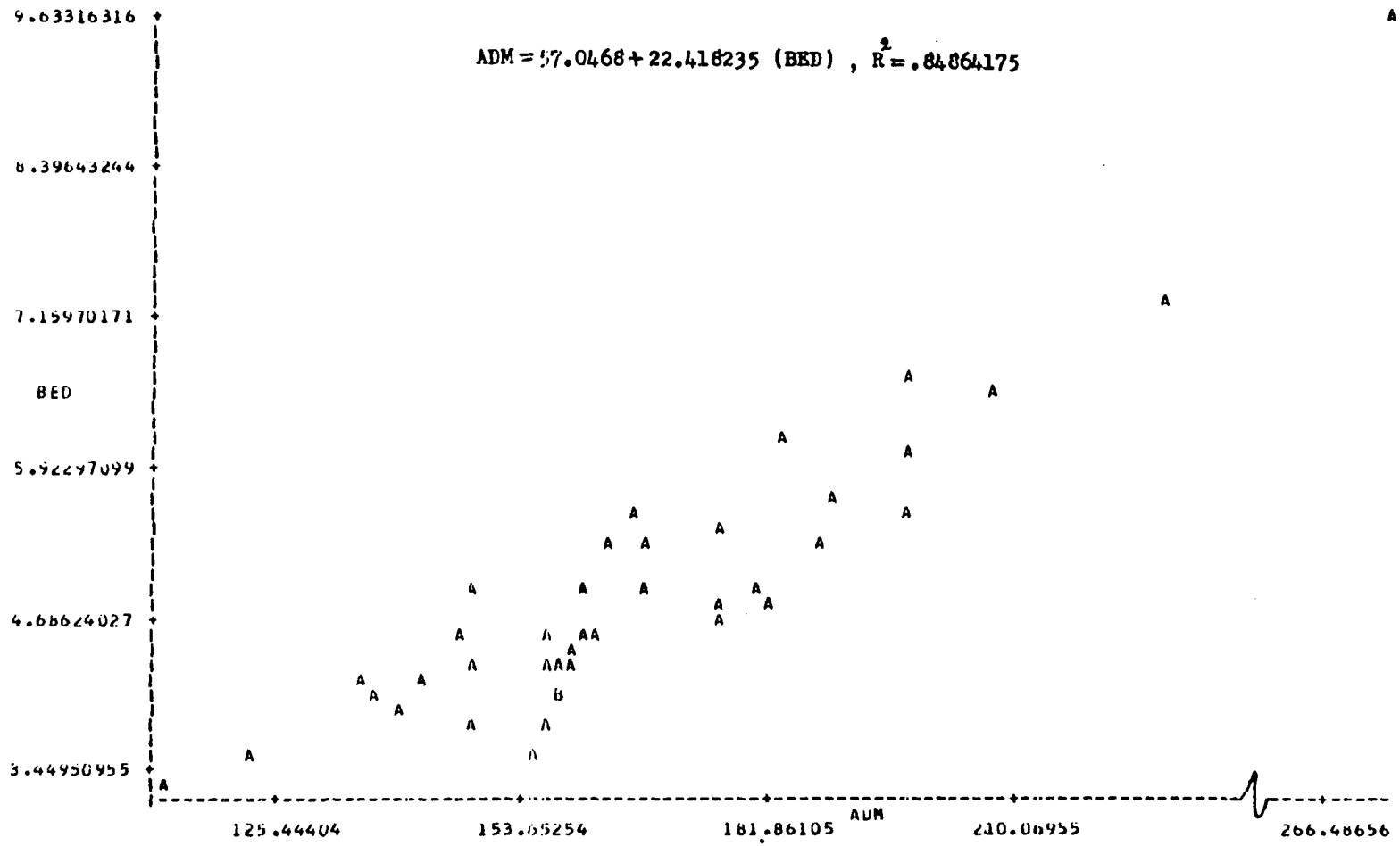

FIG.1 Plot of bed vs admission

(Bed and admission per 1000 population, 1976 data).

The objective of being equally and easily accessible to everyone in many instances is in direct conflict with the criteria of reasonable cost. Scarcity of resources such as personnel and facilities makes the compromise highly difficult, if pcssible at all. Generally, the cost of health care to patients is combined of two parts, access cost, and the cost of services itself. In contrast to most industries, hospitals do not concern themselves with access cost which is similar to the cost of securing raw materials and cost of distributing the end product. The burden of access cost is directly on patients and users of medical services. Therefore, there is no incentive for hospitals to be concerned about it.

Access cost may be estimated by considering the following elements.

1. Direct cost of transportation.
2. The cost of time otherwise could be spent in a more productive way.
3. Adverse economic affect of being at a far distance hospital on a community's affair.
4. The adverse affect of inconvenient access and discouragement in seeking those services on the health of a community.

The objective of being equally and easily accessible to everyone in many instances is in direct conflict with the

criteria of reasonable or low cost. of equal access highly difficult, if possible at all. Limited amount of resources (personnel and facilities) makes the achievement more difficult. Generally, the cost of health care to the patients is combined of two parts, access cost, and the cost of services itself. The burden of access cost is directly on patients and users of medical services and there is no incentive for hospitals to be concerned about it. That cost may be estimated by considering

In this research, the objective is to find a solution to the size and location of hospitals across the state of Iowa which minimizes the sum of access cost and the cost of services. The statistical analysis made in this research has shown that there is no significant relation between the size and location of a hospital facility and the cost per unit of services produced. If this were the case, then the problem takes the simple form with its objective to minimize the transportation (access) cost.

Thus, quality and effectiveness, reasonable cost, and equality in access are major incompatible aspects one may face in planning and distributing health care resources.

CHAPTER II. LITERATURE REVIEW

It has only been during the last decade and especially after the passage of the National Health Planning and Resources Develcpment Act of 1974 that health planning and proper allocation of health resources have been perceived as a national problem rather than a local one. New York's Metcalf-McCloskey Act of 1964 was the first state law to require certification of need prior to the building of new private health care facilities. Of course, Certificate of Need (CCN) is only one of many aspects of the health planning problem. Major research applicable to the problem on hand can be divided in two groups, cost analysis (optimum size hospital) and location planning (for obtaining minimum transportation cost).

Cost Analysis

The optimum size hospital (86)

Pulley and Fulmer (86) based their analysis on data available for the years 1971 and 1972 for non-federal, short-term general hospitals located in North and South Carolina. For 1971, there are data for 174 hospitals, ranging from 12 to 803 beds, and for 1972, there are 178 hospitals, ranging in size from 12 to 815 beds. Hospitals

affiliated with schools of medicine are excluded from the study. In this model, the variables identified as cost factors are as follows.

The following relationship is estimated:

$$Yi = a + B_1X_{1i} + \ldots + BkXki + e_i$$

where i (observations) = 1,2..., n (n = number of hospitals), k (variables) = 1,...,15 (independent variables as listed below)

and where the terms are defined as follows:

Yi = the measure of average cost
= total operating expense per bed

X1 = output measure
= number of beds

X2 = output measure squared
= (number of beds)

X3 = obstetrical activity
= obstetrical discharges as percent of total discharges

X4 = surgical activity
= operating room visits per 100 admissions

X5 = lab activity
= clinical lab inpatient tests per admission

X6 = X-Ray activity
= X-Ray diagnostic procedures per admission

X7 = emergency and outpatient activity

= emergency and clinic visits per bed

X8 = pharmacy activity

= pharmacy expenses as percent of total expenses

X9 = nursing education

= nursing education expenses as percent of total expenses

X10= medical staff

= medical staff expenses as percent of total expenses

X11= factor price variable

= cost of a nursing man-hour

X12= a measure of management

= employees per patient per day

X13= a measure of management

= net accounts receivable, in days

X14= utilization rate

= percent occupancy

X15= length of stay

= average length of stay

e_i= an error term that includes the influence on the dependent variable of omitted independent variables and also reflects errors in observation and measurement

Coefficients of correlation for this model had an R^2 value of .866 and .855 for 1971 and 1972, respectively.

It was thus concluded that hospitals' cost is affected by economy of scale. The optimum size hospital for 1971 and 1972 data was 279 and 346 beds respectively. However, the cost curve in both cases had a plateau ranging from 200-350 and 250-425 beds for 1971 and 1972, respectively.

Variations in cost among hospitals of different sizes(24)

In the model developed by Cohen (24), when the analysis has been based on the relation between the total units of output and total annual cost. The measure of units of output is the weighted sum of different types of services provided by a hospital. The weighting factors used by Cohen were previously developed by Donald E. Saathoff and Richard A. Kurtz first published in The Modern Hospitals in October, 1962. These factors are the relative amount of resources spent on each activity in comparison with regular adult and pediatric patients. The relative weighting factors used in this study are shown in Table 6.

Table 6. Relative weighting factors.

Service Units	Relative Cost	Units/ Patient Day	Relative Cost/ Patient Day
Operations, weighted	4.75	.033	.1508
Deliveries	2.36	----[1]	2.36
X-rays, diagnostic	.16	.65	.1040
Laboratory examinations	.07	2.01	.1407
Physical therapy treatments	.15	.153	.023
Electrocardiograms	.20	.06	.012
X/ray, therapy treatments	.39	.03	.012
Blood transfusions (inc. plasma)	.90	.02	.018
Newborn days	.53	----[2]	.53
Outpatient visits	.28	.40	.112
Electroencephalcgrams	.73	.0055	.004
Emergency room treatments	.16	.16	.026
Adult and pediatric days	1.00	1.00	1.00

[1] - Births used as units.
[2] - 365 newborn census used as units.

The model shows that there is a quadratic relationship between the total annual cost and the weighted sum of units of output.

$$C = 499446.3 + 17.16104(Sk) + .00002395(Sk)^2$$

where C = total cost

Sk = weighted sum of units of service, and

$$Sk = \sum WiQi$$

where Wi = relative weight (cost) of service i

Qi = quantity of service i is provided by facility k

This model was tested by using data available from 82 eastern hospitals. Its validity was verified by having a coefficient of correlation $R^2 = .9925$.

The relationship of cost to hospital size (23)

The study done by Carr and Feldstein (23) to determine the relationship between the cost and hospital size is probably the most comprehensive and in-depth study done thus far on the subject. The researchers' access to 1963 data of 3147 U.S. voluntary short-term general hospitals makes the results more reliable. However, in spite of the comprehensiveness of the study, it may not be applicable to each locality and demographic territory. The variables utilized in this multi-regression analysis were total cost, hospital size, the number of services provided, the number of outpatient visits, whether or not the hospital had a nursing school, the number of student nurses, the number of different types of internships and residency programs, the number of interns and residents, whether or not the hospital was affiliated with a medical school, and the average wage rate.

Carr and Feldstein used two approaches to empirically estimate the independent effect of size oncost. In the first analysis, data from 3,147 U.S. voluntary short-term general hospitals were used to relate total hospital cost to hospital size and a number of other variables by means of multiple regression analysis. The major finding of the first analysis

was consistent with the hypothesis that cost per unit of service in hospitals is affected by the economy of size. It was found that average cost initially declined with increased hospital size but, after a point, began to increase with size. However, the results of the all-hospital analysis were not considered conclusive because the adjustments for variations in the services provided by hospitals of different sizes were apparently inadequate. The coefficient of determination for this model, R^2, was found to be .947.

In a second series of analysis, the effect of the amount of specialized service provided upon cost is partially held constant by dividing the hospitals into five categories according to the number of facilities and services provided. Regression coefficients were then calculated for each group of hospitals, using essentially the same variables as in the first analysis.

For hospitals with a given number of services, economics are associated with increased size. As the number of services for hospitals with a given number of services, economics are associated with increased size. As the number of services increases, a relatively low level of average cost is reached in hospitals of successively larger size. Only for the largest hospitals in the highest service-capability group were diseconomies of scale indicated within the size range covered by the regression analysis.

The authors also recommend that

> Our findings suggest that small hospitals with high service capability should not generally be built because they are likely to be of uneconomic size. Large hospitals increases, a relatively low level of average cost is reached in hospitals of successively large size. Only for the largest hospitals in the highest service-capability group were diseconomies of scale indicated within the size range covered by the regression analysis.

The authors also recommend that small hospitals with high service capability should not generally be built because they are likely to be of uneconomic size. Large hospitals having low service capability are also likely to be of uneconomic size.

The coefficient cf determination, R^2, for the second model ranges from .844 for the lower service capability groups to .896 for the higher service capability groups.

Location Planning

As far as the author is aware, no analytical model has been developed yet which is readily applicable to the health care industry. However, many studies have been done on plants with spatially uniform consumption points or sources of raw material such as sugar and milk processing plants that have some similarities to the delivery of health care. However, there are major differences between these factories and hospitals. Included in these differences are the following:

-- Factories such as sugar and milk processing plant can cluster the consumption points and sources of raw materials.
-- Group or bulk transportation can be utilized.
-- The capacity and mode of transportation is a controllable factor.

Obviously, none of these options are available to the health care industry. However, some of the studies in location planning which can be used as analogs to the health care facility planning problem are mentioned in the following.

Economic aspects of broiler production density (56)

This study, which is done by Henry and Seagrave (56), is concerned with the optimum location and size of processing plants which minimize the sum of processing and transportation cost. The analysis is based on the assumption that within an area with a certain population density, the transportation cost is directly proportional to the distance traveled from production centers to processing plants. It is also assumed that the efficiency of processing plants is affected by economy of scale. The purpose of this research was to minimize the sum of processing and transportation cost per unit of product.

Some considerations in estimating assembly cost functions for agricultural processing operations(45)

This model, which has been developed by French (45), takes the following factors into consideration:

-- Procurement cost. Securing raw materials for plants with large volumes will raise the price of raw materials. In order to be competitive and attract the suppliers at remote distances, higher prices should be offered.

-- In delivering raw materials from distant places, a higher transportation cost is involved.

-- Plants with too small and too large capacity may not be as efficient as medium-sized plants.

-- Once the product has been produced, centralized plants have a higher distribution cost to deliver the product to the consumers.

By considering these factors, French has developed a model that yields an optimum level of centralization and transportation distance with a minimum total cost per unit of product.

The assumptions of a homogeneous and uniform distribution of population, straight line or grid system roads between the points of raw material and plants make this model less applicable in the real world.

Research Directly Applicable to Health Planning

A quantitative model to plan regional health facility systems

Dokmeci (38) presents a quantitative planning model to determine the optimal characteristics (number, size and location) of a regional health facility system. The system consists of a medical center, immediate and local hospitals, and health centers. The quantitative model is based on the minimization of the total cost (sum of transportation and facility cost) to the society. The optimal characteristics of the system are obtained by using a heuristic method which includes both interactions of sublevel hospitals and environmental conditions as well. A numerical example is given to illustrate the computational procedure. Three major assumptions are made in developing this model:

-- That the facilities are located on a bounded plane, and an infinite set of potential facility locations is possible.

-- That patients travel from all points to health care facilities on a straight line.

-- That average cost per day at all levels of care decreases as the size of the hospital increases.

These assumptions may not necessarily be true in all cases.

Location of ambulatory care centers in a metropolitan area(95)

This model, which is developed by Shuman and others (95), is concerned with the problems associated with prepaid group practice plans and other forms of health maintenance organizations (HMO). A mathematical model is developed for determining the best locations for prepaid group practice or HMO ambulatory care clinics within a metropolitan area. The study is based on the fact that enrollees' interest in subscribing to HMO services declines as the distance increases. On the other hand, the providers have difficulties in establishing facilities in every remote locality. One of the constraints is financing. Each facility requires a fixed amount of investment regardless of its size, and then variable investments increase as the volume of service goes up. The other contraint is the minimum feasible HMO, smaller than which is not profitable. This model compromises between these variables to obtain an optimum location for HMOs in Allegheny County in Pennsylvania.

Manpower mix for health services(94): A prescriptive regional planning model

Shuman and others (94) formulated a model to determine the mix of manpower and technology to provide health services of acceptable quality at a minimum total cost to the community. Total costs include the direct costs associated

with providing the services and developing additional manpower, as well as the indirect costs (shortage costs) resulting from not providing needed services. The model is applied to a hypothetical neighborhood health center, and its sensitivity to alternative policies is investigated by cost-benefit analyses. Possible extensions of the model to include dynamic elements in health delivery systems are discussed, as is its adaption for use in hospital planning, with a changed objective function.

CHAPTER III. HEALTH CARE DELIVERY IN THE STATE OF IOWA

The delivery of health care may not be so impressive as the sunshine and clean air that one may notice in rural areas at first glance. In some sparsely populated areas, the lack of properly maintained roads and sufficiently equipped hospitals in nearby communities makes accessibility of the health care services less convenient. Consideration of the major cause of death in Iowa, which is shown in Table 7, makes prompt and easy access to the primary and secondary health care institutions necessary.

Table 7. Major cause of death in Iowa in 1975.[1]

Age Group	Major Cause of Death	Percent
1-19	Accident	57.4%
20-34	Accident	51.5%
35-49	Malignant neoplasms & heart disease	52.9%
50-64	Malignant neoplasms & heart disease	68.2%
65+	Malignant neoplasms & heart disease	63.9%

[1]Source: Compiled from "Draft, Health System Plan," August 1977. Iowa Health Systems Agency.

But the sparse distribution of population in rural Iowa discourages the availability of such services in all communities.

Rural-urban Distribution

Population density has an important effect on centralization of the health care institutions. More than 1.2 million of the nearly 2.87 million population of Iowa live in rural areas. Only seven of the ninety-nine Iowa counties have cities which are categorized as Standard Metropolitan Statistical Areas (SMSA). These seven counties comprise less than 30 percent of the state's population. Also no other county will be added to the number of SMSA's until 1982. (16) Prediction of population in Iowa (61) indicates that population density in 1980 would be as low as 11.1 persons per square mile for Ringgold County and as high as 555 for Polk County. Eighty-nine (90 percent) of the counties have a population density of less than 90 persons per square mile. Currently, statewide population density in Iowa is about 50 persons per square mile and the distribution of this density is as follows:

Less than 20 persons per sq. mile	12 counties
20.1-30 persons per sq. mile	39 counties
30.1-50 persons per sq. mile	28 counties
50.1-70 persons per sq. mile	4 counties
70.1-90 persons per sq. mile	6 counties
90.1-200 persons per sq. mile	7 counties
200.1+ persons per sq. mile	3 counties
	99 counties

This population forecast also indicates that the population of about 40 counties will decrease from 1975 to 1980. For some counties this decline will continue until 2020. As one may expect, Iowa is moving toward urbanization and counties with a lower population density lose their residents to more densely populated areas.

By 1990, Iowa will have more than 3,088,000 population, an increase of 9.3 percent over 1970 figures. During the same period the number of people in the age group 0-19 will decrease from 1,081,140 to 896,840 (a 20.5 percent decrease) and the age group 65 and over will increase by 21.6 percent.

These changes in population mix and its distribution are important factors which deserve attention in health planning and the distribution of health care resources.

Roads and Transportation

Currently three interstate highways pass through Iowa, with a total of 728 miles in the system. The proposed expansion which will be carried out after 1978 will add an additional 61 miles to the system. Iowa has about 98,800

miles of rural and 13,430 miles of municipal roads. In 1974, Iowa ranked 9th nationally in total public road and street mileage with 112,510 miles.(62) Yet in spite of the large number of roads, it may take longer to get to a given place in Iowa than in most non-agricultural states. Iowa's secondary road system is set up on a "grid" basis so that virtually all roads run north-south or east-west. Therefore, driving to any given point is usually a "step" process rather than a "straight line" process.(60)

In 1975, Iowa had 1,534,884 registered automobiles and 1,865,754 licences drivers.(63) There are 18 urban transit operations in 19 major Iowa cities. These systems transported about 14.0 million passengers with a total of 292 vehicles. The cost of providing this service was about $6,879,817 and revenue was about $3,648,565. There are 83 taxicab operators in 61 cities throughout Iowa. In 44 of these cities, the taxicab is the only form of public transportation. Also, the 12 carriers which operate on regularly scheduled intercity routes in Iowa provided service to approximately 365 of the state's 950 cities and carried about 2,017,995 passengers. Also in 1975, there were 175 rural and special transportation services for the olderly, handicapped, and underprivileged in 92 of Iowa's 99 counties.(64)

Average travelling distance (ATD) within counties

Eighty-nine of Iowa's 99 counties are square or rectangular in shape, with areas ranging from 376 to 964 square miles. County roads are also in east-west or south-north direction and form a "grid" system. Assuming a uniformly distributed population and large enough, the number of roads in a county, the average length of travel may be calculated as follows:

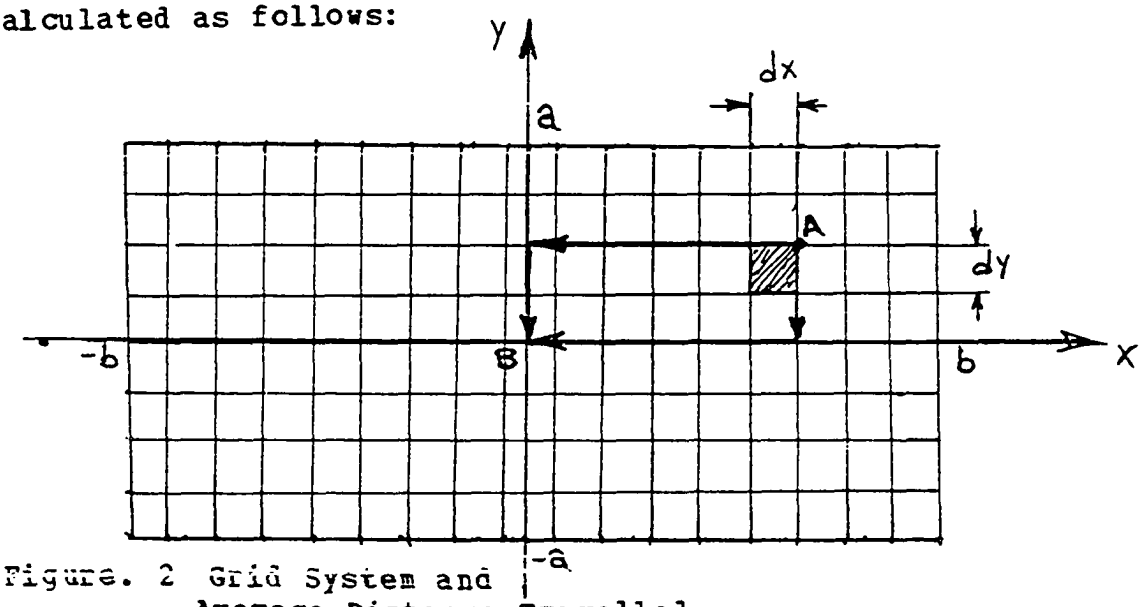

Figure. 2 Grid System and Average Distance Travelled.

Total one way travelled distance $d = 4P\int_{y=0}^{a}\int_{x=0}^{b}(x+y)\,dxdy =$

$2Pab(a+b)$

Where P is population density (persons per sq. miles) and total population = 4pab. Thus, the average travelling distance $r = \frac{d}{4Pab} = \frac{1}{2}(a+b)$.

Similarly, by assuming that hospitals are located at the center of the county, the average travelled distance can be

calculated for counties with irregular shapes. Using these assumptions, the value of r for Iowa's 99 counties is as shown in Table 8. The average distance from the center of one county to another is also calculated, to be discussed later.

