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Modeling the Determinants of Hospital Mortality

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This is to certify that the dissertation prepared by Abdolmohsin S. Al-Haider entitled Modeling the Determinants of Hospital Mortality has been approved by his committee as satisfactory completion of the dissertation requirement for the degree of Doctor of Philosophy.

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MODELING THE DETERMINANTS OF HOSPITAL MORTALITY

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by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Abstract

MODELING THE DETERMINANTS OF HOSPITAL MORTALITY

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This study examined hospital characteristics that affected the differential in hospital mortality, while controlling for the effect of community attributes. Analytical models for the determinants of hospital mortality