Health Care Delivery

Based on the degree of specialization of staff and the type of services offered, health care institutions are categorized in three levels: Primary, secondary, and tertiary. There is no black and white distinction between each two adjacent levels of care, and one may find some overlap between two areas. However, the University of Iowa Hospital and Clinics are the only institutions equipped to deliver a full range of tertiary health care. This hospital also provides primary and secondary care for all Iowans as well as the residents of neighboring states. Other hospitals can provide primary and secondary services and, to a limited extent, some tertiary services. With the extra hospital bed capacity within the state, those counties which do not have any should not be hopeful of having their Certificate of Need (CON) approved by the Health Systems Agency and of establishing a hospital in their own communities. The trend is moving toward more centralization of hospital services. The expansion of existing facilities is more justifiable to

Table 8. Average travelled distance within each county.[1]

	County	r In Miles Average Travelled Distance		County	r In Miles Average Travelled Distance
01	Adair	11.7	34	Floyd	11.0
02	Adams	10.8	35	Franklin	11.8
03	Allamakee	12.4	36	Gremont	11.2
04	Appanoose	11.1	37	Greene	11.8
05	Audubon	10.3	38	Grundy	11.2
06	Benton	13.3	39	Guthrie	12.0
07	Black Hawk	11.7	40	Hamilton	11.8
08	Boone	11.8	41	Hancock	11.8
09	Bremer	10.3	42	Hardin	11.7
10	Buchanan	11.6	43	Harrison	13.0
11	Buena Vista	11.8	44	Henry	10.3
12	Butler	11.9	45	Howard	10.7
13	Calhoun	11.8	46	Humboldt	10.3
14	Carroll	11.8	47	Ida	10.3
15	Cass	11.8	48	Iowa	11.8
16	Cedar	11.8	49	Jackson	15.3
17	Cerro Gordo	11.8	50	Jasper	13.2
18	Cherokee	11.8	51	Jefferson	10.4
19	Chickasaw	11.1	52	Johnson	12.3
20	Clarke	10.1	53	Jones	11.9
21	Clay	11.8	54	Keokuk	11.8
22	Clayton	14.0	55	Kossuth	15.8
23	Clinton	13.8	56	Lee	13.3
24	Crawford	13.1	58	Linn	13.2
25	Dallas	11.9	58	Louisa	9.5
26	Davis	11.0	59	Lucas	10.4
27	Decatur	11.7	60	Lyon	12.6
28	Delaware	11.7	61	Madison	11.6
29	Des Moines	10.5	62	Mahaska	11.7
30	Dickinson	10.1	63	Marion	11.8
31	Dubuque	12.3	64	Marshall	11.8
32	Emmet	10.1	65	Mills	10.3
33	Fayette	12.3	66	Mitchell	10.6

[1]Source: Compiled from large scale maps produced by DOT for each county.

Table 8 (Continued)

	County	r In Miles Average Travelled Distance		County	r In Miles Average Travelled Distance
67	Monona	12.4	84	Sioux	13.7
68	Monroe	10.8	85	Story	11.8
69	Montgomery	10.2	86	Tama	13.3
70	Muscatine	10.8	87	Taylor	11.2
71	O'Brien	11.8	88	Union	10.2
72	Osceola	10.1	89	Van Buren	10.7
73	Page	11.4	90	Wapello	10.3
74	Palo Alto	11.7	91	Warren	11.8
75	Plymouth	14.4	92	Washington	11.7
76	Pocahontas	11.7	93	Wayne	11.7
77	Polk	11.9	94	Webster	13.3
78	Pottawattamie	15.6	95	Winnebago	10.1
79	Poweshiek	11.8	96	Winneshiek	13.1
80	Ringgold	11.3	97	Woodbury	14.9
81	Sac	11.8	98	Worth	9.9
82	Scott	12.1	99	Wright	11.7
83	Shelby	12.2			

HSA than the creation of new facilities. Also, in case of new discoveries which call for the provision of new types of services and treatments, larger hospitals are more apt to become pioneers in offering the new service, thus in turn creating more centralization.

Hospital beds per 1000 population are not evenly distributed, as indicated in Table 9. The number of hospital beds (excluding VA hospitals) per 1000 population ranges from 1.65 for Benton County to 15.83 for Johnson County. By taking VA hospitals into account, Marion County would have the highest ratio of 29.86 and the overall statewide average would be 5.89 beds per 1000 population. With a national average of 4.42, Iowa has a capacity of 33 percent more than the national average. However, even with that extra capacity there are nine counties in Iowa which have no acute general hospital facilities. The national health planning agencies strive for an intermediate target rate of 4.0 beds/1000 as a national average and a long term goal of 3.6 beds/1000.

It is too obvious to need elaboration that the availability of hospital beds and the number of physicians practicing within a county are closely interrelated. Physicians, especially those with a higher degree of specialization are always clustered around major hospitals and medical centers. Presently, the rate of physicians per 10,000 population ranges from 2.9 in Butler County to 53.7 in

Table 9. Population density, # physicians, hospital beds, EMT-A's for the population.[1]

County	A	B	C	D	E
01 Adair	17.3	4.0	2.98	20.3	26.0
02 Adams	14.5	3.2	5.68	6.5	69.4
03 Allamakee	24.0	5.2	4.83	8.5	17.1
04 Appanoose	29.0	4.6	5.07	0	1.3
05 Audubon	20.5	4.3	3.16	4.4	4.3
06 Benton	32.1	3.0	1.65	2.2	4.3
07 Black Hawk	239.7	8.7	8.74	7.2	10.9
08 Boone	45.8	6.4	4.95	4.9	3.4
09 Bremer	55.8	5.7	3.02	8.2	19.3
10 Buchanan	39.2	8.5	2.24	8.5	16.6
11 Buena Vista	36.7	5.2	4.19	16.7	18.1
12 Butler	29.4	2.9	0	43.2	48.5
13 Calhoun	24.2	7.2	2.96	14.5	36.7
14 Carroll	41.2	9.7	6.14	8.0	16.3
15 Cass	30.3	7.0	6.13	25.4	26.0
16 Cedar	29.2	4.1	0	30.5	47.7
17 Cerro Gordo	54.3	15.4	7.7	0.21	3.3
18 Cherokee	29.2	19.1	7.18	6.0	6.0
19 Chickasaw	30.0	4.6	3.29	27.7	18.3
20 Clarke	18.4	6.3	8.6	6.3	12.7

[1]Source: Compiled from:
1) Comprehensive Emergency Medical Services (EMS), State of Iowa.
2) Guide to the Health Care Field, Am. Hosp. Assoc., 1977 Edition.
3) Prediction of Population in Iowa 1970-2020. Unpublished data, Iowa Office for Planning and Programming.
4) Iowa Offical Register, 1975-1976.

A = Population density per square mile 1975.
B = Number physicians per 10,000 1975.
C = Hospital beds per 1,000 1974.
D = Emergency Medical Technician Ambulances per 10,000 1975.
E = Emergency Medical Technician Ambulances per 10,000 1975.

Table 9 (Continued)

	County	A	B	C	D	E
21	Clay	33.0	4.2	4.56	11.1	13.8
22	Clayton	27.0	5.7	3.14	0	30.0
23	Clinton	84.0	6.5	6.17	0	9.8
24	Crawford	25.2	3.3	4.99	8.9	14.5
25	Dallas	45.2	8.5	2.92	3.3	4.8
26	Davis	16.7	17.6	14.36	4.7	8.2
27	Decatur	17.5	6.4	4.2	10.8	14.9
28	Delaware	33.3	3.6	3.56	18.3	41.5
29	Des Moines	112.1	9.8	5.75	11.1	14.8
30	Dickinson	36.4	9.5	3.64	19.0	24.2
31	Dubuque	158.8	9.2	5.62	4.1	7.0
32	Emmet	35.2	9.3	6.47	5.0	8.7
33	Fayette	37.0	6.6	3.3	24.4	37.8
34	Floyd	40.3	7.4	4.38	4.9	8.4
35	Franklin	22.9	3.7	3.88	13.4	27.1
36	Fremont	17.5	6.5	8.64	31.7	38.5
37	Greene	21.7	8.1	6.40	6.5	23.8
38	Grundy	27.6	4.3	3.04	9.4	10.0
39	Guthrie	21.7	6.2	2.86	17.0	29.8
40	Hamilton	31.4	6.0	4.08	14.9	18.8
41	Hancock	23.5	4.5	2.39	0	38.8
42	Hardin	38.3	5.0	3.64	23.2	41.8
43	Harrison	24.1	5.9	2.74	16.1	23.4
44	Henry	40.1	10.2	3.40	6.2	6.2
45	Howard	24.5	5.2	3.64	0	6.95
46	Humboldt	28.4	4.8	2.59	28.3	36.3
47	Ida	20.7	4.4	6.71	30.2	75.0
48	Iowa	26.4	6.5	2.85	4.5	11.1
49	Jackson	33.1	7.0	12.39	30.0	52.8
50	Jasper	49.0	5.8	2.99	14.1	19.6
51	Jefferson	32.6	8.4	6.39	9.1	14.5
52	Johnson	125.0	53.7	15.83	1.8	3.8
53	Jones	34.3	4.5	5.19	32.9	42.7
54	Keokuk	23.7	4.3	0	0	4.4
55	Kossuth	23.5	4.7	1.74	2.6	6.0
56	Lee	78.9	8.9	7.67	2.2	3.7
57	Linn	232.9	9.2	5.59	3.7	5.6
58	Louisa	27.0	5.5	0	6.4	12.6
59	Lucas	24.0	5.7	7.99	14.4	17.5
60	Lyon	22.3	3.0	2.29	9.9	11.4
61	Madison	21.8	5.6	3.24	0	1.6
62	Mahaska	38.6	8.6	4.26	0.45	6.3

Table 9 (Continued)

	County	A	B	C	D	E
63	Marion	48.0	8.4	3.15	8.8	14.9
64	Marshall	74.4	11.2	5.15	5.4	9.3
65	Mills	28.2	3.2	0	27.0	45.3
66	Mitchell	27.3	9.4	4.87	6.3	18.1
67	Monona	17.3	5.8	3.97	31.5	55.
68	Monroe	21.4	6.4	5.58	0	6.5
69	Montgomery	30.4	7.7	5.33	12.4	32.5
70	Muscatine	89.5	4.6	2.93	0.25	0.5
71	O'Brien	30.8	6.7	4.35	41.8	51.1
72	Osceola	21.6	5.8	4.31	29.1	29.0
73	Page	35.6	9.9	5.66	26.2	29.7
74	Palo Alto	23.8	5.9	4.64	27.0	31.0
75	Plymouth	27.9	4.9	2.82	10.8	24.3
76	Pocahontas	20.8	5.8	2.65	15.7	25.0
77	Polk	508.3	13.8	6.42	4.9	7.6
78	Pottawattamie	89.5	7.5	6.22	5.7	10.1
79	Poweshiek	34.4	6.4	4.29	3.5	14.9
80	Ringgold	11.5	3.2	5.01	16.2	3.2
81	Sac	26.4	5.2	2.62	0	19.9
82	Scott	331.5	9.4	4.57	2.7	5.2
83	Shelby	26.2	5.2	5.47	23.4	18.3
84	Sioux	38.0	4.4	4.16	26.1	35.8
85	Story	121.3	10.0	3.84	9.0	12.2
86	Tama	28.4	3.4	0	56.7	78.4
87	Taylor	15.7	7.2	0	8.5	16.9
88	Union	30.4	10.8	6.41	9.3	16.9
89	Van Buren	16.7	8.6	0	1.2	2.5
90	Wapello	91.0	10.0	8.18	0	9.9
91	Warren	56.5	3.1	0	7.7	12.0
92	Washington	30.8	5.7	2.86	10.3	21.7
93	Wayne	15.7	8.3	4.42	6.0	6.0
94	Webster	65.8	11.6	7.26	2.5	9.7
95	Winnebago	33.4	5.2	2.76	4.5	28.1
96	Winneshiek	31.1	6.5	3.93	11.2	14.4
97	Woodbury	121.6	10.5	8.13	14.3	20.1
98	Worth	24.7	4.4	0	0	0
99	Wright	29.5	8.8	3.76	49.4	68.2

Johnson County. However, there is no significant correlation between the ratio of physicians per 10,000 and the death rate in different counties.

Iowans have used more medical and health care services than most of the states in the nation. According to the Health Systems Agency research,(60) the following significant differences are found between Iowa and the rest of the nation:

* Iowa's 1975 rate of admission/1000 was 188 (199 in 1976) compared with a U.S. average of 157 (19.7 percent higher).

* Iowa's 1975 rate of admission/1000 was higher than 47 of the 50 states.

Previously it was mentioned that on a state-by-state basis, there is a positive correlation (R^2=.85) between the availability of hospital beds per 1000 population and admissions/1000.

* Iowa's 1975 patient day/1000 use rate was 1459 (1949 in 1976) compared to the national average of 1209 (21 percent higher).

The report also suggests that patient day use rate could be reduced by at least 10 percent without adversely affecting health. However, some of the controversial issues are not agreed upon by all parties involved.

Under the existing circumstances the estimation of bed requirements in Iowa is summarized as follows: During 1976, there were 565,432 admissions to 135 general short term hospitals, which is 197 admissions/1000 or 1521 patient

days/1000. By dividing 1521 by 365 days of the year, 1521/365 = 4.16, the Average Daily Census (ADC) or average daily bed requirement per 1000. Furthermore, it should be realized that in addition to seasonal fluctuations, the process that generates demand for hospital services has a Poisson distribution.(58) Having a Poisson distribution that the expected value of its random variable is estimated to be λ, by normal approximation, the probability that the demand exceeds the capacity $\lambda + 3\sqrt{\lambda}$ is about.0013. Thus a capacity of $1521 + 3\sqrt{1521} = 1638$ patient days will meet the needs of the community 99.87 percent of the time. If a higher assurance is required in meeting the demand, one may use $1521 + 4\sqrt{1521} = 1677$ patient days/1000. Similarly 1638/365 = 4.48 beds/1000 or 1677/365 = 4.59 beds/1000. The rate of 4.0 beds per 1000 can suffice only by drastically reducing admission rates, length of stay, or both. That calls for a significant deviation of resources in expanding outpatient treatment facilities.

Emergency Medical Services

Accidents and heart disease are the major causes of death in Iowa. In 1975, highway accidents in the state took the lives of 674 persons and another 3000 were disabled permanently.(63,63) Major cardiovascular diseases killed 16,129, 50 percent of whom died before reaching a hospital.

Statistics indicate that 20 percent of accidental and coronary deaths could have been prevented if proper emergency medical services had been immediately available to the victim.(43) In response to the importance of this problem, the Governor's Emergency Medical Services Advisory Council has launched an effort to provide emergecny medical services to Iowa citizens. The complexity of the problem requires the cooperation of numerous agencies including the organizations listed below:

American College of Emergency Physicians
American College of Surgeons
Area Colleges, Adult Education Division
College of Osteopathic Medicine
Communication Division, Dept. of General Services (Iowa)
Comprehensive Health Planning Agencies
County Communication Commissions
County Crime Commissions
Creighton University School of Medicine
Emergency Dept. Nurses Association
Emergency Medical Services Administrative Assoc.
Fire Service Extension, Iowa State University
Health Systems Agency
Law Enforcement Administrators Telecommunication Advisory Committee
Iowa Ambulance and Rescue Assoc.
Iowa Firemen's Assoc.
Iowa Dept. of Public Safety
Iowa Dept. of Transportation
Iowa Heart Assoc.
Iowa Highway Patrol
Iowa Hospital Assoc.
Iowa Medical Assoc.
Iowa Office of Planning & Programming
Iowa Regional Medical Program
Iowa Society of Osteopathic Physicans and Surgeons
Iowa State Dept. of Public Instruction
National EMT-A Registry
Program in Health Occupations Education and Adult Education Division of the Area Schools

State Trauma Society and other Specialty
Physicians Assoc.
University of Iowa School of Medicine
U.S. Dept. of Health, Education and Welfare
U.S. Dept. of Transportation

For the sake of planning, the Governor's EMS Advisory Council has categorized this service into four levels. Each level, with regard to the degree of sophistication and preparedness, should meet a certain minimum specific criterion established by the Council. The four levels of emergency services are identified as follows:

Community Emergency Service: Service will have the capability to render resuscitative and life support services; capability for prompt diagnosis and treatment of life-threatening conditions--specifically including cardiac arrythmia, shock, and respiratory deficiency; and have standing agreement with hospital(s) for transferal of patients, as appropriate.

Regional Emergency Service--Type A: Service will have staff and equipment required to provide the medical and surgical specialties necessary to render resuscitative and life support care to critically injured and seriously ill patients of all ages, plus specialty coverages available in less than 15 minutes--in internal medicine, general surgery, neurosurgery, orthopedics, obstetrics, anesthesiology, and pediatrics.

Regional Emergency Service--Type B: This type of service is similar to Type A, without neurosurgery.

Comprehensive Emergency Service: Service will be able to deliver complete and advanced medical care for all emergencies.

The affect of categorization of hospitals has been challenged by some authorities in this field. Some believe that this categorization does nothing but create unwanted competition between hospitals. There is always pressure to upgrade the categorization of a hospital in order to save its pride and reputation. If the intent of this categorization is to determine how patients should be taken to which hospital, then the burden would be on EMT-A's to decide where they should be taken. Although the operation of Emergency Services is not always financially self-sufficient, its existence has the significance of sophistication and reputation which is important to a hospital and its medical staff. Delivery of emergency medical services involves utilization of the following resources:

-Trained personnel
-Ambulances or other vehicles loaded with emergency equipment
-Properly maintained roads
-Communication networks and dispatching facilities
-Hospital facilities
-Public relations and community cooperation

Since 1971, EMS courses have been conducted through Iowa. Aimed at the education of qualified emergency medical

personnel, through August 1975, the effort has resulted in providing 3013 certified emergency medical technicians (EMT) in Iowa.(43)

The distribution of EMT's and ambulances in Iowa, like the distribution of hospitals has not occurred on a planned basis. Assuming a one-to-one ratio between the number of EMTs and EMT-As, Table 9 shows that the rate of ambulance (and EMTs) per 10,000 population varies significantly from county to county. This rate is as low as 0 and as high as 56.7.

Iowa's transportation facilties could be improved and the distances shortened by making diagonal roads to supplement the present "grid" system. Currently, the 113,000 miles of public roads and highways amount to approximately 2.8 percent of Iowa's land area.(63) However, with the high cost of road building and the energy shortage which encourages public transit system, the possibility of building new roads is remote.

CHAPTER IV. HEALTH PLANNING AND ALLOCATION OF HEALTH CARE RESOURCES

Until recently there was a common approach in which the operation of health care institutions was viewed as a philantropic activity and not as an industry. Based on that attitude, these institutions have gained special legal and social privileges, such as tax exemption, immunity in professional liability and labor practices. Still a significant number of hospitals and health care institutions are classified as non-profit organizations and are tax exempt. By the same token, in some states hospitals were not held liable for the outcome of services they delivered. Also, until August 1974, the National Labor Relations Board (NLRB) did not have jurisdiction over the labor practices of non-profit hospitals.

Yet the experience showed that free market and self-regulatory practices in the operation of health care institutions has not produced agreeable results. Thus, it was felt inevitable that this part of the economy should be viewed as an industry, its expansion controlled, and its objectives modified. Acceptance of, and reliance on regulatory agencies is a well-established legislative practice in American society. Beginning with the creation of

the Interstate Commerce Commission, the first statutory agency, in 1887, regulatory agencies have taken control of almost every aspect of the American economy, from atomic energy to labor practices. Now there are numerous laws in effect and more to come to control many facets of the health care delivery system. The intention of these laws is to give direction to one or more of the following areas:

-Cost and price regulation
-Regulation of capital expenditures
-Regulation of professional performance
-Regulation of institutional quality
-Personnel licensure
-Regulation of health professions education
-Regulation of private health insurers

The most recent and comprehensive laws, to which the subject of this research is related, are Public Laws 92-603 and 93-641. The major provisions of PL 92-603 are: Utilization control or Professional Standard Review Organization (PSRO), cost control, and capital expenditure control. The National Health Planning and Resource Development Act of 1974, namely PL 93-641, supercedes or supplements all previous health planning laws and has the following major provisions:

1 - Provision of adequate primary health care services for the economically and medically underserved (convenient accessibility).

2 - Creation and expansion of multi-institutional services for coordination or consolidation of institutional services to prevent wasteful duplication.

3 - Development and expansion of medical group practices (Health Maintenance Organizations, HMO) for out-of-hospital treatment of patients when

possible.

4 - Increase in training and use of paramedical staffs (such as nurse practitioners and physician assistants).

5 - Development and encouragement in the creation of multi-institutional shared support services in order to promote efficiency and avoid unnecessary duplication.

6 - Promotion of the activities that improve the quality of health care.

7 - Maintainance of health care institutions at appropriate levels of capacity to meet the needs of communities on a geographical basis.

8 - Support and promotion of activities for disease prevention and research on the effects of malnutrition and environment on the health of society.

9 - Adoption of a uniform and simplified cost accounting method suitable for the current reimbursement system and cost control activities.

10 - Promotion of awareness and education of the public in health related matters.

In this law it is stated that "equal access to quality health care at a reasonable cost is a priority of the federal government." Also, it has been stated that "(a) a lack of uniformly effective methods of delivering health care; (b) a maldistribution of health care facilities and manpower, and (c) the increasing cost of health care" are reasons for the passage of this law.

The focal point of this research is to provide analysis and solution to "...equal access...at a reasonable cost." As far as this research is concerned, the organizational

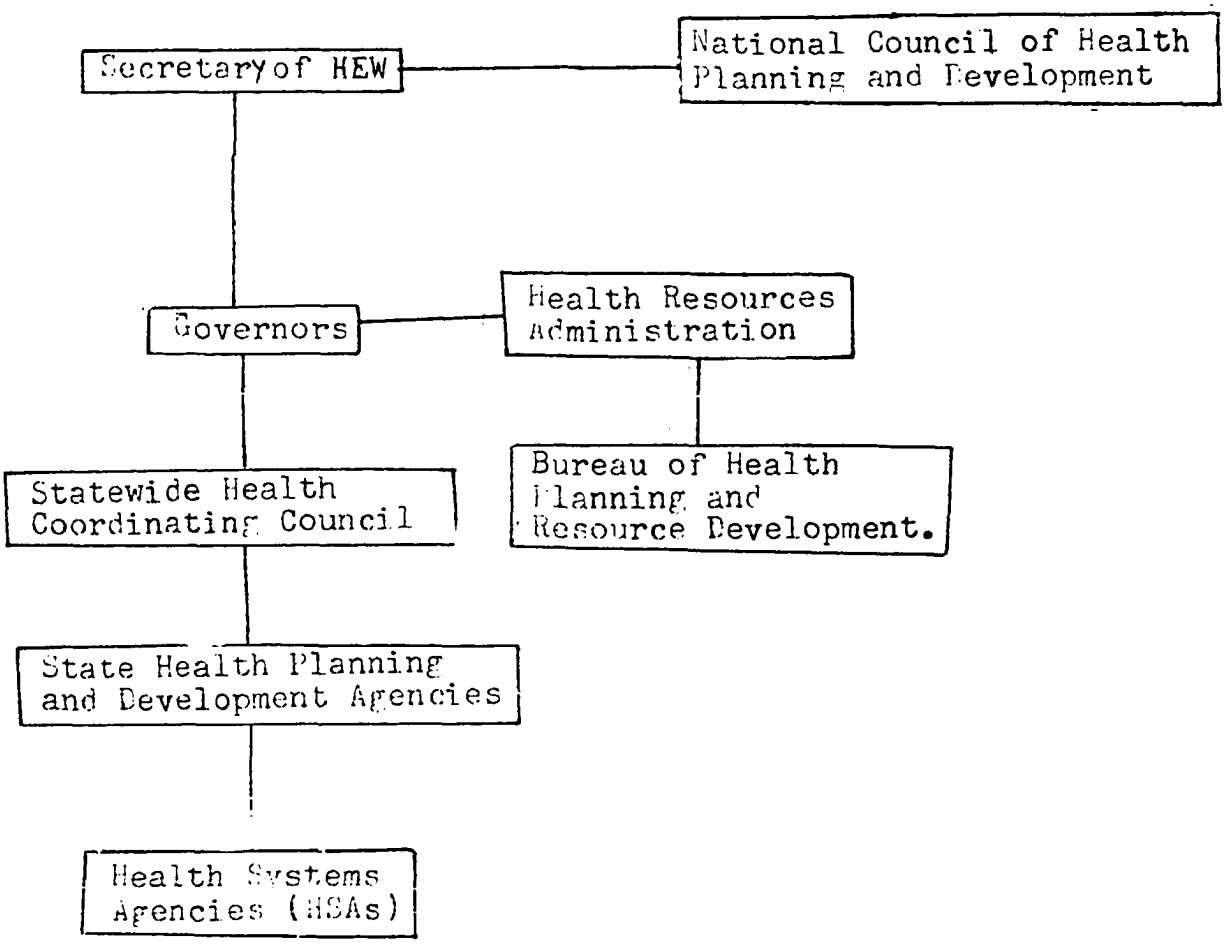

FIG. 3 National and local authorities involved in Health Planning and their relationship.

structure for implementation of this law is shown in Figure 3.

On the national level, the National Council of Health Planning and Development is formed of 15 representatives of consumers, providers, and public interest groups, whose members are appointed by the Secretary of DHEW. The law mandates the governors of states to establish the organizational structure and to set guidelines for its implementation. Also, in order to facilitate planning, states should be divided into regions and the needs of each region be evaluated accordingly. However, each regionalization and planning criterion should meet the requirements announced by DHEW or specified in this law. Basically the law is a combination of three previously-existing programs, Comprehensive Health Planning, Regional Medical Programs, and Hill-Burton Programs.

Previously, Iowa was divided into 15 areawide Health Planning Councils which were under the direction of the Iowa Comprehensive Health Planning Advisory Council. As the new law calls for reorganization of the health planning structure, 90 of Iowa's counties are divided into five health service areas. Seven counties in the southwest and two counties in the east central part of the state are under the jurisdiction of Nebraska-Iowa (Midland) and Illinois-Iowa respectively, as shown in Figure 4.

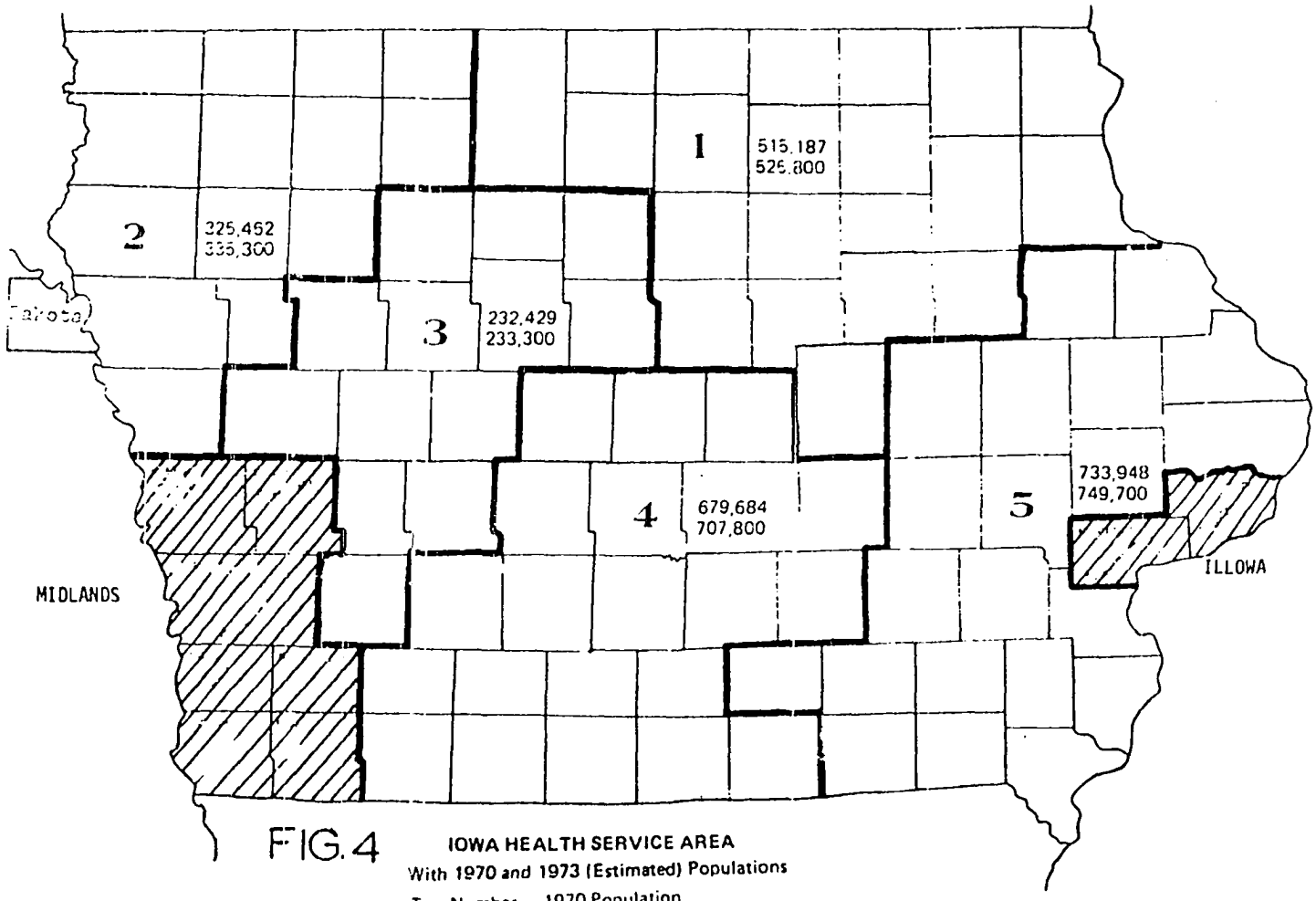

FIG. 4 **IOWA HEALTH SERVICE AREA**
With 1970 and 1973 (Estimated) Populations
Top Number – 1970 Population
Bottom Number – 1973 (Est.) Population

The Office for Comprehensive Health Planning which was under the Office for Planning and Programming has now been replaced by the Iowa State Health Coordinating Council (SHCC) and is under the Iowa Department of Health. There are also specific guidelines, which must be followed, regarding the number of consumers, providers, insurance companies, and equal rates of the two main political parties in each council or agency.

The Iowa Comprehensive Health Plan, in pursuing its responsibilities, has adopted the following principles: (28)

1. "Health decisions should be made at the local level." The Iowa Comprehensive Health Plan strongly relies on input from all concerned citizens and has given assurance that its successor also will follow this pattern and seek the opinion of all informed and knowledgeable individuals. As the methodolgies used in the health planning field are new and not yet tested, its successful implementation depends on impartial consultation of all parties involved. Public hearings are usually held before entering a decision.

In spite of the goal of local solutions to the health care problem, the existing regionalization method is in contradiction with this goal. The counties which form a region are hundreds of miles apart and coordination between the needs of these counties is only remotely possible. For instance, Kossuth and Clayton counties in Area 1, Emmet and Moncna in Area 2, Adair and Cass Counties in Area 3, Marshall and Taylor in Area 4, and Dubuque and Lee Counties in Area 5 are too far apart to be considered in one planning area. The

criterion used for the establishment of a health services area is population and not square miles of area or distance.

2. "Consumer as well as provider participation is a primary requirement of all health planning and programming activities." There is a specific guideline in PL 93-641 about the number of each interest groups represented at various levels of decision-making. Democratic participation of providers and consumers in the decision-making process makes both parties aware of each others needs and problems. Strong emphasis is placed on impartial and pluralistic fact-finding and decision-making.

3. "...plans for purposed health programs and projects should be based on identified needs of people...." The goal is to correct the maldistribution and ineffective delivery of health care services. The implied intent is to redirect the flow of services to under-served or poor sections of the population: i.e., "...meeting the special health needs of the poor and near poor is a responsibility that must be shared by all components of the Iowa health systems...."(28) It should be mentioned that providing the services and educating the people to correct their own personal health practices are two different problems. And one does not necessarily lead to the other. In this plan it is also stated that: "...the sponsors of a proposal should identify the target population to be served, should verify and document the health needs of the target population that will be met by the proposed project and shouuld present economic feasibility information to demonstrate that the project can be fully utilized by the target population....". The burden of proof is on the sponsor of a proposal. If the needs of an area remain neglected and providers show no interest in serving it, no provision is made in this plan for taking initiatory actions on the part of health planning agencies. This problem is associated with the goal of "equal accessibility," which will be discussed later.

4. "...comprehensive health services should be readily accessible to all citizens of the state...." With the limited resources and manpower available in the health care industry, oversupply of services in one area will deprive other parts of a community. Thus, the concept of accessibility implies redistribution of health care resources.

The incentives for redistribution of services on the national and local basis are of two general forms:

a. Positive incentives: Obtaining new markets and attracting a neglected or under-served area into the health care market. Experience has shown this form of incentive has no significant (if any) effect on the distribution of health care institutions. Hospitals maintain occupancy at a certain level even if there is an oversupply of services in that area. It was noted previously that having an excess bed capacity (bed/population) leads to higher admission rate per population. There was a close positive correlation between these two variables (R^2=.85). Thus, there is not much of an incentive for dispersion and reaching the outlying population.

b. Negative incentives: denying payments, limiting increases, preventing construction or requiring that admissions have third party approval, etc.

...authority is given to Comprehensive Health Planning (CHP) for review of all proposals for capital expenditures when federal reimbursements (Medicare, Medicaid, and Maternal and Child Health payments for depreciation and interest) are anticipated for:
1-Plant and equipment over $100,000; or,
2-Changes in bed capacity; or,
3-Substantial change in service....(29)

The CHP derives its authority from Section 1122 of the Social Security Amendment of 1973 (Public Law 92-603). It is also stated in the plan that:

> ...when a proposal is not submitted for review, or it is found not in accordance with the standards, criteria, and/or plans developed by the CHP agency, federal reimbursement for depreciation and interest on capital may be denied upon the decision of Secretary of the Department of Health, Education, and Welfare.

This approach may limit the growth of health care facilities in one area but does not necessarily provide services for rural and/or under-served areas. More positive action is needed for getting the doctors into rural and remote parts of the country.

> In Mexico, for example, most medical degrees are awarded by the National University of Mexico, with a condition that the new graduate spend a period of "social service" in a rural district.

Recently, this period was increased from six months to one year. Iran uses military conscription laws as a vehicle for getting manpower into outlying areas through a Rural Health Service Corps (and those exempt from military service should serve a minimum of two years in rural areas before they can practice medicine in larger cities, author). The Soviet Union has long required a three year period of rural service for most, though not all, new graduates. While the United States has not gone as far as these foreign examples, the National Health Service Corps, set up under the Emergency Health Personnel Act of 1970, has been a step in this direction. Under this law physicians, dentists, nurses, and some other health professionals are brought into a federal program which in effect meets military obligations. They are

then sent to communities of need, mostly rural, where they serve the poor without charge and others on a fee basis; sometimes they work in organized health units and sometimes in traditional private offices. Of about 5,000 communities estimated to need such assistance, a few hundred have so far been helped.(82)

However, with the voluntary draft situation, the effects of this plan will be diminished. As a result, 140 counties in the U.S. still do not have a single doctor.(82) On October 12, 1976, the Health Professions Educational Assistance Act, Public Law 94-484 was signed into effect. It "will be instrumental in solving the problems of geographic and specialty maldistribution" of health care professionals. The new law continues financial support to health profession schools through capitation grant, but now requires medical schools to provide an annually-increasing percentage of affiliated residency positions for individuals in primary care specialties and expands the medical school scholarship program, while requiring recipients to serve in health-manpower shortage areas for at least two years. It also establishes a federal program of insured loans for health profession students and revises the National Health Service Corps program. Some states have devised their own means of meeting the needs of the rural areas.

> A $1.5 million state grant program to get physicians to practice in 68 rural and smaller Ohio communities was proposed Tuesday by Gov. James A. Rhodes, who submitted his plan to the Ohio General Assembly. Under Rhodes' plan, doctors of medicine or osteapathy would receive $50,000 grants for participating full time or not less than three years in a community where the services of a family practitioner are not reasonably and readily available. The grant would be free of State or municipal income taxes....(27)

> All proposed health programs should include mechanisms to assure that services provided to the people of Iowa are of high quality....

Assessment of quality in the delivery of health care is a complex and difficult task to pursue. Lack of standards for the quality of health care and variety in the level of expectation of different groups of society make the evaluation subjective and immeasureable. So far no significant action has been taken by health planning authorities to or assess the quality of health care.

6. "...proposed health programs and projects should be designed to provide the most benefits at the least possible cost to the patients, and consistent with appropriate quality control." When it comes to the cost of health care, state and federal agencies mainly use their bargaining power and cost control authority to reduce the cost for publicly supported patients. Consumers whose expenses are paid by themselves or by private insurance companies do not benefit from that cost control endeavor. In many instances this group of patients has to carry the burden of the expenses not acceptable to the government. And this price discrimination is becoming a common practice, as in New Jersey, where "...hospitals may charge Blue-Cross patients less than other insured patients, according to a January 13 (1976) ruling by the State Supreme Court.(15)

7. "...proposed health programs and projects should reflect a concern for the human rights of patients...." This statement refers to privacy of information, patients' access to their files, and consent and information about the type of treatment they are going to receive and possible side effects of such treatments.

8. "...a more concentrated effort and consequently more health dollars must be spent on disease prevention through Good Environmental Practices, Public Health Services, Occupational Standards, and Health Educations...."

The consitutionality of health planning laws and regulatory control has been challenged in many instances. Even though three years have passed since the passage of this law, there has been reluctance on the part of state authorities to implement it fully. Also, in those states which have apparently tried to implement it, state officials do not believe they should do what they are doing.

> A $59,000 state appropriation for a new health planning agency--which almost everyone agrees will not do much that is not already being done--was approved Wednesday of a Joint Appropriations Subcommittee of the Iowa Legislature.
>
> The agency, to be called the Health Planning and Development Agency, is required by the federal government.
>
> Last week the Committee balked at approving a request for money for the agency, after State Health Commissioner Norman Pawlewski said he could not defend the proposed budget for the body.
>
> Representative George Cusack (Democrat, Davenport) said the proposed agency is "no doubt duplicacy," and he added that committee members had discussed their dissatisfaction with officals from the Dept. of Health, Education, and Welfare. "Our frustration about the federal act were pretty well made known," said Cusack.
>
> ...Senator William Gluba (Democrat, Davenport) said the new agency would do some of the regulatory work now being performed by the Office for Planning

> and Programming." If that's all they do between now and a year from now, it would be a substantial contribution."(35)

On the other hand, study shows that the cost of health planning agencies per capita in comparison to health care is not significant. In September 1974, a study conducted by the Task Force on Model District Health Departments, Environmental Health Committee, Comprehensive Health Planning Council of the State of Iowa showed that the cost of health planning for a hypothetical region combined of 6 counties would be $7.87 per capita. This is based on the assumption of a total population of 176,565 and on urban/rural ratio of 57.2% and 42.8%.(28)

Regarding the fact that health expenditures during 1974 were $484.53 per capita, spending an additional $7.87 (1.7% of total cost) for planning is not significant. Also, there is a strong belief on the part of some groups that the newly-proposed health planning laws will have a significant impact on cost containment and proper distribution of health care resources.

CHAPTER V. ACCESSIBILITY AND OPTIMUM DISTRIBUTION OF HOSPITALS

Health care institutions, based on the type and scope of their work, can be divided into two major categories, outpatient and inpatient institutions. The Joint Commission on Accreditation of Hospitals defines an outpatient institution as follows:

> An organizational unit of the hospital that is designed to support the provision of nonemergency health care service to patients who do not remain in the hospital....

Inpatient institutions are also divided in two categories: long term and short term facilities. The distinction between these two is made as follows:

> Short-term--Average length of stay for all patients is less than 30 days for over 50 percent of all patients admitted to units where average length of stay is less than 30 days....(69)
>
> Long-term--Average length of stay for all patients is 30 days or more or over 50 percent of all patients admitted to units where average length of stay is 30 days or more.(2)

The Iowa Department of Health has classified long term facilities in the following three categories:(30)

- -Skilled Nursing Care Facilities
- -Intermediate Nursing Care Facilities
- -Residential Care Facilities

The focal point of this research is to analyze the problems associated with the delivery of care by short term hospitals. The criterion established by the Hospital Accreditation program of the Joint Commission(30) for eligibility for an accreditation survey is that a hospital:

1. Shall be located within the United States or one of its territories or shall be owned or controlled by the United States or by an entity organized under the laws of the United States or one of its states' territories or possessions;

2. Shall have a current license to operate as required by its appropriate governmental jurisdiction;

3. Shall maintain at least six inpatient beds, which shall be continuously available for the care of patients who stay on the average in excess of twenty-four hours per admission;

4. Shall have been in operation under the present ownership for at least six months prior to survey;

5. Shall have a governing body and an organized medical staff and nursingservice and provide for the following:

   Assurance of quality of professional services
   Building and grounds safety
   Dietetic services
   Emergency services
   Functional safety and sanitation
   Infection control
   Medical record services
   Nuclear medicine services
   Pathology services
   Pharmaceutical services
   Physical science services
   Policy on patients' rights
   Professional library services
   Social services
   Special care services

6. Shall have at least one of the following clinical servcies: medicine, obstetrics-gynecology, pediatrics, or surgery;[1]

7. Shall provide that only a member of the medical staff shall admit a patient to the hospital, either individually or in cooperation with a licensed practitioner with clinical privileges;

8. Shall provide that only a licensed practitioner with clinical privileges shall be directly responsible for a patient's diagnosis and treatment within the area of his privileges, that each patient's general medical conditions shall be the responsibility of a physician member of the medical staff, and that other direct medical care to patients shall be provided only by a member of the house staff or by other specified professional personnel or by allied health personnel acting under the supervision of a licensed practitioner with clinical privileges;

9. Shall provide registered nurse supervision at all times and such other nursing services as are necessary for continuous care;

10. Shall complete and return an Application for Survey;

11. Shall provide the information requested in the Hospital Survey Questionnaire;

12. Shall provide without restriction by reason of race, color, or national origin.

Except for requirements 1, 2, 4, and 12, registration with and membership in the American Hospital Association is not different from that of the JCAH's.(2) Hospitals from other parts of the world can also be a member of the American

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[1]Shall have anesthesia services as well.

Hospital Association. Compliance with and being under the jurisdiction of United States laws is not a requirement for membership in the AHA. The prevailing labor and human relation practices of a hospital also will not bar it from membership to AHA.

The American Hospital Association and Joint Commission on Accredition of Hospitals derive their authority from the hospital members and other professional groups. JCAH, whose history goes back to 1918, is jointly sponsored by the American Hospital Association, the American College of Surgeons, the American College of Physicians, and the American Medical Association in order to improve the quality of medical practices and delivery of health care services.

The scope of hospital services has a wide span which may vary from primary to secondary and highly specialized tertiary care. The type of services which may be provided by hospitals are enumerated as follows:(2)

1 - Postoperative recovery room
2 - Intensive cardiac care unit
3 - Intensive care unit
4 - Open-heart surgery facilities
5 - Pharmacy with full-time registered pharmacist
6 - Pharmacy with part-time registered pharmacist
7 - X-ray therapy
8 - Cobalt therapy
9 - Radium therapy
10 - Diagnostic radioisotope facility
11 - Therepeautic radioisotope facility
12 - Histopathology laboratory
13 - Organ bank
14 - Blood bank
15 - Electroencaphalography
16 - Respiratory therapy department

17 - Premature nursery
18 - Self-care unit
19 - Skilled nursing or long term care unit
20 - Hemodialysis (inpatient)
21 - Hemodialysis (outpatient)
22 - Burn care unit
23 - Physical therapy department
24 - Occupational therapy department
25 - Rehabilitation inpatient unit
26 - Rehabilitation outpatient unit
27 - Psychiatric inpatient unit
28 - Psychiatric outpatient unit
29 - Psychiatric partial hospitalization program
30 - Psychiatric emergency services
31 - Psychiatric foster and/or home care
32 - Psychiatric consultation and education program
33 - Clinical psychology service
34 - Organized outpatient department
35 - Emergency department
36 - Social work department
37 - Family planning services
38 - Genetic counseling services
39 - Abortion service (inpatient)
40 - Abortion service (outpatient)
41 - Home care department
42 - Dental services
43 - Podiatric services
44 - Speech pathology services
45 - Hospital auxiliary
46 - Volunteer services department
47 - Patient representative services
48 - Alcoholism/Chemical dependency inpatient unit
49 - Alcoholism/Chemical dependency outpatient unit
50 - TB and other respiratory diseases unit
51 - Neonatal intensive care unit

Besides the self-regulatory and professional organizations, governmental and health regulatory agencies have also more detailed criteria and standards which require a certain level and mix of the previously mentioned services to be provided by the hospitals. These criteria are used for evaluating the professional performance and licensing of the hospitals. For instance, once a hospital is established,

based on its size and location, it must be a participating member of regional emergency medical services of that area. Some of these requirements established by the Comprehensive Emergency Medical Services (EMS) plan for the State of Iowa are as follows.

Community emergency services

1 - Blood obtainable from established bank or local donor (available to the patient in less than one hour).

2 - Laboratory capability available in less than 30 minutes.

3 - Radiological technician available in less than 30 minutes.

4 - Intensive care/coronary care.

5 - Staffed operating room available in less than 30 minutes.

6 - Two-way communication with local ambulance service.

Also active medical staff with the minimum following capabilities:

1 - A participating general surgeon.

2 - A physician able to diagnose and treat cardiac arrythmias and myocardial infractions, and administer cardiac drugs.

3 - A board-certified anesthesiologist, or a member of the American College of Anesthesiologists who is not

board-certified. (If the above mentioned specialty is not available, then a certified Registered Nurse Anesthetist should be utilized.)

4 - Emergency room staff with annual training in cardio-pulmonary resuscitation.

Regional emergency service--Type A

1 - 24-Hour laboratory coverage, technician in-house or available on call in less than 15 minutes.

2 - A blood bank, as defined by the American Hospital Association (available either in-house or in the community).

3 - 24-Hour radiological coverage, including angiographic capability available on call in less than 15 minutes.

4 - Operating room available promptly.

5 - ICU and/or CCU facility.

6 - Two-way communication with local ambulance service.

7 - Helicopter landing space.

Regional emergency service--Type B

Under this category the hospital's facility will be the same as in Type A, excluding helicopter landing space.

Comprehensive emergency services

1 - In-house coverage 24 hours a day by designated medical specialties that include obstetrics, general surgery, thoracic surgery, neurosurgery, orthopedics, cardiovascular

surgery, urology, pediatrics, internal medicine, and anesthesiology.

2 - A blood bank, as defined by the American Hospital Association.

3 - 24-Hour in-house laboratory coverage.

4 - 24-Hour in-house radiological services including angiographic capacity.

5 - Operating rooms immediately available for emergency surgery.

6 - Intensive care unit-coronary care unit.

7 - Two-way communication with local ambulance services.

8 - Helicopter landing space.

Results of categorization survey (conducted by EMS Council) indicate that the hospitals that meet the categorization criteria are not evenly distributed throughout the state. The frequency distribution of hospitals by the categorization criteria currently is as follows:

Comprehensive Emergency Service (University of Iowa Hospitals and Clinics, Iowa City)	1
Regional Emergency Service--Type A	12
Regional Emergency Service--Type B	16
Community Emergency Service	71
Immediate Aid Outpatient Service	50
Total	140

As of September 1975, the distribution of these facilities throughout the state is shown in Figure 5.

As it can be seen from Figure 5, there is no emergency care facility located in eight counties in Iowa. It should

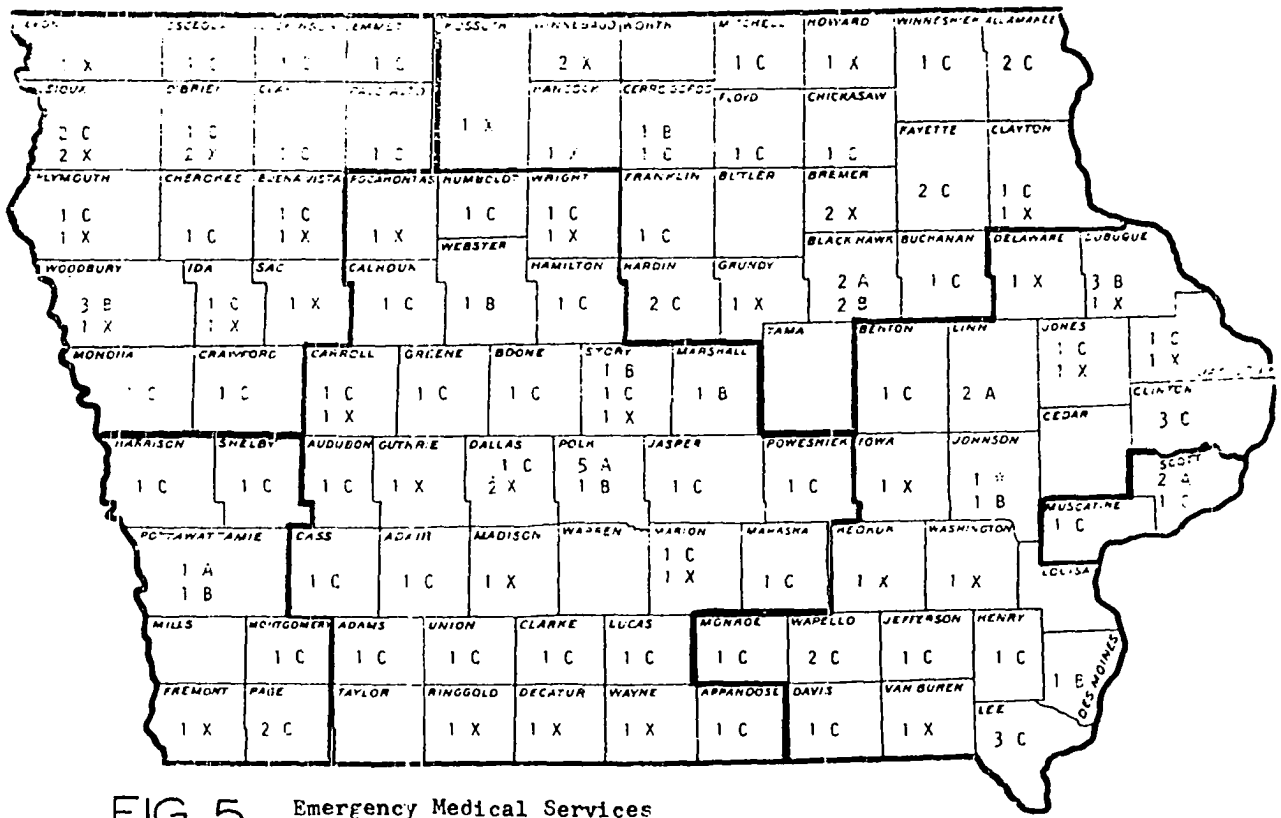


FIG. 5 Emergency Medical Services
Categorized hospitals in Iowa
September, 1975

KEY

* Comprehensive Emergency Service
A Regional Emergency Service (Type A)
B Regional Emergency Service (Type B)
C Community Emergency Service
X Immediate Aid Outpatient Service

Number indicates number of hospitals with that type of categorization

Letter indicates type of categorization

not be assumed that once a hospital is placed in a certain category it necessarily meets all the standards and requirements. According to the Iowa Health Systems Agency: (60)

> There are, at this time, approximately 370 ambulance services equipped with 560 ambulances in the area; a ratio of one ambulance per 4500 persons. This ratio is higher than other midwestern health service areas. The future availability of ambulance services is of particular concern to residents of rural areas. It is estimated that one-half of the ambulances (approximately 275) in the service area do not meet Iowa or federal Department of Transportation standards. Of these, approximately 100 vehicles would have to be replaced, with the remainder requiring equipment additions.

And as for the hospitals:

> There are a sufficient number of hospitals that provide inpatient diagnosis and emergency treatment. Many small emergency treatment facilities, particularly in rural areas, face problems in staffing, and are unable to meet various quality standards. The future availability of emergency treatment facilities would depend on whether all hospitals continue to provide emergency services. Due to financial problems, or the inability to meet future quality standards, certain hospitals might not continue to provide emergency services.

It has become a generally accepted assumption that smaller hospitals are not as efficient and cost effective as larger hospitals. Some of the quantitively measurable factors which can be used in the evaluation of cost and its relation with the size of a hospital are occupancy rate, investment rate per bed, full-time personnel per bed, annual

cost per patient day or per weighted sum of equivalent patient day of all services, and annual cost per bed.

Occupancy rate

Occupancy rate is the ratio of the average daily census (ADC) to the average number of beds maintained during the reporting period. Both at local and national levels, smaller size hospitals have had an occupancy rate consistently lower than the larger hospitals have. Tables 10, 11, and 12 show these differences.

Table 10. Occupancy rate of short-term community hospitals during 1974.[1]

Bed Size	U.S.	Iowa
6-24	49.5	51.9
25-49	57.9	53.0
50-99	65.9	62.8
100-199	71.9	69.1
200-299	77.5	70.3
300-399	79.9	67.8
400-499	81.3	79.5
500 or more	81.8	76.7
Overall	75.6	68.1

[1]Source: Compiled from Hospital Statistics, 1975 Edition, American Hospital Association.

Table 11. Occupancy rate of short-term community hospitals during 1975.[1]

Bed Size	U.S.	Iowa
6-24	48	56.2
25-49	56.7	52.5
50-99	64.7	62.7
100-199	71.2	69.6
200-299	77.1	71.1
300-399	79.7	68.7
400-499	81.1	80.2
500 or more	80.9	74.4
Overall	75.0	68.0

[1]Source: Compiled from Hospital Statistics 1976 Edition, American Hospital Association.

Table 12. Occupancy rate of short-term community hospitals during 1976.[1]

Bed Size	U.S.	Iowa
6-24	47.6	52.1
25-49	55.7	53.8
50-99	63.5	60.0
100-199	70.5	66.8
200-299	76.6	72.5
300-399	79.0	69.4
400-499	80.3	78.9
500 or more	80.9	76.5
Overall	74.6	67.9

[1]Source: Compiled from Hospital Statistics 1977 Edition, American Hospital Association.

It can be seen from these tables that occupancy rate has a positive relation with the size of a hospital. (It should be mentioned that in Iowa, there is only one hospital within the range of 400-499 beds, and its relatively higher occupancy rate must have a reason other than its size.)

It would not be feasible, moreover, for rural and smaller hospitals to have the same level of occupancy as do the larger hospitals in metropolitan areas. In issuing a Certificate of Need (CON), occupancy rate is the major factor that Health Systems Agencies take into consideration.

> Additional beds should not normally be considered needed if existing facilities by department are not operating at the appropriate levels listed below.

Average Daily Census	% Occupancy
10	50
15	57.5
20	60
25	62.50
30	65
35	67.5
40	70
45	71.25
50	72.50
55	73.75
60	75.0
65	76.25
70	77.5
75	78.75
80	80
85	81.25
90	82.5
95	83.75
100 or more	85

These percentages are used to demonstrate that smaller units cannot be expected to operate at the same average level

of occupancy as larger units and still provide reasonable services for the peak periods of utilization. (44)

So one may conclude that from the standpoint of utilization, larger size hospitals are considered to be more efficient.

Investment per bed

The total amount of investment (fixed assets) per bed is another factor which may be used to evaluate the relationship of cost with the hospital size. Although this factor is in favor of smaller hospitals, it should be recognized that the scope and intricacy of their service is not the same. Larger-sized hospitals, to a varying degree, provide secondary and some tertiary care services needing more expensive equipment which smaller size hospitals are not expected to acquire.

The new health planning laws regulate the capital expenditure of hospitals and discourage the acquisition of extra property or unnecessary investment. Under the Social Security Act, Section 1122, each expense item in excess of $100,000 should meet the requirement of the State Health Systems Agency (recently, however, some states have raised that limit). Failing to obtain a Certificate of Need (CON), that item may not be acceptable to the Department of Health, Education, and Welfare for reimbursement of charges for Medicaid and Medicare patients. Since about 50% of the

national health expenditure is funded by the public, HSA's have an upperhand in enforcing the law. However, there is no legal authority to bar a hospital from acquiring a property if it chooses to pursue its own plan and disregard HSA's recommendations. Benevolence and donations of individuals may also increase the hospitals' properties on an unplanned basis. The average investment rate during 1974, 1975, and 1976 for groups of hospitals by size in Iowa and in the United States is shown in Tables 13, 14, and 15 respectively.

Table 13. Investment rate per bed during 1974 for short-term community hospitals.[1]

	Investment Rate Per Bed in 1974	
Bed Size	U.S.	Iowa
6-24	$25,961	$27,236
25-49	26,373	24,931
50-99	31,442	28,281
100-199	39,531	30,368
200-299	47,421	33,050
300-399	50,852	33,707
400-499	52,208	51,145
500 or more	53,094	42,980

[1]Source: Compiled from Hospital Statistics, AHA, 1974 data.

Table 14. Investment rate per bed during 1975 for short-term community hospitals.[1]

Bed Size	Investment Rate Per Bed in 1975	
	U.S.	Iowa
6-24	$29,448	$18,483
25-49	2,,375	26,347
50-99	33,694	25,465
100-199	43,364	35,126
200-299	53,179	38,018
300-399	54,496	36,023
400-499	54,889	49,480
500 or more	62,070	47,480

[1]Source: Compiled from Hospital Statistics, AHA, 1975 data.

Table 15. Investment rate per bed in 1976 for short-term community hospitals.[1]

Bed Size	Investment Rate Per Bed in 1976	
	U.S.	Iowa
6-24	$34,702	$19,260
25-49	32,217	27,249
50-99	38,773	2.8043
100-199	47,486	35,243
200-299	59,720	46,926
300-399	60,378	40,459
400-499	62,102	79,942
500 or more	68,589	53,145

[1]Source: Compiled from Hospital Statistics, AHA, 1976 data.

In 1976, in Iowa, there was only one hospital within the range of 400-499 beds and probably is the reason that the change in its investment rate is not compatible with the national and local figures. Also, it seems that type of ownership has an impact on the investment rate. In Iowa, for example, most hospitals within the range of 300-399 beds are under the same form of management (affiliated with the same church) and their investment rate is not as high as it might otherwise be expected to be. Most hospitals in Iowa fall within the range of 25-99 beds. Table 16 shows the share of this group of the total bed capacity in Iowa.

Table 16. Proportion of hospitals within 25-99 beds and their share of the total bed capacity.[1]

Year	% Hospitals 25-99 Beds	% of Total Bed Capacity
1974	60.7%	28.2%
1975	61.1%	27.1%
1976	62.4%	28.0%

[1]Source: Compiled from "Guide to Health Care Field." 1977 Edition, AHA.

Full-time personnel per bed

Nationally, during 1976, the number of full-time employees per hospital bed ranges from 1.74 for small-sized hospitals to 3.1 for the larger ones. It is probably true

that larger institutions become less manageable and more bureaucratic, but also the larger hospitals provide more services to outpatient visits. Some hospitals may utilize a different mix of professionals than the others. Thus, without considering the other aspects of this stiuation, this measure cannot be applied conclusively.

Annual cost per weighted sum of units of service

It has been indicated that cost per patient-day, admission, or per bed is not a comprehensive measure of evaluation. The larger-sized hospitals provide more extensive emergency services, admit more surgical patients (compared to medical patients), treat more outpatients, and conduct more laboratory tests than do smaller size hospitals. If these activities are excluded, the comparison will be biased in favor of small hospitals. In addition, larger hospitals have a better opportunity to support or partially sponsor programs for education of health care professionals. Weighted sum of units of services which, in statistical analysis, is referred to as units of service (UOS) or adjusted patient day (AJPD), is derived as follows:

$$UOS = PD + PD\sum Cifi + g.B \quad --(1)$$

Where PD = total number of patient days throughout the year.

Ci = relative weight of service i to the services rendered to an inpatient (relative cost is used in this analysis).

fi = ratio of number of services (i) rendered per patient day.

g = patient-day equivalent of each birth (it is estimated that g = 2.89).
B = number of births.

The following model is found to be reasonably accurate for the estimation of equivalent patient-day of total units of service: (24)

$$UOS = PD\left[\left(1 + \frac{\#\text{ surgical cases}}{\#\text{ PD}}(4.75) + \frac{\#\text{ emergencies}}{\#\text{ PD}}(.16) + \frac{\#\text{ outpatient visits}}{\#\text{ PD}}(.28) + (.25)\right)\right] + 2.89B \quad \text{------(2)}$$

The amount in the brackets will be referred to as the multiplier. The numbers in parentheses are the weighting factor of its corresponding nominator. The figure .25 compensates for uncounted services such as laboratory tests, social services, etc. These ratios are dependent on the size of a hospital. Again, it must be remembered that it is reasonable to expect that larger hospitals admit more surgical patients, emergency cases, and treat more outpatients than do smaller hospitals. A review of 1974, 1975, and 1976 data as summarized in Tables 17, 18, and 19 shows the variation of the ratio of these services to the patient day.

Table 17. Ratio of selected types of services to patient-day for differentsize hospitals, 1974 data.[1]

	# Surgical Patient-Day	# Emergencies Patient-Day	# Outpatient Visits Patient-Day	UOS Multiplier (See Eq.2)
6-24	.02496	.25975	.85383	.96492
25-49	.03683	.19624	.66984	1.6439
50-99	.03396	.13677	.38566	1.5412
100-199	.05065	.20962	.51221	4.6675
200-299	.07175	.15194	.44516	1.7398
300-399	.04599	.09486	.32179	1.5737
400-499	.04064	.16276	.39358	1.5793
500 or more	.02944	.06042	.34627	1.4965

[1]Source: Compiled from Hospital Statistics 1974 data, AHA.

Table 18. Ratio of selected types of services to patient-day for different size hospitals 1975 data.[1]

	# Surgical Patient-Day	# Emergencies Patient-Day	# Outpatient Visits Patient-Day	UOS Multiplier (See Eq.2)
6-24	.C2055	.17452	.29308	1.45759
25-49	.03786	.19853	.52435	1.608
50-99	.03086	.13743	.39384	1.5289
100-199	.C5070	.21627	.54421	1.67783
200-299	.06184	.15992	.43726	1.6918
300-399	.C5150	.11616	.45627	1.64079
400-499	.0222	.0620	.17289	1.48277
500 or more	.03134	.0711	.08352	1.58615

[1]Source: Compiled from Hospital Statistics, 1975 data, AHA.

Table 19. Ratio of selected types of services to patient-day for different size hospitals, 1976 data.[1]

	# Surgical Patient-Day	# Emergencies Patient-Day	# Outpatient Visits Patient-Day	UOS Multiplier (See Eq.2)
6-24	.01208	.0886	.18232	1.3725
25-49	.03789	.16744	.56344	1.6145
50-99	.035968	.17176	.46521	1.5786
100-199	.04770	.2449	.55743	1.6718
200-299	.0690	.19099	.48723	1.7447
300-399	.05535	.11833	.49776	1.6712
400-499	.02394	.08349	.19559	1.4318
500 or more	.03092	.08217	.47134	1.5420

[1]Source: Compiled from Hospital Statistics, 1976 data, AHA.

Annual cost per bed

The annual cost of a hospital reflects the effect of staffing policy, capital investment (depreciation and interest), occupancy rate, and the volume of its operation. Thus, the relationship between annual cost and bed size brings in the effect of the problems associated with the bed size.

Some of the long term units in Iowa are somehow associated with a hospital, which makes the distinction between the cost of these two operations more difficult. Although it is required by DHEW that, from an accounting point of view, short term and long term care facilities be treated as two separate entitites, these hospitals have felt

that in responding to the American Hospital Association annual survey, the costs of these two operations were not completely separable. To avoid such obscurity in analyzing the relation of annual cost to bed size, in this analysis, only those hospitals in which long-term units do not account for more than 10 percent of their total bed capacity are considered. A selected sample of 110 hospitals, ranging from 17 to 964 beds, and their total annual cost during 1973 were analysed, (see Appendix for summary of numerical analysis), with the following results:

> There is a positive linear relation between the bed size and annual cost of a hospital. The regression formula for this relation is:
>
> Total Annual Cost = -718.17 + 28.511 (bed size)---(3)
> ($000)

The Coefficient of Correlation, R^2, for this regression model is 0.93474. The addition of terms with a higher degree does not improve the coefficient of correlation significantly. The non-linear regression model is:

> Total Annual Cost = a + b(# beds) + c(#beds)^2
> ($000)
>
> Yields: a = -295.9866 b = 22.5091 c = .00901
>
> R^2 = .94255

(See A-1 and A-2 for the summary of statistical analysis.)

Another measure which may be used to evaluate the cost effectiveness of hospital operation is the average cost per patient-day. In this study, it was found that there is no significant relationship between the average cost per patient-day and the size of a hospital. For 110 data points and a linear regression model, it has a coefficient of correlation, $R^2 = 0.10891$. (See A-3 for summary of statistical analysis.)

Results of analysis of 1974 data available on 103 Iowa hospitals ranging from 17 to 1181 beds are consistent with the results obtained from the 1973 data. The summary of analysis is as follows:

> There is a positive linear relation between the bed capacity and total annual cost of a hospital. This relationship is of the form:
>
> (Total Annual Cost) = -878.817 + 31.9675(# beds)
> ($000)

Coefficient of correlation, R^2, for this model is .93978. A quadratic relation is not a much better fit, and has an R^2 = .94745 which is significantly different.

It was also found that there is a low correlation (R^2 = .1995) between the average cost per patient-day and the size of a hospital. The graphical distribution of cost per patient-day (CPPD) vs the number of beds for 1973 is shown in Figure 6. It has been commonly understood that if larger hospitals provide a higher (more complex) level of care, then

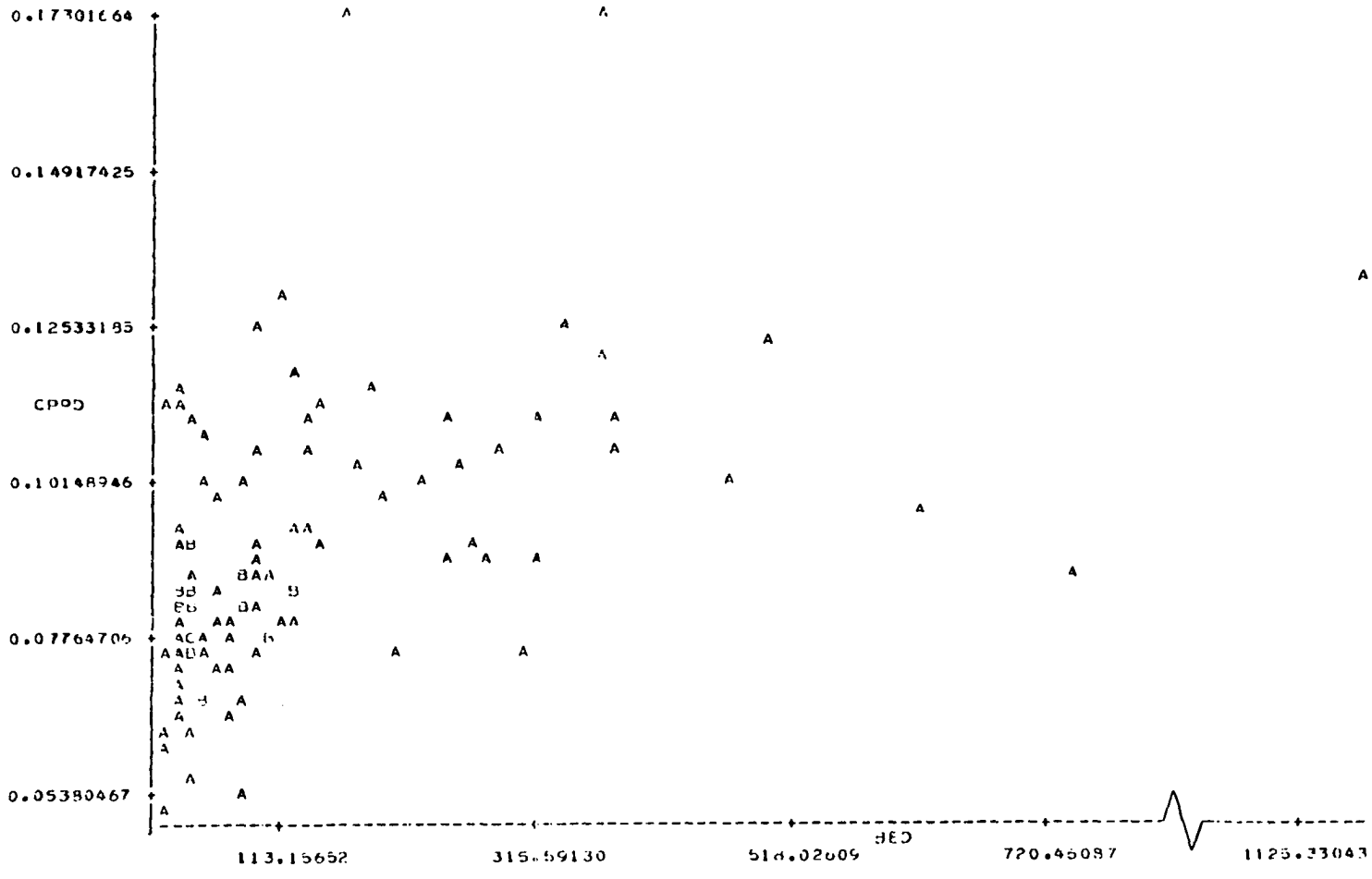


FIG. 6 PLOT OF COST PER PATIENT-DAY VS NUMBER OF HOSPITAL BEDS. 1974 DATA

their average cost per patient-day should also be higher. However, the statistical analysis showed that this assumption is not necessarily true. For instance, during 1974 the average cost per patient-day for the VA Hospital in Iowa City and Broadlawns Hospital in Des Moines was $174.20 and $172.42, respectively. During the same period, cost per patient-day for University of Iowa Hospitals was $132.55 which is 31.4% less than the VA Hospital and 30% less than Broadlawns Hospital. The difference is despite the fact that the University of Iowa Hospitals have a broader scope of service and offer more specialty services than any other hospital throughout the state of Iowa. It is natural to expect that once a facility is established, it should be staffed with certified professionals and meet certain requirements, but consequently the way it is utilized is dependent upon management policies and practices involved. (See A-4, 5, 6, and 7 for summary of statistical analysis and graphical presentation of the data.)

The results of cost analysis made on data available on 103 and 106 hospitals in 1975 and 1976, respectively, confirm the results obtained from data from previous years. The changes in coefficients of regression models reflect the rate of increase in health care costs. During 1975, the total cost had a positive linear relation with the total units of services (UOS). This relationship has the following form:

Total Cost ($000) = -579.276 + 0.08169(UOS)---(4)

The Coefficient of Correlation, R^2, for this model is 0.954778. For the sake of brevity, the summary of cost analysis made on 1973, 1974, 1975, and 1976 data on Iowa hospitals is shown in Table 20.

One should not mistake hospital cost for charges rate. A review of a survey of hospital charges (published by AHA from time to time) reveals that the rates charged in larger hospitals and for similar services are consistently higher than those charged in smaller hospitals.

Although analysis shows that the annual cost and the average cost per patient-day and cost per unit of service have no significant correlation with the size of a hospital, small hospitals cannot afford to provide certain kinds of services. Services that require a considerable amount of investment, highly specialized personnel, and a minimum level of demand are offered by only a selected number of hospitals. If non-economic factors such as administrators' desire for reputation and personal preferences influence the establishment of an unnecessary facility, health care regulatory agencies may evaluate such an expansion more objectively. Also, as previously mentioned, under the Iowa Emergency Medical Services Plan, all hospitals are not expected to deliver the same variety and level of emergency

Table 20. Coefficient of correlation obtained from linear regression.

Year		No. Beds	Patient Day (Ptday)	Avg. Cost Per Ptday (CPPD)	Avg. Cost Per Bed (CPBD)	units of Service (UOS)
1973 103 Data Points	Cost	H.C.[2] R^2=.93474 (A-1,2)[1]				
	Bed			L.C.[3] R^2=.10892 (A-3,7)	L.C. R^2=.35224 (A-4,6)	
	Ptday			LC. R^2=.09516 (A-5)		
1974 103 Data Points	Cost	H.C. R^2=.93978 (A-8)	H.C. R^2=.95221 (A-9)			

[1]Alpha-numerical notations in parentheses refer to Appendix page number for the summary of statistical analysis and graphical presentation of relationships between data.

[2]H.C. = High correlation.

[3]L.C. = Low correlation.

Table 20 (Continued)

Year		No. Beds	Patient Day (Ptday)	Avg. Cost Per Ptday (CPPD)	Avg. Cost Per Bed (CPBD)	units of Service (UOS)
	Bed			LC. R^2=.19952 (A-10)		
1975 110 Data Points	Cost	H.C. R^2=.93096 (A-11)	H.C. R^2=.89947 (A-12)			H.C. R^2=.95478 (A-15)
	Bed			L.C. R^2=.12224 (A-13,14)		
1976 106 Data Points	Cost	H.C. R^2=.93984 (A-16)	H.C. R^2=.96581 (A-17)			H.C. R^2=.95663 (A-18)
	Bed			LC. R^2=.17674 (A-19,20)		
	Ptday			LC. (A-21)		

service. Frequency distribution of selected types of services provided by hospitals across Iowa is shown in Table 21. Also a review of facilities reported by hospitals(2) shows that no hospital in Iowa with fewer than 72 beds meets all the requirements established by the Iowa Emergency Medical Services Advisory Council. Provision of services such as obstetrics, emergency, intensive care, and coronary care is costly and inefficient. The monthly birth rate reaches its peak during September and October, and utilization of facility and personnel for other types of services is not always possible. Intensive, coronary, and emergency services are not expected to be fully utilized, and extra capacity should always be available for dealing with emergency cases. However, one should not assume that services and facilities are allocated economically nor that the current distribution has been achieved on a planned basis. For instance, while the number of births in each of 64 of 134 short term hospitals in Iowa during 1976 was fewer than 200, with some of the reported figures as low as 20, the necessity of 129 obstetrics departments remains questionable. Recently, the regulations of the Department of Health, Education, and Welfare require a minimum number of births in a community for justification of need for an obstetrics facility in an area. But the opposition of the American Hospital Association and local health planning authorities

Table 21. Distribution of services by hospital size and number.[1]

Service	A	B	C	D	E	F
1. Obstetrics Dept.	57	30	20	12	10	129
2. Premature Nursery	1	4	5	9	7	26
3. Pediatrics Dept.	15	15	18	12	10	70
4. Occupational Therapy	2	3	2	7	11	25
5. Inhalation Therapy Dept.	17	22	17	11	12	79
6. Social Work Dept.	3	13	13	11	15	55
7. Pharmacy with Full-Time Pharmacist	3	8	16	12	16	55
8. Pharmacy with Part-Time Pharmacist	41	26	5	1	1	74
9. Home Care Dept.	0	1	2	1	0	4
10. Urology Dept.	0	5	7	8	8	28
11. Coronary Care Unit	16	14	3	5	9	47
12. Intensive Care Unit	2	3	1	5	10	21
13. Combined CCU/ICU	12	13	17	8	3	53
14. Electroencephalography	1	2	5	8	16	32
15. Blood Bank	28	21	12	9	7	77
16. Eye Bank	1	0	1	1	1	4
17. Organ Bank other than eye	0	0	0	0	1	1
18. Neurosurgery	1	0	3	7	10	21
19. Thoracic Surgery	1	6	10	9	12	38
20. Eye Surgery	2	6	10	11	12	41
21. Corneal Transplant	0	1	1	2	4	8
22. Organ Transplant other than corneal	0	0	0	0	1	1
23. Plastic Surgery	1	2	3	6	9	21
24. Oral Surgery	12	13	17	12	12	66

[1]Source: Iowa Hospital Statistics, Vol. 3, Table II, June 1974.

A = Number of hospitals, 50 beds or less.
B = Number of hospitals, 51-100 beds.
C = Number of hospitals, 101-200 beds.
D = Number of hospitals, 201-300 beds.
E = Number of hospitals, over 300 beds.
F = Total number of hosptals.

Table 21 (Continued)

Service	A	B	C	D	E	F
25. Open Heart Surgery	0	0	0	1	2	3
26. Inpatient Hemodialysis	0	0	2	3	3	8
27. X-Ray Diagnostic	58	34	21	13	16	142
28. X-Ray Therapeutic	1	3	13	10	9	36
29. Diagnostic Radioisotope Facility	1	3	11	12	12	39
30. Therapeutic Radioisotope Facility	1	1	6	10	10	28
31. Cobalt Therapy	0	2	3	2	3	10
32. Radium Therapy	0	1	10	11	10	32
33. Organized Outpatient Dept.	11	4	7	4	10	36
34. Psychiatric Inpatient Unit	0	2	3	10	11	26
35. Psychiatric Outpatient Unit	0	2	3	5	9	19
36. Abortion Service (Inpatient)	7	4	2	2	4	19
37. Abortion Service (Outpatient)	1	2	0	1	2	6
38. Hematology	59	34	19	13	16	141
39. Urinalysis	59	34	20	13	16	142
40. Biochemistry	43	27	18	11	16	115
41. Bacteriology	40	32	20	12	16	120
42. Myocology & Tuberculosis	7	15	12	9	11	54
43. Serology	31	29	17	12	14	103
44. Cytology	5	14	15	12	11	57
45. Histology	4	12	15	12	12	55

made that regulation difficult to administer. On the other hand, the advisability of having 21 plastic surgery facilitiies in Iowa while 15 short term hospitals have no ICU or CCU needs to be justified.

CHAPTER VI. COST ANALYSIS AND LOCATION PLANNING

In an evaluation of the cost-effective operation of hospitals, the variety, type and volume of services offered by each institution should be taken into consideration. Application of a single measure may not give a conclusive result.

From analysis of data of the past four years (1973-1976) it is found that:

1) There is a positive strong correlation between the size of a hospital, patient-day, weighted sum of units of service and the annual cost.
2) There is no significant correlation between the size of a hospital and the average cost per patient-day or cost per units of service. This is partially due to the difference in mix of services by hospitals.
3) The type of management practices and ownership (governmental and non-governmental) are important factors in total annual and average cost of services.
4) Hospitals are selective on the type of services they may offer. That selectiveness may be based on personal preferences, economic incentives, or requirements imposed by health planning agencies.

5) There are certain kinds of services that some hospitals are not able or willing to provide, even if those services are recommended by health planning authorities and demanded by corresponding communities.

6) Outgrowth of hospitals in a certain area and centralization of services may not necessarily be economical. It is not intended to recommend that all hospitals should provide all types of services nor that certain types of facilities have to be centralized to ensure a minimum level of utilization.

Optimum Location and Capacity of Hospitals

It is important to identify the factors that affect patients' decision in preferring one hospital over another. Consumers of health care services may not always be economically thoughtful in their selection of health care facilities. Except for emergency cases in which access time is the most important factor, in other instances the consumers' personal preferences and subjective criteria may affect the selection of a certain facility. Morrill and Earickson (80) on selected 123 hospitals in Chicago metropolitan areas and identified 99 variables which affect patient travel distances. These 99 variables include 15

concerned with patient-handling capacity; 17 with quality and service variations; 8 with costs and means of payment; 14 with characteristics of the patient population; 18 with characteristics of the hospital service area; 5 with relation to other hospitals; 13 with charge-over time; and 11 with characteristics of occupancy and length of stay. These 99 variables accounted for two-thirds of the variance and are reduced into nine major dimensions described below.

Dimension 1: Elements such as annual admissions, annual expenses, total and medical-surgical patient-days, and number of employees may come under this category. Of the variance accounted for by the nine factors, the share of this dimension is 26 percent.

Dimension 2: Accounting for 15 percent of the explained variations is a spatial one, ranking hospitals by the character of the service area and the relative location of the hospital. The major elements of this factor are the percentage of hospitals' different types of patients who come from their own community.

Dimension 3: Accounting for 13 percent of the variations, aligns hospitals according to length of stay and quality of scope of service (i.e., variety of services and kinds of care available).

Dimension 4: Accounting for 12 percent of the variations, orders hospitals by the importance of obstetric

and pediatric care.

Dimension 5: Comprising eight percent of the variation, orders hospitals according to their dynamism, growth (or stagnation), age, population change, and bed change during the last 15 years.

Dimension 6: With seven percent of the variation, accounts for hospitals' racial attitude and their propensity to admit non-white patients.

Dimension 7: Accounting for six percent of the variation ranks hospitals in order of their expense per bed.

Dimension 8: With eight percent of the variation, is a spatial one, ranking hospitals according to their competitive position, such as distance to the nearest hospital, community population, and the percent of the community's patients to hospitals in the area.

Dimension 9: With five percent of the variation, orders hospitals by proportion of elderly patients and age distribution of patients.

Distance traveled by patients to hospitals is a complex function of the relative location of patients, physicians, hospitals, the hospitals' size, quality and scope of care, religious affiliation, possible racial discrimination in admission, method of payment (private or public aid) and so forth. However, within a relatively homogeneously area, the demand for a hospital should decline as costs of reaching it

increase--that is, as the real or perceived price of its care rises. These may be direct cost of transport, the cost of time otherwise spent productively, or simply the probability of not being aware of a hospital the farther one is from it. For these reasons, one may expect a steady decline in the ratio of patients using a hospital as the distance from the hospital increases. In this study, for the community-hospital analysis, a simple distance model of the gravity or "power" type was used: $Fij = A/\check{D}ij$ ------ (5). Where Fij is the number of patients from area i to hospital j, Dij is the distance from area i to hospital j, and b is the degree of slope of decline. Variability of this model between hospitals of different sizes and types of service was found to be too wide to be used as a general model. The value of slope, b, ranges from .25 for special-purpose hospitals to 1.324 for satellite and rural hospitals. That is, the mean distance traveled by patients to a special-purpose hospital is longer than to a satellite hospital. Also, in that study, it has been found that the slope, b, is affected by population density. However, this model has a coefficient of correlation, R^2, ranging from .93 for small city hospitals to .70 for satellite hospitals.

Another model which was tried in this study by Morrill and Earickson is an exponential model, $Fij = Ae^{-D_{4J}}$, which provides a better fit. The value of R^2 for this model ranges

from .66 for satellite hospitals to .95 for special-purpose or research hospitals.

As an example, gain and loss of patients, by area 11, 6 from and to other areas during the survey period is shown in Figures 7 and 8. In Iowa, it seems that patients use more subjective and intangible criteria in selection of a hospital. The patients may travel across the State to go to the hospital of their choice even though a like or better level of care is available in their hometown or county.

Before the passage of the National Health Planning and Resource Development Act of 1974 (Public Law 93-641) by which Iowa was divided into 16 planning areas (see Figure 2), the Iowa Hospital Association and Iowa Regional Medical program conducted a survey on patients origin and their travel pattern within Iowa. This survey, conducted during a four-week period from September 2-29, 1973, As it can be seen from Figures 7 and 8, the boundaries of health planning a is a good indicator of patients' origin and their travel pattern.reas are hardly recognized by patients, and health services are sought at unreasonably remote places. The summary of patient travel between and within all 16 areas is shown in Table 22.

There is an implied relationship between the health of a community's residents and its proximity to a hospital. Socio-economical status, level of education, and

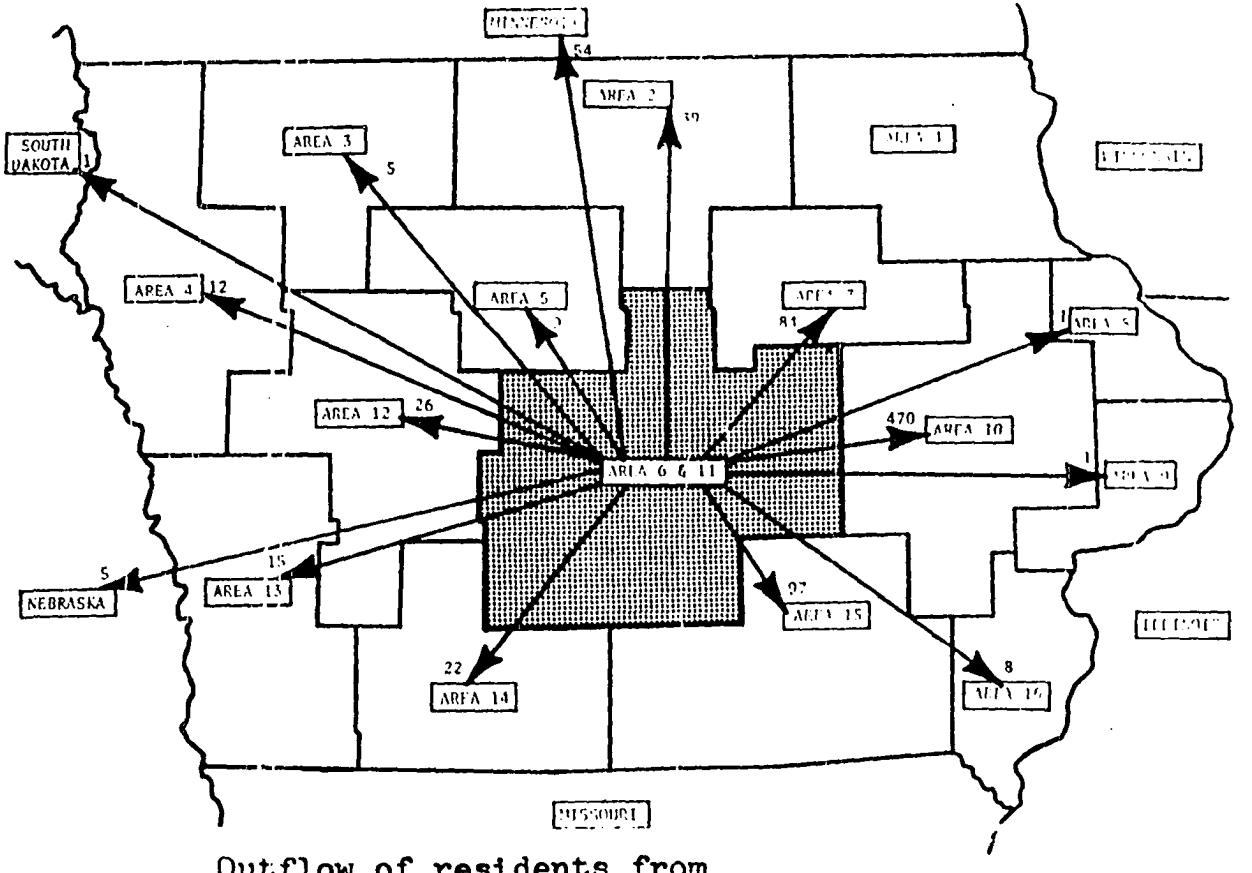


FIG. 7

Outflow of residents from area 6 & 11 to other planning areas and surrounding states, September 2-29,1973 .

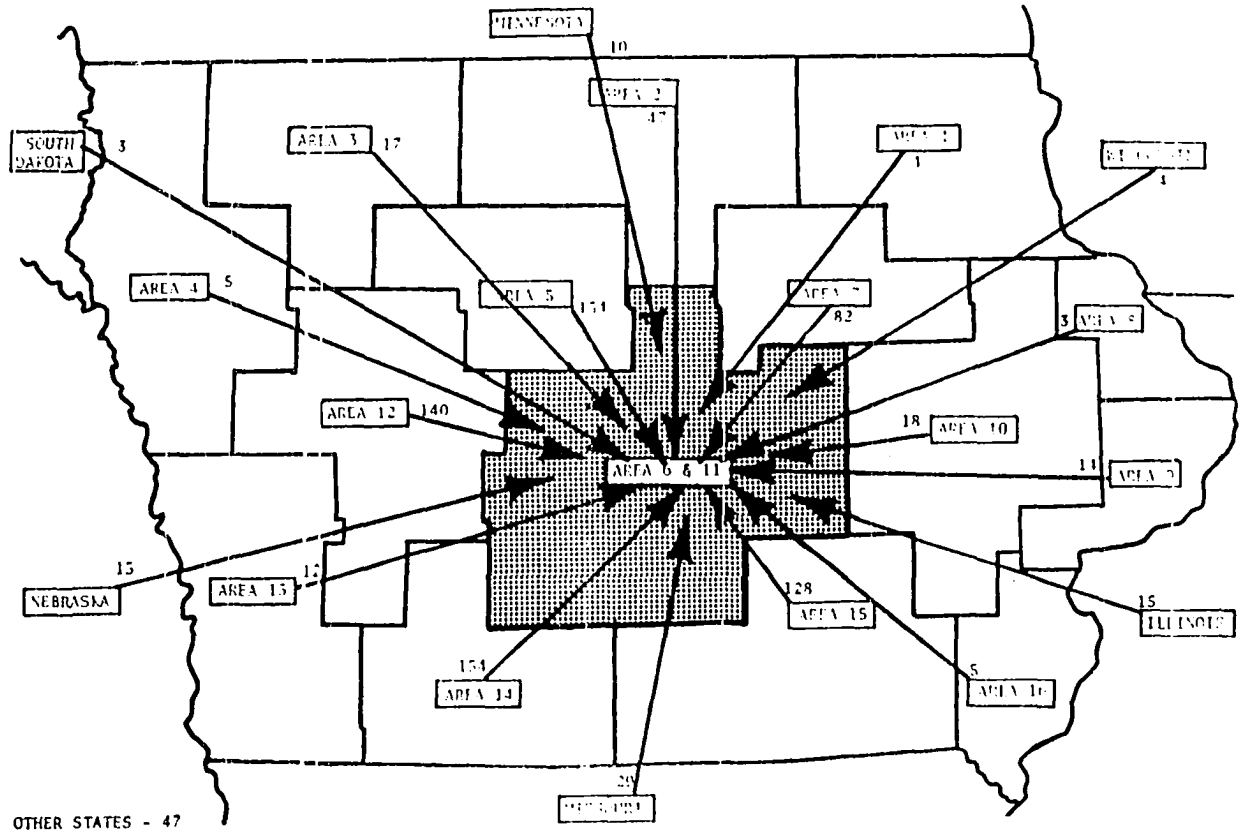


FIG.8 Inflow of residents from other planning areas and states to area 6 & 11, September 2-29, 1973.

Table 22. The number of Iowans hospitalized in each Iowa health planning area of residence, September 2-29, 1973.[1]

Area of Resid.	Area of Hospitalization								
	1	2	3	4	5	7	8	9	Total
1	698	62	1			135	13		
2	5	1534	24	12	49	8	1	2	
3		9	1033	137	31			1	
4		3	55	2470	3		1		
5	1	47	19	13	1008	2			
7	25	45				2497	1	2	
8	5	1		1		9	1480	51	
9				2		2	61	2505	
10	3	1	1	2	4	54	42	27	
11,6		39	5	12	9	84	1	1	
12			21	76	81	3			
13		1	1	17				1	
14				7					
15				1	1				
16				1				11	
Total	737	1742	1160	2751	1186	2794	1600	2601	

[1]Source: Iowa Hospital Statistics, Vol. 1. Iowa Hospital Association and the Iowa Regional Medical Program. June 1974.

Table 22 (Continued)

Area of Resid.	Area of Hospitalization							
	10	11,6	12	13	14	15	16	
1	139	4						1052
2	79	47			4			1765
3	49	17	5	1				1283
4	91	5	7	2		1		2638
5	80	154	11	1		2	1	1339
7	198	82		1		1	1	2853
8	126	3					1	1677
9	426	14				5	12	3027
10	4116	18		3		15	14	4300
11,6	470	7276	26	15	22	97	8	8065
12	62	140	1248	33	3			1667
13	68	12	71	1896	4			2071
14	38	154	10	43	579	8		839
15	242	128		2	16	1957	35	2382
16	273	5		1		9	1472	1772
Total	6457	8259	1378	1998	628	2095	1544	6730

accessibility to health care services have significant impact on the health of people and being far from hospitals may be the result of some form of deprivation that has an adverse affect on health itself.

In the case of selective and preplanned admissions, proximity to hospitals may not be as critical as it is in emergency cases.

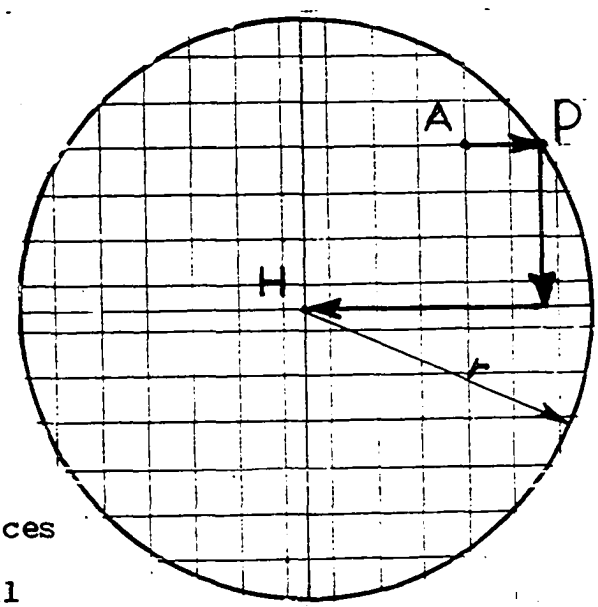
For most accidents, injuries, and coronary diseases, access time is vitally important. Thousands of lives could be saved each year if the injured had reached a hospital only a few minutes sooner. Thus, the Emergency Medical Services Council in Iowa set guidelines and objectives to ensure that convenient and reasonably fast access to emergency services be available to all citizens of Iowa. Some of its objectives are as follow:

> By March 31, 1976 develop a mechanism for determining proper placement, distribution, and number of adequate ground, air, and water transportation vehicles in such a manner as to ensure maximum response times of ten minutes for all calls in urban areas and 20 minutes for calls in rural areas. (43)

It was also planned that:

> By March 31, 1976 develop and distribute to Regional EMS Councils a Health Facilities Standards and Distribution Guide to be used as a planning mechanism for determining proper distribution of categorized emergency medical service facilities which collectively provide total patient care requirements and which will place all persons in Iowa within 60 minutes of a categorized hospital after the dispatch of an ambulance. (43)

Some of the means necessary for meeting these goals are properly maintained roads, emergency vehicles, and emergency facilities located within a certain distance from the communities. The requirement of the 60-minute time limit will be met if communities are not farther than 35 miles. The reasoning behind this statement goes as follows: Assume an area with radium r whose hospital is located at its center and ambulances and rescue personnel are stationed at distance r/2 from the center.



A = Location of ambulances

H = Location of hospital

P = Location of patient

(By stationing ambulances at distance r/2, instead of at the center, access time to the outskirt areas will be reduced.) Leaving 2 minutes for preparation and time lost for miscellaneous activities, the maximum access time will be

$$2 + \frac{1.5r}{S} < 60 \text{ min}$$

where S is allowable or possible speed in miles per minute. Assuming an average possible speed of 55 mph, then maximum allowable r will be 35.5 miles. Then, based on the EMS plan, no community should be farther than 35 miles from a hospital. Appendix B, based on the Iowa road system and its grid structure previously discussed, shows the distance matrix of counties with less than 35 miles from their neighboring county. For the sake of convenience, each county is identified by its county number instead of its name.

Projection of patient visits in 1980

During 1976, there were 565,432 admissions to 135 short-term general hospitals in Iowa. This figure includes 36,162 admissions by the University of Iowa Hospitals, which offer the only tertiary care in the state. Although the UIHs provide some primary and secondary care, and although some large hospitals may occasionally provide some tertiary care services, the services of UIH are all considered to be tertiary. Being other than that, something should be done to use those expensive facilities only for the purpose for which it has been established. Then total primary and secondary admissions will be 565,432-36,162=529,270, which is 182 admissions per 1000 population. (102,6)

Nationally, the ratio of outpatient visits to inpatients admission is increasing year by year. This ratio from 1965-1976 is shown in Table 23.

Table 23. Ratio of outpatient visits to inpatient admissions to non-federal short-term hospitals during 1965-1976.[1]

Year	Ratio of Outpatient Visits to Inpatient Admissions
1965	3.5004
1966	3.9604
1967	4.0754
1968	4.1830
1969	4.2766
1970	4.5653
1971	4.9241
1972	5.4256
1973	5.6339
1974	5.9144
1975	5.8567
1976	6.0974

[1]Source: Guide to the Health Care Field. 1977 Edition, AHA.

Following this trend, the ratio may be as high as 11.55, but it is not expected that it will last for a long period of time, slowing down in the near future. The reasons behind such a conclusion are that:

1 - The introduction of publicly funded health programs has created a rush on the part of previously under-served groups to receiving free or cheap medical services. This rush is expected to ease off

gradually.

2 - The administration of publicly-funded preventive medicine and vaccination programs will reduce outpatient visits.

3 - The expansion of medical services such as outpatient and family practice clinics will reduce the number of hospital visits.

During 1976, this ratio in Iowa was 4.628, which is 31.7 less than the national average. Also, a review of historical data (only 3 years is available) for Iowa shows that the State's ratio has been significantly lower than the national average. Thus, it may be expected that this ratio in Iowa will be as high as 5.5 by 1980, so that the total number of annual visits per 1000 population will be

182 + 5.5(182) = 1183.This figure excludes the outpatient visits to clinics that are not part of a hospital. Also, the minimum number of inpatient and outpatient visits required to feasibly maintain a minimum-sized hospital (72 beds) is derived as follows:

(No. Admissions/yr) x (Average Length of Stay) =

(365 days) x (No. beds) x (Occupancy Rate)

$$\text{Thus, No. Admissions/yr} = \frac{365 \times (\text{No. beds})(\text{Occupancy Rate})}{\text{Avg. Length of Stay}}$$

Assuming an occupancy rate of 78% and the prevailing average length of stay as 7.57 days,

$$\text{No. Admissions} = \frac{365 \times 72 \times .78}{7.57} = 2708 \text{ inpatient admissions}$$

Outpatient Admissions = 2708 x 5.5 = 14894

14894 + 2708 = 17600

Thus, a minimum-sized hospital is 72 beds or 17,600 inpatient and outpatient visits per year. Based on population estimates by the Iowa Office for Planning and Programming and the estimated number of patient visits per 1000 population (1183 per year), the total number of visits in 1980 for each county is shown in Table 24.

An optimumization model may now be set up to meet the requirements and objectives of health planning authorities and so that access cost (transportation) is also minimum. In the cases of smaller and less populated communities whose patient load is not enough to keep a minimum-sized hospital (72 beds) open, a tradeoff analysis should be made in choosing the following alternatives:

1 - To establish a small-sized hospital (72 beds) and to maintain its occupancy rate at a certain level, the patients of nearby communities should be directed to use those facilities. Table 24 shows that by 1980, 39 counties in Iowa will not be populated enough to justify the establishment of a minimum-size hospital.

2 - To refer the patients to the next nearest community,

Table 24. Estimated patient visits in 1980 by county.

	County	No. of Visits (Dj)
01	Adair	12194
02	Adams	7151
03	Allamakee	18579
04	Appanoose	18198
05	Audubon	10523
06	Benton	27476
07	Black Hawk	163972
08	Boone	30864
09	Bremer	30739
10	Buchana	27127
11	Butler	25200
12	Calhoun	20441
13	Carroll	15954
14	Cass	28943
15	Cedar	20005
16	Cerro Gordo	19647
17	Cherokee	56892
18	Chickasaw	19357
19	Clarke	18307
20	Clay	9955
21	Clayton	22757
22	Clinton	25410
23	Clinton	70902
24	Crawford	20419
25	Dallas	32853
26	Davis	10461
27	Decatur	10497
28	Delaware	23077
29	Des Moines	53289
30	Dickinson	17482
31	Dubuque	116232
32	Emmet	16440
33	Fayette	32225
34	Floyd	24556
35	Franklin	16121
36	Fremont	10714
37	Greene	14286
38	Grundy	16036
39	Guthrie	16269
40	Hamilton	21251
41	Hancock	15810
42	Hardin	25704
43	Harrison	20584

Table 24 (Continued)

	County	No. of Visits (Dj)
44	Henry	20461
45	Howard	13880
46	Humboldt	14543
47	Ida	10331
48	Iowa	18301
49	Jackson	25853
50	Jasper	43374
51	Jefferson	15496
52	Johnson	95459
53	Jones	23996
54	Keokuk	16097
55	Kossuth	27586
56	Lee	47170
57	Linn	198352
58	Louisa	13056
59	Lucas	12578
60	Lyon	15400
61	Madison	15568
62	Mahaska	25974
63	Marion	33168
64	Marshall	52246
65	Mills	15605
66	Mitchell	14843
67	Monona	14397
68	Monroe	11017
69	Montgomery	15526
70	Muscatine	48783
71	O'Brien	21292
72	Osceola	10315
73	Page	23284
74	Palo Alto	15994
75	Plymouth	28330
76	Pocahontas	13717
77	Polk	373234
78	Pottawattamie	101848
79	Poweshiek	25692
80	Ringgold	7163
81	Sac	17877
82	Scott	185557
83	Shelby	18125
84	Sioux	32628
85	Story	86778
86	Tama	24660

Table 24 (Continued)

	County	No. of Visits (Dj)
87	Taylor	9321
88	Union	14801
89	Van Buren	9132
90	Wapello	44804
91	Warren	43662
92	Washington	19446
93	Wayne	9895
94	Webster	54985
95	Winnebago	16165
96	Winneshiek	24897
97	Woodbury	128474
98	Worth	10632
99	Wright	19935

with a hospital if the distance is less than 35 miles.

One may not think of other options such as either not delivering a service or delivering at a price higher than acceptable. It is hard to make the higher costs acceptable to residents of a community, or to insurance companies and government agencies, especially if higher costs are due to inefficiency. In this study, a compromise has been made between these two alternatives: Each county in which the number of annual patient visits is less than 8800 (half of 17600) should refer its patients to the next nearby community.

For general formulation of the optimization model, the following variables are defined:

$d_{i,j}$ = Average one way traveled distance from facilities (population center) in area i to population center (facilities) in area j.

$$C = \begin{bmatrix} C & C & C & \cdots & C \\ C & C & C & \cdots & C \\ \vdots & & & & \\ C & C & C & \cdots & C \end{bmatrix}$$

Where $C_{i,j}$ is the traveling cost per mile from area i to area j. Generally, the transportation cost between all areas will not be the same. In areas where cheap public transportation is not available, if the patient does not own an automobile, the use of taxi and ambulance services of other communities would be costlier than in metropolitan areas. It may also be more

costly to go from i to j than from j to i.

Vij = The annual number of patients in area i who visited facilities located in area j.

Dj = Total annual number of patient visits needed by residents of area j.

Then, the optimization model which minimizes travel cost and meets other constraints is as follows:

$$\text{Minimize} \sum_{J=1}^{n} \sum_{i=1}^{n} C_{ij} d_{ij} V_{ij} \quad \text{------ (6)}$$

Subject to:

$$\sum_{J=1}^{n} VJi = Dj \qquad j = 1, 2, \ldots n \quad \text{------ (7)}$$

$$\sum_{i=1}^{n} Vij \geq 17600 \text{ if } dj \geq 8800 \quad \text{------ (8)}$$

$$dj, Vj, dij \geq 0$$

$$\sum_{i=1}^{n} Vij = 0 \qquad \text{if } Dj < 8800 \quad \text{------ (9)}$$

Equation (6) gives the total transportation cost within and between all areas.

Equality (7) assures us that the demand of each area is met whether the patients are treated within the area of their

own residence or are sent elsewhere.

Unequality (8) implies that if the number of patient visits of residents of an area is larger than 8800, than a hospital with at least a minimum capacity of 17,600 visits should be established in that area.

Equality (9) requires that if the annual number of patient visits in an area is less than 8800, then there would be no hospital in that area. Consequently, no patient will visit this area in seeking service. The residents of such areas should also be diverted elsewhere.

In this study, transportation costs per mile to and from all directions are assumed to be identical. This assumption is made for the sake of simplicity, even though it may not be realistic in some areas. Then the transportation cost matrix per mile will be:

$$C = C\begin{bmatrix} & \\ & I \\ & \end{bmatrix} \quad \text{------(10)}$$

Where C is transportation cost per mile between and within each of the areas and I is a nxn identity matrix.

Values of dij's and Dj's are given in Table B and 24 respectively. The graphical presentation of patient flow among Iowa's 99 counties is shown in Figure 9. The required number of hospital beds for meeting the needs of each county is shown in Figure 10.

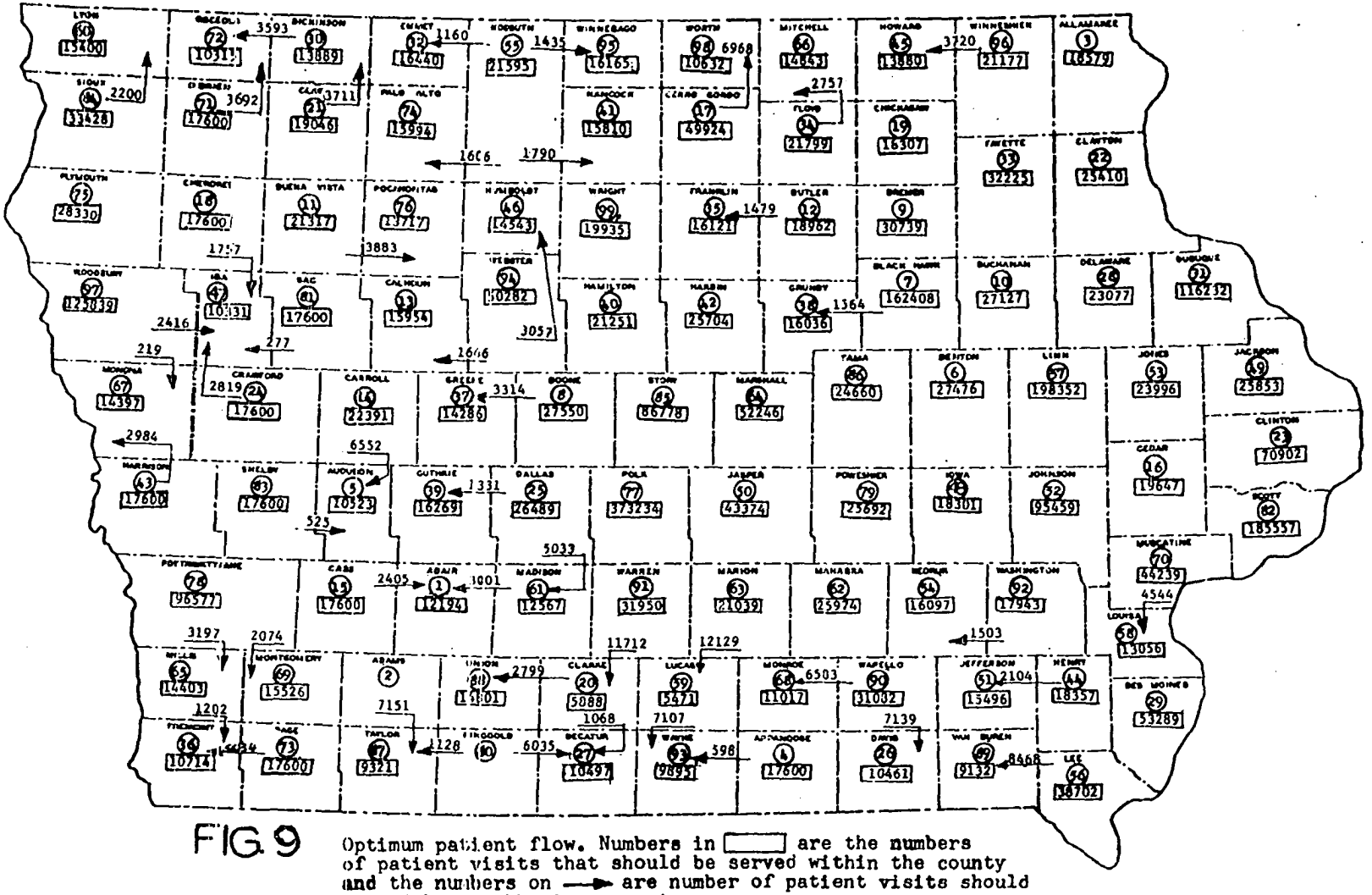


FIG 9

Optimum patient flow. Numbers in [ ] are the numbers of patient visits that should be served within the county and the numbers on ⟶ are number of patient visits should served by neighboring counties.

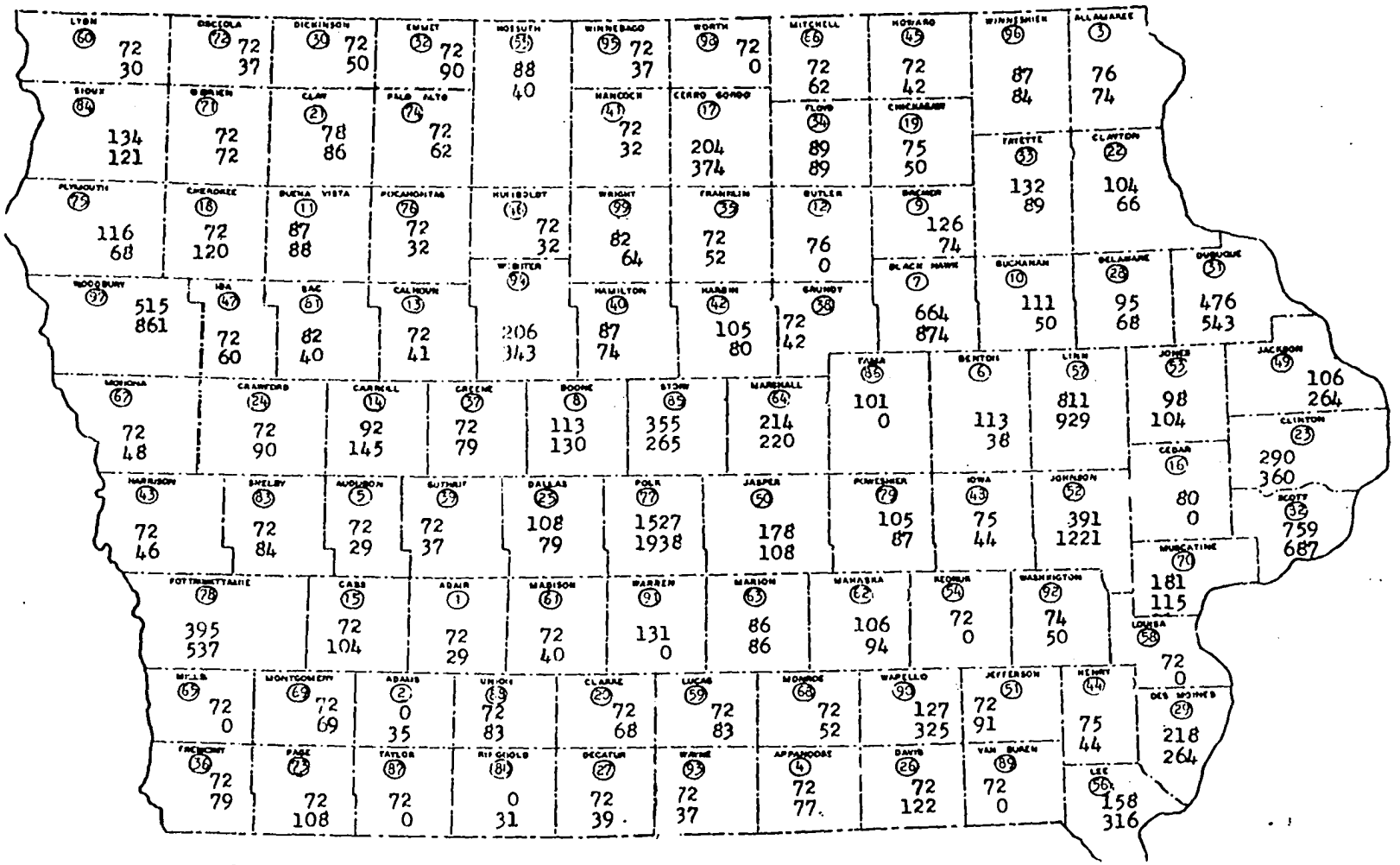


FIG. 10 Optimum distribution of hospital bed capacities. Upper numbers are optimum capacities and lower numbers are the existing capacities.

As can be seen from Figure 9, in order to have a minimum transportation cost and also maintain the hospitals' capacity at or above a certain level, one county may have to gain patients from some counties and lose to others. At first glance it may not appear logical, but it should be realized that

a) County lines are political and geographical lines which have purposes other than health planning. Thus, one should not feel any geographical barrier in using the facilities in other communities, especially since--in most cases--the average distance traveled between counties is less than 25 miles, which is not significant.

b) When a county gains patients from its nearest neighboring county, it may lose patients to other counties and in other geographical directions.

The proposed distribution of hospitals and their capacity is greatly affected by the existing road structure, industry (or population) locations, and transportation means. A change in these factors may increase the need for redistribution of health care facilities. There are some health planning authorities who believe that the development of an air transportation system and communication network for responding to emergency cases would be more economical than the relocation and redistribution of current health care

facilities. Ecological factors such as noise, safety, shortage of energy, and unfavorable climate in Iowa make air transportation impractical for the foreseeable future. The Iowa Department of Transportation has no plan for building new major highways and it does not seem to be in need of new highways for years to come. Moreover, the traditional methods of delivering emergency medical services would be the practical way of reaching all Iowans at a reasonable cost, and exotic ideas such as patient transportation by helicopter and computer-aided diagnosis and treatment are currently too remote to be considered for even metropolitan areas, much less for rural areas.

Proper distribution of hospitals, bed capacity, physicians, long-term care facilities, and availability of emergency medical services all go hand-in-hand, and one cannot be accomplished without the others. By achieving properly allocated hospital facilities, other services will also follow the pattern accordingly. Offering support on the local and national level to physicians who choose to practice in rural and sparsely populated areas can have some impact in achieving these goals. Such support may be in the form of a tax-break or community land grant for establishing outpatient clinics and small primary care hospitals.

Instead of linear relation between the annual cost and the total volume of operation (patient day or bed capacity in

this case) used in this study, one may use a quadratic relation. However, non-linear relations do not give a significantly better fit and improvement in the coefficient of correlation, R^2, is less than .5 percent. Using a non-linear relation, the formulation of an optimization model will be as follows:

suppose $C_j = a + b(U_j) + c\ (U_j)^2$ -- (10)

where Cj is thte total annual cost of providing Uj units of service (in area j), a, b, and c are constants.

Then total annual cost would be:

Production Cost + Transporation Cost.

Then the objective function will be:

$$\text{Minimize} \quad \sum_{j=1}^{n} C_j + \sum_{i=1}^{n} \sum_{j=1}^{n} C_{ij}\, d_{ij} V_{ij} \text{ ------ (11)}$$

Subject to: 1) $$\sum_{i=1}^{n} V_{ji} = D_j \text{ ------ (12)}$$

2) $$\sum_{i=1}^{n} V_{ij} = U_j \text{ ------ (13)}$$

As the number of planning areas increases, the size of this problem rapidly goes out of proportion, and the computer time required for its execution will increase drastically. However, it is doubtful that its solution would be very much different from consideration of a linear relationship.

CHAPTER VII. CONCLUSION

Experience has shown that the market forces (supply and demand) in the health care industry have not produced results by themselves that are to the best interest and satisfaction of the nation. Usually, in fact, competition on the part of suppliers has an adverse effect on the cost of services provided by hospitals and results in undesireable allocation of scarce national resources. Consumers of health care services are also not in a position to satisfy their needs by other means and methods or to restrain their own demands. Moreover, consumers do not have much choice and control over the amount and level of care they may and should receive; that is determined by the discretionary judgment of hospitals and their medical staff who have control over supply and demand at the same time.

Furthermore, once in the public eye (and supported by the law), equal access to health care services, regardless of ability to pay, is the right of individuals; application of the free enterprise principle of "Let them alone" to this sector of the economy is inconceivable. In so doing, the first to lose the battle for hospital care would be rural residents, the elderly, and the underprivileged. And that is not a socially-acceptable situation. However, the trend

shows that health care industry is moving toward centralization of its facilities in metropolitan and heavily-populated areas at the expense of rural areas.

A higher degree of centralization limits the providers' ability in grasping the needs of the community and responding to those needs with flexibility and comprehensiveness. Also, it lessens the consumer's influence and input in health planning policies and allocation of resources. Once centralization has gained momentum and takes place, it will take a longer period of time to put the system back in order again.

In Iowa, for example, the ratio of hospital beds per 1000 in some areas is as high as twice the national average while some areas have no convenient access to acute health care facilities. As a result, in spite of the oversupply of hospital facilities at the state level, new facilities should be established to serve the underserved areas, further worsening the maldistribution and oversupply of hospital beds across the state.

In this research it was also found that the annual rate of admissions per 1000 has a strong positive correlation with the ratio of hospital beds per 1000. Thus, it may be concluded that the root of some of the cost and utilization of the problem can be traced to excessive availability of hospital bed capacity in one area or improper distribution of

facilities.

These problems include:

-- Excessive transportation costs and inconvenient access that may discourage or deprive some groups from seeking or receving proper treatments.

-- Overuse of facilities by communities in which an extra capacity is available. That may be induced by hospital policies or physicians' incentive to maintain hospitals at a certain level of cccupancy.

-- Unpredicted shift of populaticn from one area to another, slower populaticn growth or any other changes that disturb the proper ratio of hospital bed per 1000. This shift may be caused by emigration or the community's failure to attract new industries and employment opportunities. This will expedite the centralization process and leaves less hope for smaller communities to have convenient access to health care services.

Thus, it is realized that the necessity of comprehensive health planning laws to regulate the distribution of health care facilities is inevitable. The main purpose of health planning laws is to

-- Improve the quality of health care delivery.

-- Provide equal access by all citizens, regardless of their sccio-economical status.

-- Contain the cost of health care services.

It should be realized that the problems of the health care industry and its delivery system deserve more thoughtful consideration and analysis than solutions generated by a spirit of the moment. Social consciousness on the part of providers, consumers, financiers, legislators, and government executive officers is also needed, although this attitude cannot always be legislated.

Belief and accusations about the overuse or misuse of services reimbursed under the present third party payment system have become widespread. Government study shows that misuse of publicly supported programs is more gross and significant than for other areas reimbursed by private insurance companies. Only through public education and awareness can wasteful consumption be stiffly curbed. No single party should be blamed for the skyrocketing costs of health care. Many problems in this field go hand-in-hand. Misuse of public health programs by providers as well as by consumers, politically oriented solutions, and subtle profiting from the resulting chaos are all closely interrelated and probably have the same origin: the social

attitude of individuals toward each other. Any reformatory action has more social implications than do economic and health planning attempts in restraining the cost of health care.

One of the channels through which public awareness can be achieved is effective participation of all parties involved in the process of planning and policymaking. Under the current health planning laws, full consideration is given to consumer participation.

The number of delegates representing each group both at the local and national levels is clearly specified. However, the quality and effectiveness of participation is not to be confused with the number of delegates specified by the law. Health planning is a complicated socio-economical and technical field, knowledge about which is not yet fully developed and many issues of which have yet to be resolved. Moreover, it is too early to evaluate the results obtained by some of the implemented plans. The subject is new to the providers and much more to the consumers.

Locally, the problem is more severe and consumer participation is not effective enough. Low turn out at public hearings arranged by the Health Systems Agency, at elections for consumer representatives, and the backgrounds of elected bodies all indicate the low extent of effectiveness of consumer participation. With the voluntary

nature of representation, one should not expect all consumer representatives to be professionally qualifed and knowledgeable on the subject matter.

Under the current health planning laws, the size of a planning area is defined in terms of its population. This measure in Iowa, which is mostly rural and sparsely populated, does not seem to be effective, limiting the extent and effect of consumer participation. Then, an area indicated by square miles is recommended as the standard to be used to determine planning areas instead of population.

Naturally in health planning areas encompassing wide regions, consumer participation will be less effective; ctiizen feedback does not flow easily; and planning agencies do not have a good grasp of the total problem. Further, the larger the planning area, the greater the chance of not fulfilling the needs of all parts of the region comprehensively. Too small a planning area may create the problem of overall coordination and emphasize the inavailability cf qualified personnel and delegates to manage its committees. In the current research, each county has been considered to be one planning area.

Rural transportation in Iowa, especially for the elderly, handicapped, and indigent, is a major problem, and, in most places, the private automobile is the only means of transportation. Moreover, all towns are not yet connected to

the 911 emergency telephone system. Although it might not be useful for emergency cases, a public transportation system shuttling between remote areas and nearby hospitals once or twice a week would be very helpful in facilitating access to these centers.

Another helpful innovation would be mobile clinics which visit an area at proper intervals. These could improve the delivery of health care and reduce costs. Mobile clinics should be associated with one or a group of hospitals and refer patients for hospitalization when it is deemed necessary. Joint sponsorship of mobile clinics by several hospitals in a region could control the flow of patients to a certain hospital, thus preventing overcrowding in one area and low occupancy in another. Such a referral network system would eliminate the need for duplication of services in several hospitals, so that, for example, services such as obstetrics, radiation therapy, and special surgical facilities could be centralized in fewer places. It would also reduce the number of hospital beds required in the region.

In conjunction with the solution offered above, it would also require one well-equipped hospital be centrally located to give administrative, medical, and technical advice to smaller hospitals operating within a certain distance and as satellites of the main hospital. Smaller hospitals, in

return for receiving administrative and medical services, would limit the scope of their work to primary care and refer more complicated cases to the nucleus hospital. As there is always an overlap between two adjacent regions, one small hospital might have such an arrangement with more than one main hospital. Development of such a network makes the provision of ancillary services also on a shared basis by participating hospitals more efficient and at a lower cost.

The size of the region and the maximum distance between the nucleus and satellite hospitals has to be carefully determined. The level and variety of services delivered by each hospital also need to be specified. The outlook for effective implementation of such a regional plan, as well as overcoming the politics involved in it, is not so encouraging. Collective efforts and shared services between Iowa hospitals has not been experienced yet. For example, many hospitals in Iowa hesitate to participate in a joint purchasing policy, even though it might benefit all hospitals. Personal differences and fear of losing identity and autonomy overshadow the economic outcome of cooperation among hospitals. Communities and hospital authorities may be willing to sacrifice favorable economic aspects of the solution for the sake of self-sufficiency.

The current reimbursement system also has an important impact on the cost and quality of health care. Most

insurance policies and third-party payments do not cover outpatient visits and annual check-ups. This discourages individuals from seeking timely and effective medical services. Consequently, a great majority of the population do not seek preventive medical care when they should and then there is a tendency to overuse it when it is too late. Although a limited number of health insurance plans sponsored by some employers provide check-up coverage, this is not a commonly-accepted practice, and its privilege is limited to a selected number of company officials.

In response to the problems of third-party payment, the establishment of Health Maintenance Organizations (HMO), such as Kaiser Permanent Medical Care Programs, has proved to be relatively successful. Under these plans, the hospital and its clinics are the providers and the insurers at the same time. Subscribers, by paying a certain amount annually as a subscription fee, receive a full range of comprehensive medical services. Some community hospitals have also experienced such arrangements and obtained satisfactory results.

One may argue that in the long run these organizations may lead to an unbreakable monopoly of health care industry, since in order to respond to the needs of young and unsettled families such an organization should have health care facilities in most parts of the country. This may be true,

but even if health care industry is molded into the form of a nation-wide utility industry, the conceivable advantages of this system outweigh its drawbacks. The major advantages of such an arrangement are as follow:

1 - By reducing the number of middlemen operating between the producers and the consumers, who do nothing but inflate the cost, savings to the consumer would be substantial. The proportion and the amount of the national health expenditures handled by private insurance companies shows the potential for saving.

2 - Direct relationships and communication between consumers and producers create a better opportunity for community participation and cooperation. They also help hospitals assess and respond to the needs of the community more precisely and objectively.

3 - Once the insurer and the provider are the same, delivery of health care services will undergo a major change. Although a hospital's implied benefit is in a higher admission rate and longer length of stay per admission, it would shift toward the expansion of outpatient facilities.

Since now every increase in cost is passed onto insurance companies, who in turn reflect that increase in their insurance premium, there is no incentive for

conservation and cost containment. With this process, neither consumers feel directly pressured to curb their unnecessary demand nor do providers to apply conservation measures. Direct contact between providers will make both parties more cost-conscious.

Support of community members, industry, and major employers is necessary for successful implementation of this plan.

One should not underestimate the impact of personal habits on the health of individuals. Instead of directing all resources toward treatment of patients, public education should be considered as part of the solution too. By starting health education at the school level and helping children mold sound health habits, better results would be obtained. Hospitals also should expand their responsibility in educating the public about its health. If it is considered that 1836 hospitals are owned and operated by state and local governments, it would be immediately recognized that the potential and means for carrying out this task are already available.

Cooperation between the Iowa Department of Health and Emergency Medical Services Advisory Council is also an important element which cannot be taken lightly. The EMS Council, which functions as a legislative and goal-setting authority, should be aware of the difficulties involved in

implementing the goals. However, the identity of these two departments has to remain intact.

Regarding health planning laws and their impact on accounting, more flexibility is required to allow rural hospitals to be mingled with long-term care facilities. As small rural hospitals cannot maintain a higher level of occupancy, they should be allowed to utilize the extra beds for extended care patients as long as "Uniform Accounting Procedures" are observed. This would help small hospitals obtain more financial stability during the lower occupancy period. Current regulations require that hospitals not be mixed with the operation of long-term care facilities.

Size and Location of Hospitals

The proposed plan for distribution of hospitals is intended to meet the needs of the community from 1980-1985. In areas where the existing situation is not compatible with the proposed plan and there is an extra capacity available, one of the following plans can be pursued:

A - Maintaining the status quo, but not allowing any further expansion until the population growth is matched with the capacity. This method is applicable only if the extra capacity is not extremely high. The net average population growth (birth-death) in Iowa during 1975 was 4.6 per 1000

of the population, thus, that adjustment may not be achievable in the foreseeable future.

B - Reassigning part of the facilities and services to operate in other areas. However, once hospitals are licensed to operate and deliver certain types of services in an area, reassignment would not always be possible. Cooperation of participating hospitals in this matter is very important.

C - Encouraging merging of two or more hospitals. That will make the hospital authorities recognize the extra capacity and duplication of facilities and services. Thus, part of the reduced capacity can be assigned to hospitals in other areas.

D - Creating sound and meaningful public relations. Although rural residents like to have hospitals located in their own community, they also have a tendency to use the services of large hospitals in metropolitan areas even if there is no difference in the quality of service. Rural hospitals should launch a well-designed public relations and marketing campaign to make the public aware of the variety and quality of services available in the hospital of their own community. On the other hand, community residents should be informed that by-passing these services will jeopardize the

existence of their community hospitals.

Most of the hospitals' collective effort, by the American Hospital Association, is absorbed by lobbying through legislators to influence the passage of favorable laws, but less attention is paid to public relations and community acceptance. For example, the number and variety of laboratory tests and radiology procedures per admission has been increasing significantly, which is mainly attributable to malpractice problems. This tension could have been satisfactorily eased if public relations had been in greater depth than they are now.

In this research, analysis of data from the last four years from hospitals with sizes ranging from 18 to 1160 beds indicated that the total annual cost of operating a hospital has a strong positive linear correlation with its size. On the other hand, statistically no significant correlation was found to exist between the cost per patient day or per weighted unit of service and the size of a hospital. This can be interpreted that once a hospital is established and is equipped for providing certain types of services, administrators and consumers will try to utilize it and to maintain it at a minimum level of occupancy. In some instances that level of utilization and occupancy is achieved by satiating the community and encouraging the use of the hospital.

Based on the above, it may be concluded that in order to minimize transportation costs, each community should have its own hospital facilities. However, a survey of current hospital facilities in Iowa indicates that no hospital with fewer than 72 beds meets the requirements of the Emergency Medical Services Council. It is estimated (based on the previous and current data) that, in 1980, a 72 bed hospital with an 80 percent occupancy rate can treat a total of 17,600 inpatient and outpatient visits per year. Thus, those counties which would have need for fewer than 8800 (half of 17,600) visits per year should seek the service of facilities in nearby counties rather than establish a facility of their own. The limitation on this solution is that according to EMS requirements, no citizen should have to wait to receive emergency services in an equipped facility longer than 60 minutes after the emergency service has been requested. The proposed size and location of hosptials minimizes the travel cost and meets the other constraints at the same time. Although this plan is based on the population distribution in 1980, no adjustment seems to be necessary from 1980-1985 unless the delivery of health care services undergoes drastic changes.

Recommended Areas Which Need Further Research

1 - Currently, the allocation of resources in funding

various health programs is either politically influenced or subjectively determined. A comprehensive study is required to determine the optimum level of expenditures spent in each of the following areas:

a - The amount of resources spent on health education rather than health care itself.

b - The amount spent on preventive medicine and infection control rather than treatment of diseases.

c - The allocation of resources for health and nutrition of children, support of indigent, pregnant; working mothers; drug addicts; and health of the elderly.

2 - National Health Planning and Resource Development Act, Public Law 93-641 specifies the size of areas served by each Health Systems Agencies by its population to be within the range of 500,000 to 3,000,000. Obviously, besides population, the following factors are of importance in the effectiveness of HSA's:

a - Population density, its mix and components, socio-econonomic status and homogeneity.

b - The area of the region (in square miles) and the farthest distance between the communities making

up the region.

In every regionalization plan, the optimum number and distance of participating hospitals in a collective effort and the utilization of shared services have to be determined. As an example, hospitals located within a certain distance from each other have a better opportunity to exchange services in areas of laundry, blood banks, and data processing than do those that are many miles apart.

3 - Allocation of bed capacity for different types of services. Utilization of hospital facilities established with the intention of use for a certain type of service cannot easily be used for other types of services. For instance, conversion of beds in a surgical ward to accommodate medicalpatients in most cases is possible (although not economical). Although utilization of intensive care units for medical-surgical patients is possible, the reverse process is not technically possible. Thus, certain types of facilities provide better flexibility than others do. The problem then is to obtain the optimum allocation of hospital beds for different types of services to meet the following criteria:

a - It provides maximum flexibility in accepting all kinds of patients.

b - It provides that the number of beds allocated to each type is within a certain range.

The problem of "Maximum Flexibility" can be extended to the case when several hospitals are operating in a region and exchange patients.

4 - Based on the available data, it was concluded that there is a linear relationship between the total cost and the number of hospital beds (or patient-day and units of service). Thus, one may expect the average cost per patient-day or per units of service to remain constant. But, further analysis shows that it is not necessarily true and average costper patient-day significantly varies between hospitals and even between hospitals of the same size. That implies the necessity of further research through other methods to investigate the effect of economy of scale on hospitals' costs.

5 - Usually, it has been claimed that larger and/or more expensive hospitals are capable and will provide a higher quality of service. However, no substantial evidence is available to prove or disprove such an argument. At least at the basic and primary levels of care this may not be true. Thus, further research should be done to investigate the

relationship of hospitals' costs with the quality of services they provide.

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* * * * * * * * * * * * * * * * * * * * * * * * * MULTIPLE REGRESSION * * * * * * * * * * * * * *

DEPENDENT VARIABLE..     COST

VARIABLE(S) ENTERED ON STEP NUMBER  1..     BED

MULTIPLE R              0.96647       ANALYSIS OF VARIANCE     DF      SUM OF SQUARES          MEAN SQUARE          F
R SQUARE                0.93407       REGRESSION                1.    2005913844.10506    2005913844.10506    1530.07193
ADJUSTED R SQUARE       0.93346       RESIDUAL                108.     141587262.08585       1310993.16746
STANDARD ERROR       1144.98610

---------------- VARIABLES IN THE EQUATION ------------------     ------------ VARIABLES NOT IN THE EQUATION

VARIABLE              B          BETA      STD ERROR B          F       VARIABLE      BETA IN     PARTIAL    TOLERANCE

BED              28.48837       0.96647       0.72830    1530.072
(CONSTANT)     -718.6565

MAXIMUM STEP REACHED
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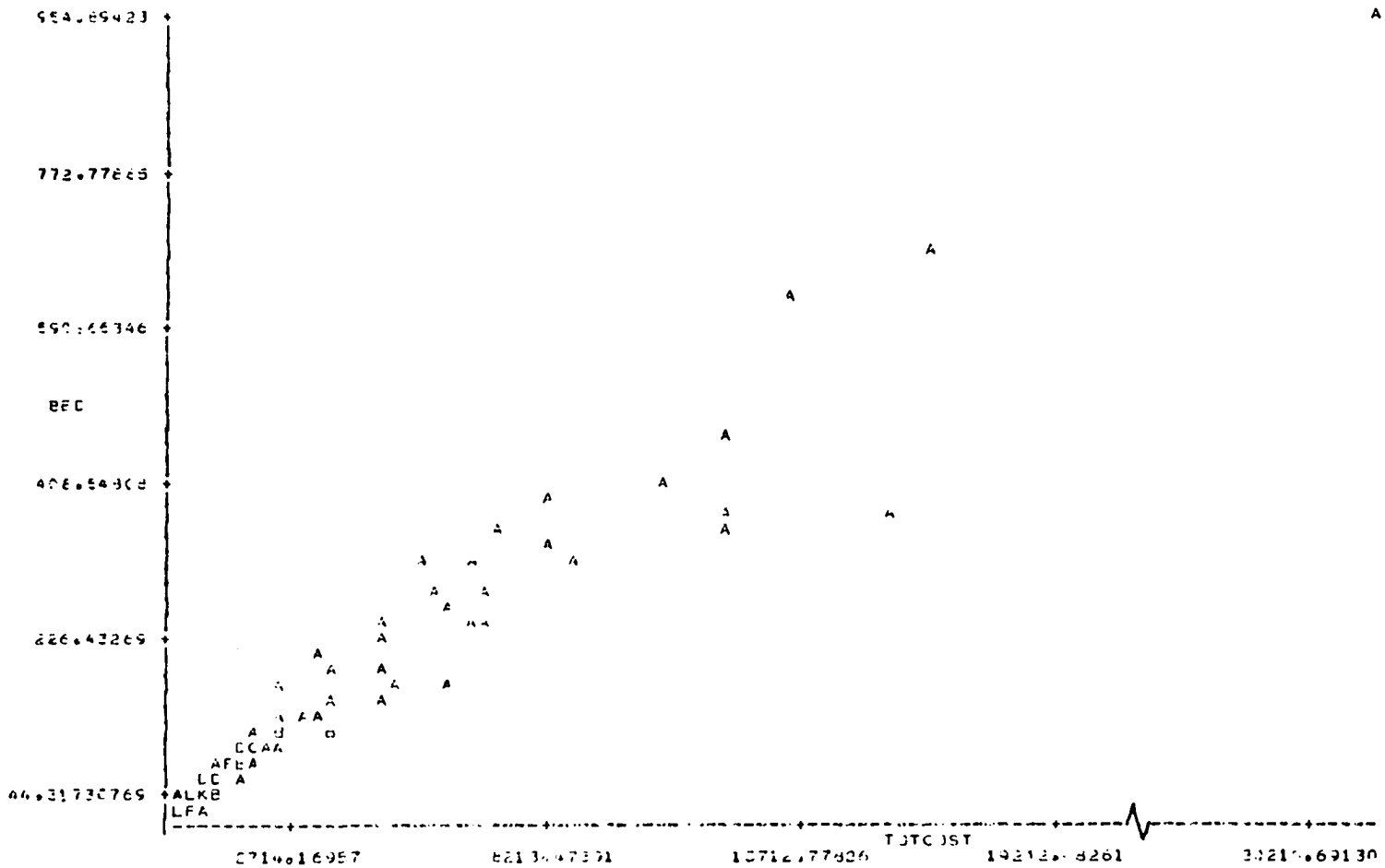
A-1 Analysis of relationship between number of Beds and total cost, 1973 data.



A-2 Plot of total cost vs number of beds, 1973 data.

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	0.[illegible]3210	0.[illegible]3210	13.[illegible]123	0.0[illegible]7	0.1[illegible]891993	25.44592 %
ERROR	108	0.[illegible]4934895	0.[illegible]45653			STD DEV	CPPD MEAN
CORRECTED TOTAL	109	0.[illegible]538105				0.[illegible]137033	0.[illegible]8401

SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
BED	1	0.[illegible]3210	13.20123	[illegible]7	0.0[illegible]63210	13.20123	0.0007

SOURCE	B VALUES	T FOR H0: B=0	PROB > |T|	STD ERR B	STD B VALUES
INTERCEPT	0.07758211	28.75455	[illegible]1	0.00269808	[illegible]
BED	[illegible]494	3.63335	[illegible]	0.0[illegible]1306	0.33[illegible]

A-3 Analysis of relationship between cost per patient-day and number of beds, 1973 data.

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	1617.18377999	1617.18377999	58.72955	0.0001	.38234439	29.26061 %
ERROR	108	2973.99778763	27.53701613			STD DEV	CPBD MEAN
CORRECTED TOTAL	109	4591.18155762				5.24748634	18.56820

SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
BED	1	1617.18377999	58.72955	0.0001	1617.18377999	58.72955	0.0001

SOURCE	B VALUES	T FOR H0:B=0	PROB > |T|	STD ERR B	STD B VALUES
INTERCEPT	13.24317690	23.11274	0.0001	0.66233749	0.0
BED	0.82557945	7.66352	0.0001	0.10773782	0.59350184

A-4 **Analysis of relationship between cost per bed and number of beds, 1973 data.**

DEPENDENT VARIABLE CPBD

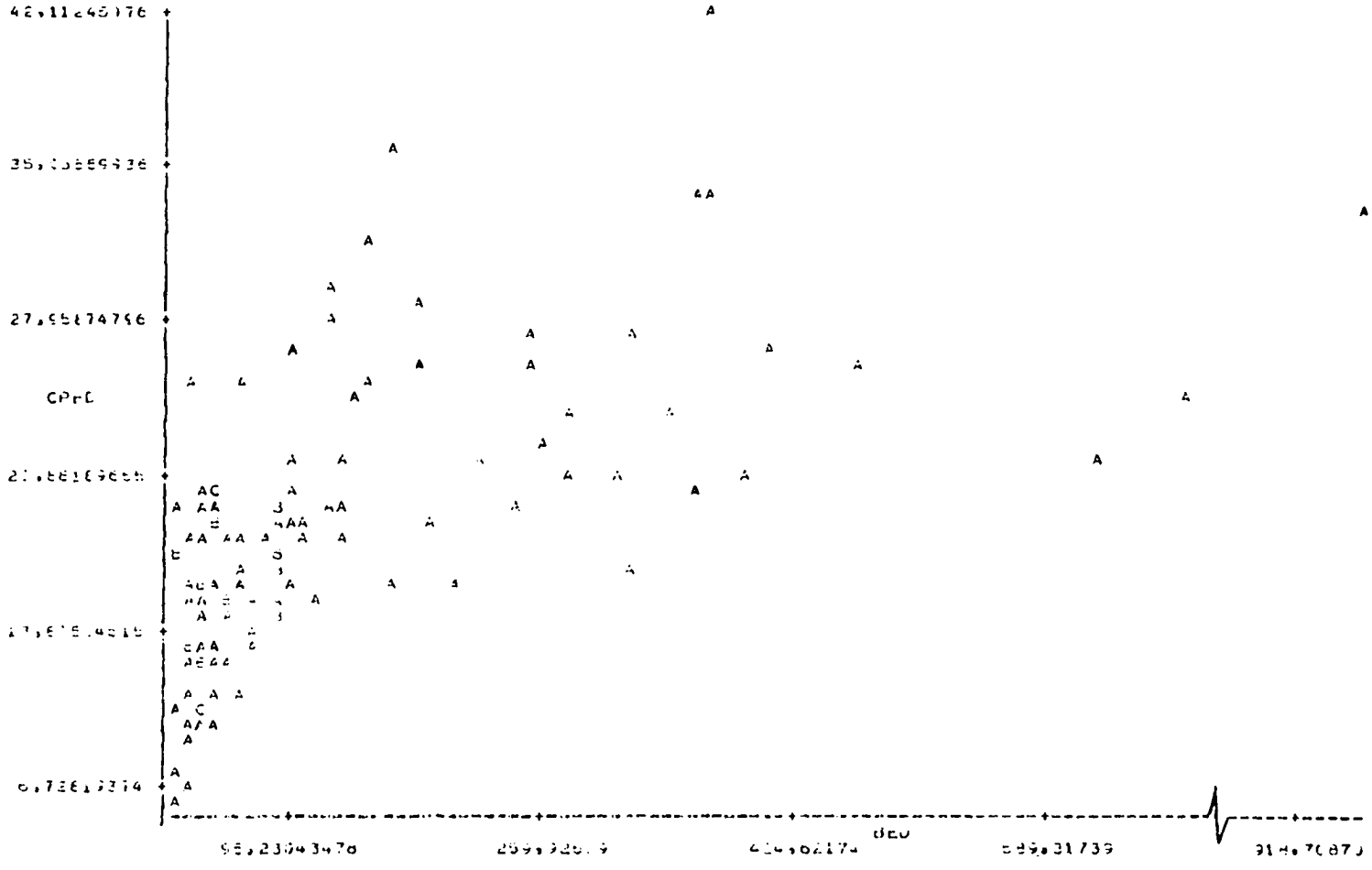
DEPENDENT VARIABLE CPPD

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	[illegible]	[illegible]	11.35911	[illegible]	[illegible]	23.64153 %
ERROR	108	[illegible]	[illegible]			STD DEV	CPPD MEAN
CORRECTED TOTAL	109	[illegible]				[illegible]	0.08401

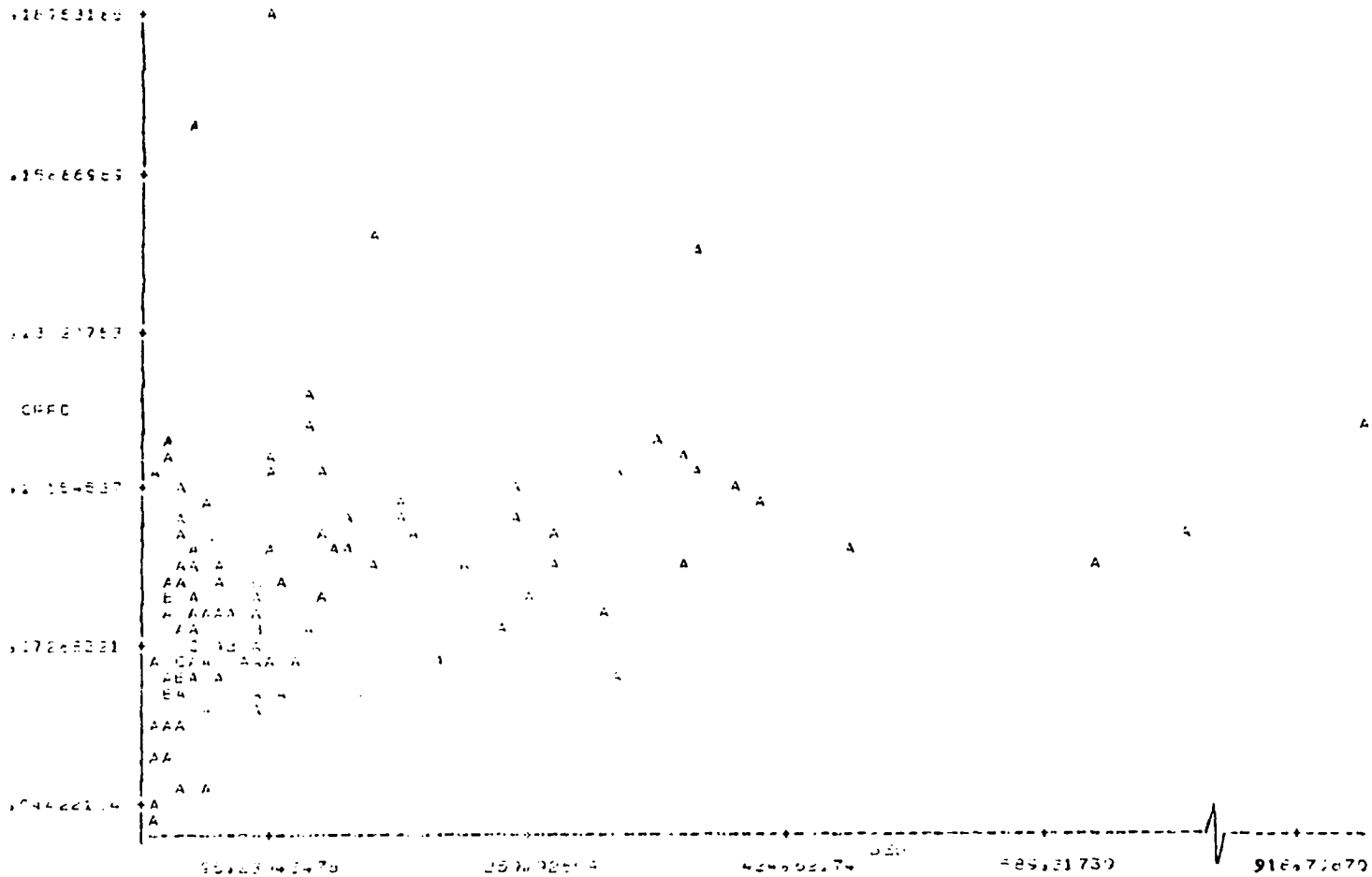
SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
PTDAY	1	[illegible]	11.35911	[illegible]	0.005527.48	11.35911	[illegible]

SOURCE	E VALUES	T FOR H0: B =	PROB > |T|	STD ERR B	STD B VALUES
INTERCEPT	0.07886349	30.32.33	[illegible]	0.01259437	0.0
PTDAY	0.01[illegible]	3.37133	[illegible]	0.00[illegible]	0.3[illegible]

A-5 Analysis of relationship between cost per patient-day and patient-day, 1973 data.



A-6 Plot of cost per bed vs bed, 1973 data.



A-7 Plot of cost per patient-day vs bed, 1973 data.

DEPENDENT VARIABLE TOTCOST

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	2948049556.93905	2948049556.93905	1575.93706	0.0001	0.93977114	39.06261 %
ERROR	101	188937116.76969	1870664.52247			STD DEV	TOTCOST MEAN
CORRECTED TOTAL	102	3136986673.70874				1367.72238502	3501.35922

SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
BED	1	2948049556.93905	1575.93706	0.0001	2948049556.93905	1575.93706	0.0001

SOURCE	B VALUES	T FOR H0:B=0	PROB > |T|	STD ERR B	STD B VALUES
INTERCEPT	-878.81772165	-5.04567	0.0001	174.17262652	0.0
BED	31.96756362	39.69807	0.0001	0.80526737	0.96941794

A-8 **Analysis of relationship between total cost and number of beds, 1974 data.**

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	2987073087.51119	2987073087.51119	2012.45524	0.0001	0.95221096	34.79550 %
ERROR	101	149913586.19754	1484292.93265			STD DEV	TOTCOST MEAN
CORRECTED TOTAL	102	3136986673.70874				1218.31561291	3501.35922

SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
PTDAY	1	2987073087.51120	2012.45524	0.0001	2987073087.51119	2012.45524	0.0001

SOURCE	B VALUES	T FOR HO:B=0	PROB > |T|	STD ERR B	STD B VALUES
INTERCEPT	-487.37741670	-3.26252	0.0019	149.38670231	0.0
PTDAY	0.11755496	44.86040	0.0001	0.00262046	0.97581297

A-9 Analysis of relationship between total cost and patient-day, 1974 data.

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	0.00892982	0.00892982	25.17478	0.0001	0.19952310	20.76209 %
ERROR	101	0.03582601	0.00035471			STD DEV	CPPD MEAN
CORRECTED TOTAL	102	0.04475583				0.01883383	0.09071

SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
BED	1	0.00892982	25.17478	0.0001	0.00892982	25.17478	0.0001

SOURCE	B VALUES	T FOR H0:B=0	PROB > |T|	STD ERR B	STD B VALUES
INTERCEPT	0.08308924	34.64370	0.0001	0.00239839	0.0
BED	0.00005564	5.01745	0.0001	0.00001109	0.44668008

A-10 Analysis of relationship between cost per patient-day and number of beds, 1974 data.

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	4099368000.29080	4099368000.29080	1437.64372	0.0001	0.935126620	41.97310 %
ERROR	168	287956560.40011	2851449.63333				
CORRECTED TOTAL	169	4387325220.69091				STD DEV	TOTCOST MEAN
						1688.62359137	4023.10909

SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
BED	1	4099368000.29080	1437.64372	0.0001	4099368000.29080	1437.64372	0.0001

SOURCE	B VALUES	T FOR HO:B=0	PROB > |T|	STD ERR B	STD B VALUES
INTERCEPT	-1083.96841480	-3.15337	0.0001	269.91473656	0.0
BED	37.09534630	37.91627	0.0001	0.97834898	0.93443051

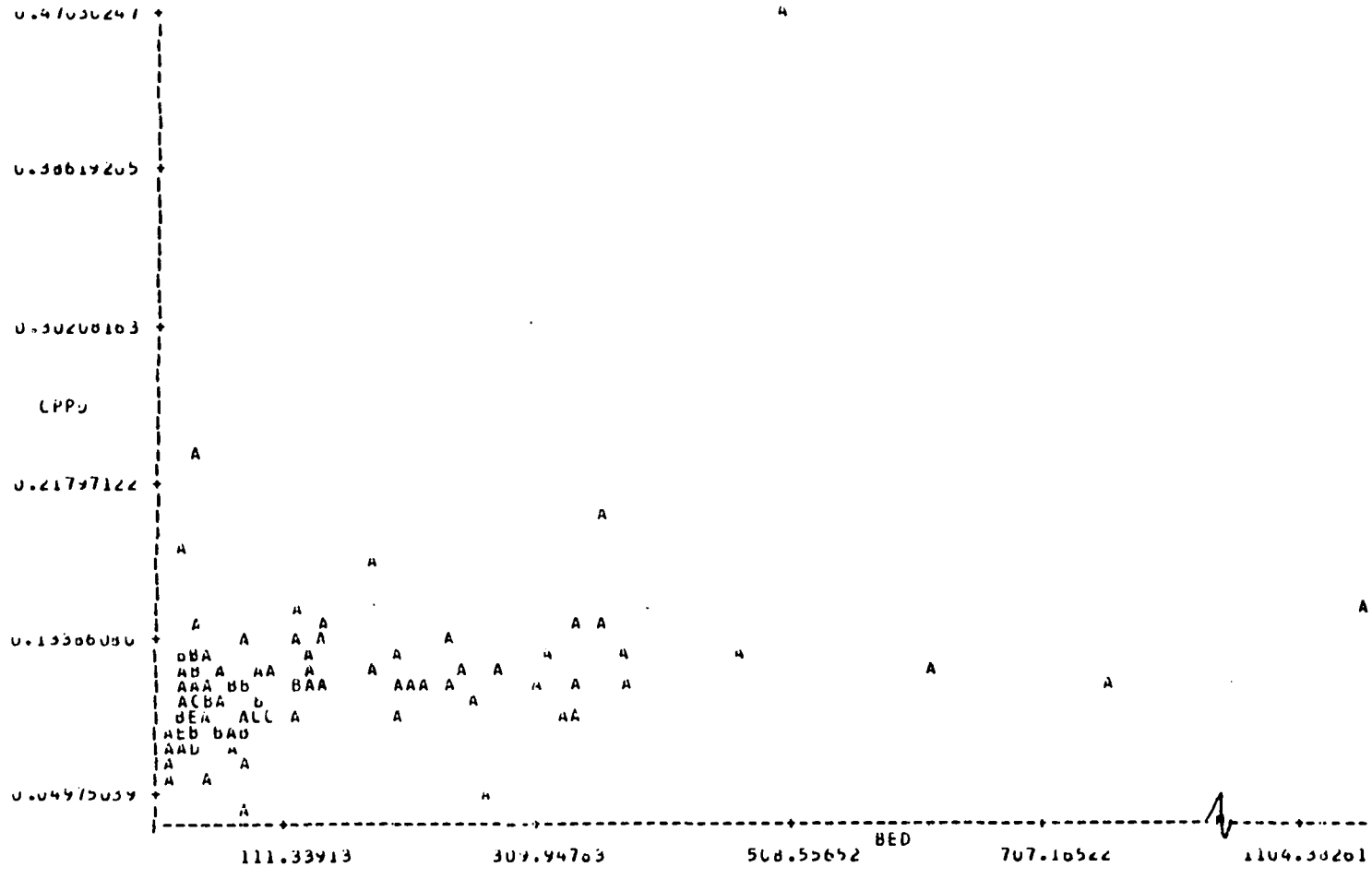
A-11 Analysis of relationship between total cost and number of beds, 1975 data.

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	3964275462.34951	3964275462.34951	966.35138	0.0001	0.89947423	50.34456 %
ERROR	108	443049764.34140	4102312.63279			STD DEV	TOTCOST MEAN
CORRECTED TOTAL	109	4407325226.69091				2025.41065659	4023.10909

SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
PTDAY	1	3964275462.34951	966.35138	0.0001	3964275462.34951	966.35138	0.0001

SOURCE	B VALUES	T FOR H0:B=0	PROB > |T|	STD ERR B	STD B VALUES
INTERCEPT	-456.47914433	-1.07026	0.0547	240.87063477	0.0
PTDAY	0.13484543	31.08619	0.0001	0.00433779	0.94840615

A-12 Analysis of relationship between total cost and patient-day, 1975 data.



A-13 Plot of cost per patient-day vs bed, 1975 data.

S T A T I S T I C A L A N A L Y S I S S Y S T E M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	0.02713927	0.02713927	15.04084	0.0004	0.12224268	33.92455 %
ERROR	108	0.19467715	0.00180437			STD DEV	EPPD MEAN
CORRECTED TOTAL	109	0.22201642				0.04247790	0.10913

SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
BED	1	0.02713927	15.04084	0.0004	0.02713927	15.04084	0.0004

SOURCE	B VALUES	T FOR H0:B=0	PROB > |T|	STD ERR B	STD B VALUES
INTERCEPT	0.09598930	18.17001	0.0001	0.00528048	0.0
BED	0.00039545	3.87825	0.0004	0.00002401	0.34963221

A-14 **Analysis of relationship between cost per patient-day and bed, 1975 data.**

S T A T I S T I C A L A N A L Y S I S S Y S T E M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	42060318282.07993	42060318282.07993	2280.23151	0.0001	0.95477825	33.78002 %
ERROR	108	1993069444.01098	18445434.67232			STD DEV	TOTCOST MEAN
CORRECTED TOTAL	109	44053252260.69091				1358.46775639	4023.10909

SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
OCS	1	42060318282.07993	2280.23151	0.0001	42060318282.07993	2280.23151	0.0001

SOURCE	B VALUES	T FOR H0:B=0	PROB > |T|	STD ERR B	STD B VALUES
INTERCEPT	-579.47634907	-3.58796	0.0006	161.44980408	0.0
OCS	0.08169118	47.75177	0.0001	0.00171075	0.97712755

A-15 Analysis of relationship between total cost and units of service, 1975 data. --

S T A T I S T I C A L A N A L Y S I S S Y S T E M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	5996996106.64146	5996996106.64146	1624.95024	0.0001	0.93984789	40.53497 %
ERROR	104	383819534.83134	3690572.16156				
CORRECTED TOTAL	105	6380815611.44340				STD DEV	TOTCOST MEAN
						1921.08619316	4739.35319

SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
BED	1	5996996106.64146	1624.95024	0.0001	5996996106.64146	1624.95024	0.0001

SOURCE	B VALUES	T FOR H0:B=0	PROB > |T|	STD ERR B	STD B VALUES
INTERCEPT	-1947.31197442	-6.26756	0.0001	442.36167537	0.0
BED	47.35527552	40.31057	0.0001	1.16731563	0.96945753

A-16 **Analysis of relationship between total cost and number of beds, 1976 data.**

S T A T I S T I C A L A N A L Y S I S S Y S T E M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	6162658373.16169	6162658373.16169	2937.86480	0.0001	0.96581045	30.55985 %
ERROR	104	218157238.28171	2097665.75271			STD DEV	TOTCOST MEAN
CORRECTED TOTAL	105	6380815611.44340				1448.33205866	4739.35019

SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
PTDAY	1	6162658373.16169	2937.86480	0.0001	6162658373.16169	2937.86480	0.0001

SOURCE	B VALUES	T FOR H0:B=0	PROB > |T|	STD ERR B	STD B VALUES
INTERCEPT	-681.90812805	-3.95064	0.0003	172.60079009	0.0
PTDAY	0.16462276	54.20237	0.0001	0.00304089	0.98275655

A-17 Analysis of relationship between total cost and patient-day, 1976 data.

S T A T I S T I C A L A N A L Y S I S S Y S T E M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	6104388581.79222	6104388581.79222	2294.04845	0.0001	0.95663143	34.41852 %
ERROR	104	276727029.65118	2660836.82357			STD DEV	TOTCOST MEAN
CORRECTED TOTAL	105	6380815611.44340				1631.26716758	4739.35019

SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
UOS	1	6104388581.79222	2294.04845	0.0001	6104388581.79221	2294.04845	0.0001

SOURCE	B VALUES	T FOR HO:B=0	PROB > ITI	STD ERR B	STD B VALUES
INTERCEPT	-872.31204156	-4.42598	0.0001	197.04776301	0.0
UOS	0.10243316	47.89623	0.0001	0.00213865	0.97607536

A-18 Analysis of relationship between total cost and units of service, 1976 data.

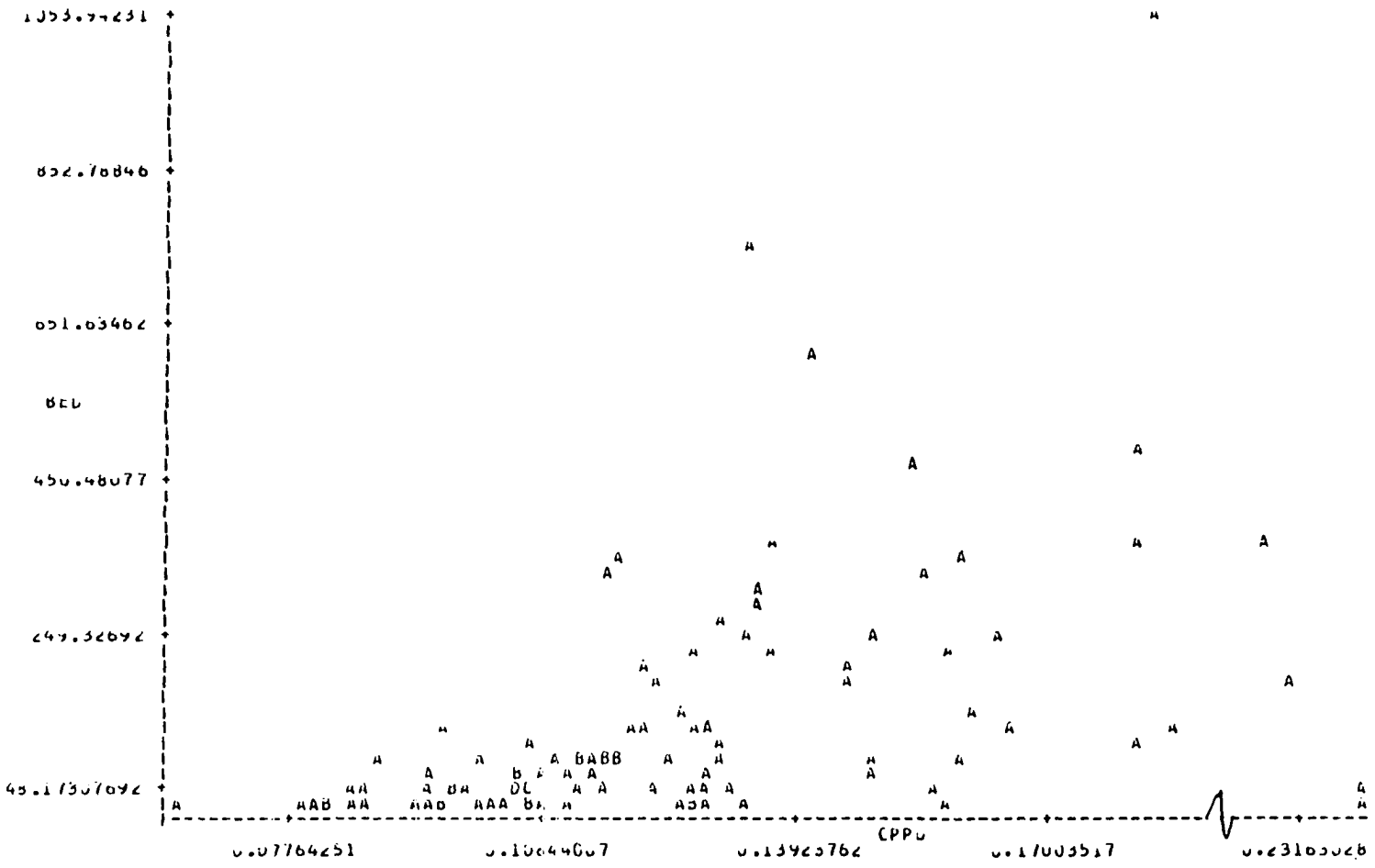
S T A T I S T I C A L A N A L Y S I S S Y S T E M

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PROB > F	R-SQUARE	C.V.
REGRESSION	1	0.02038671	0.02038671	22.32624	0.0001	0.17674702	24.09579 %
ERROR	104	0.09496609	0.00091314			STD DEV	EPPD MEAN
CORRECTED TOTAL	105	0.11535280				0.03021813	0.12541

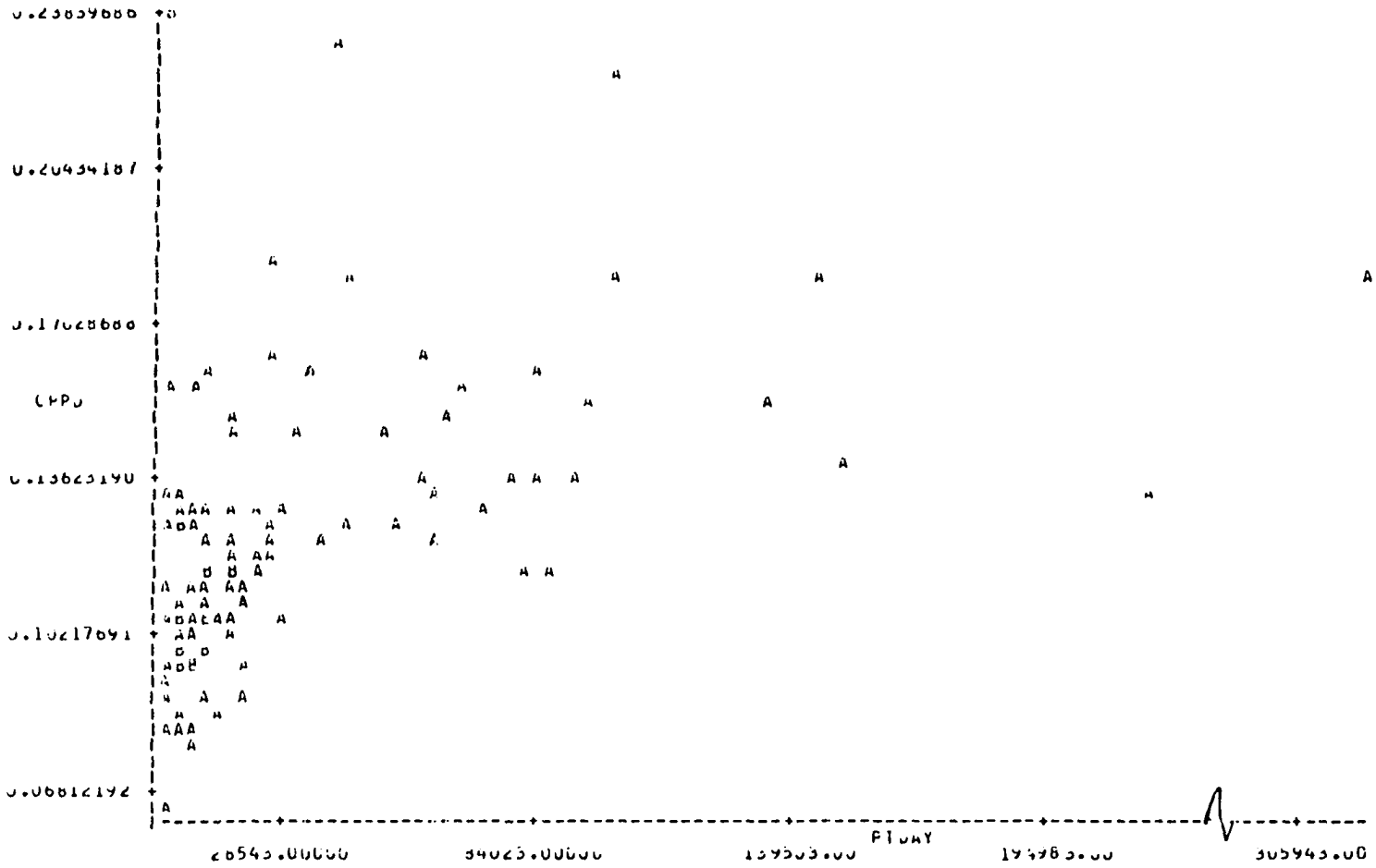
SOURCE	DF	SEQUENTIAL SS	F VALUE	PROB > F	PARTIAL SS	F VALUE	PROB > F
BED	1	0.02038671	22.32624	0.0001	0.02038671	22.32624	0.0001

SOURCE	B VALUES	T FOR HO:B=0	PROB > |T|	STD ERR B	STD B VALUES
INTERCEPT	0.11383546	29.80361	0.0001	0.00382014	0.0
BED	0.00008676	4.72528	0.0001	0.00001836	0.42041387

A-19 Analysis of relationship between cost per patient-day and number of beds, 1976 data.



A-20 Plot of beds vs cost per patient-day, 1976 data.



A-21 Plot of cost per patient-day vs patient-day 1976 data.

Table B. Average one-way travel distance within and between counties (in miles).

From	To	Miles	From	To	Miles
01	01	11.7	08	08	11.8
	02	33		25	30
	15	29		37	24
	39	28		40	24
	61	24		85	25
	88	31		94	35
				07	24
02	01	33			
	02	10.8	09	09	10.3
	15	35		12	30
	69	26		19	23
	87	23		33	29
	88	30			
			10	06	33
03	03	12.4		07	25
	96	25		10	11.6
				28	26
04	04	12.2		33	30
	26	25			
	68	21	11	11	11.8
	93	23		18	24
				21	24
05	05	10.4		76	26
	14	31		81	25
	15	25			
	39	22	12	07	30
	83	25		09	35
				12	11.9
06	06	13.3		34	23
	10	33		37	25
	48	30			
	57	26	13	13	11.8
	86	28		14	33
				37	24
07	07	11.8		75	25
	09	24		81	29
	10	25		94	24
	12	30			
	38	24	14	05	31
				13	33

Table B (Continued)

From	To	Miles	From	To	Miles
14	14	11.8	21	30	22
	24	24		71	23.6
	37	25		74	27
	81	35			
			22	22	14
15	01	29		28	32
	02	35		33	32
	05	25			
	15	11.8	23	23	13.8
	78	27		49	22
				82	24
16	16	11.8			
	52	25	24	14	29
	53	30		24	13.1
	70	32		43	31
	82	32		47	27
				67	35
17	17	11.8		83	25
	35	24			
	41	30	25	08	30
	98	21.7		25	12
				39	25
18	11	24		61	25
	18	11.8		77	26
	47	27			
	71	27	26	04	25
	75	31		26	11
19	09	23		89	24
	19	11.1		90	20
	34	29			
	45	22	27	20	21
				27	11.7
20	20	10.1		80	23
	27	21		93	23
	59	25			
	88	21	28	10	26
	91	29		22	32
				28	11.7
21	11	24		31	24
	21	11.8		53	29

Table B (Continued)

From	To	Miles	From	To	Miles
29	29	10.5	37	14	24
	44	23		37	11.8
	58	25			
			38	07	24
30	21	22		12	25
	30	10.1		38	11.2
	32	20.2		42	27
	72	20.2		86	33
31	28	24	39	01	28
	31	12.3		05	22
				24	25
32	30	20.2		39	11.8
	32	10.1			
	55	32	40	08	24
	72	20.2		40	11.8
				42	26
33	09	29		94	31
	10	30		99	23
	22	32			
	33	12.3	41	17	30
	96	33		41	11.8
				55	32
34	19	24		95	28
	34	11		99	28
	65	23			
			42	35	26
35	12	23		38	27
	17	24		40	26
	35	11.8		42	11.7
	42	26		64	35
	99	24		85	34
36	36	11.2	43	24	31
	65	21		43	13.0
	73	28		67	30
				78	30
37	08	24		83	31
	13	24			

Table B (Continued)

From	To	Miles	From	To	Miles
44	29	23	51	44	22
	44	10.3		51	10.4
	51	22		89	25
	56	22		90	26
	58	35		92	29
	92	31			
			52	16	25
45	19	22		48	26
	45	10.7		52	12.3
	66	23		57	29
	96	24		92	31
46	46	10.3	53	16	30
	55	30		28	29
	76	28		49	35
	94	23		53	11.9
	99	27		57	27
47	18	27	54	48	27
	24	27		54	11.8
	47	12.3		62	25
	67	33		74	30
	81	24		90	35
	97	34		92	25
48	06	30	55	32	32
	48	11.8		40	32
	52	26		46	30
	54	27		55	15.8
	79	31		95	30
49	23	22	56	44	22
	49	15.3		56	13.3
	53	35		89	33
50	50	13.2	57	06	26
	63	26		52	29
	64	25		53	27
	77	31		57	13.2
	79	27			

Table B (Continued)

From	To	Miles	From	To	Miles
58	29	25	64	85	25
	44	35		86	26
	58	9.5			
	70	21	65	36	21
	93	22		65	10.8
				69	24
59	20	25		73	35
	59	10.4		78	28
	63	26			
	68	20	66	34	23
	91	35		45	23
	93	19		66	10.6
				98	20
60	60	12.6			
	72	22	67	24	35
	84	26.3		47	23
				67	12.4
61	01	24		94	32
	25	25			
	61	11.6	68	04	21
	88	29		43	30
	91	26		59	20
				62	26
62	54	25		63	29
	62	11.7		68	10.8
	63	25		90	21
	68	26			
	79	25	69	02	26
	90	25		65	24
				69	10.2
63	50	26		73	21
	59	26		78	31
	62	25			
	63	11.8	70	16	32
	68	29		58	21
	91	25		70	10.8
				82	34
64	42	35			
	50	25	71	18	27
	64	11.8		21	23.6

Table B (Continued)

From	To	Miles	From	To	Miles
71	70	11.8	78	65	28
	71	22		69	31
	84	29		73	26
				78	15.6
72	30	20.2		82	29
	60	22.7			
	71	22	79	48	31
	72	10.1		50	27
				62	25
73	36	28		79	11.8
	65	35		86	25
	69	21			
	73	11.4	80	27	23
	78	26		80	11.3
				87	28
74	21	27		88	31
	32	22			
	55	30	81	11	25
	74	11.7		13	29
	76	24		14	35
				47	24
75	18	31		81	11.8
	75	14.4			
	84	25	82	16	32
	97	31		23	24
				73	34
76	11	26		82	12.1
	13	25			
	74	24	83	05	25
	76	11.7		24	25
				43	31
77	25	26		78	29
	46	28		83	12.2
	50	31			
	77	12	84	60	26.3
	85	30		71	29
	91	23		75	25
				84	13.7
78	15	27			
	43	30	85	08	25

Table B (Continued)

From	To	Miles	From	To	Miles
85	40	26	92	44	31
	42	34		51	29
	64	25		52	31
	77	30		54	25
	85	11.8		58	22
				92	11.7
86	06	25			
	38	33	93	04	23
	64	26		27	23
	79	25		59	19
	86	13		93	11.7
87	02	23	94	08	35
	80	28		13	24
	87	11.2		40	31
				46	23
88	01	31		94	13.3
	02	30			
	20	21	95	41	28
	61	29		55	30
	80	23		95	10.1
	88	10.2		99	26
89	26	24	96	03	25
	51	25		45	24
	56	33		96	13.8
	89	10.7			
			97	33	33
90	26	20		47	34
	51	26		67	32
	54	35		75	31
	62	25		97	14.9
	68	21			
	90	10.3	98	17	21.7
				66	20
91	20	29		98	9.9
	59	35			
	61	26	99	35	24
	63	25		40	23
	77	23		41	28
	91	11.8		46	27
				99	11.7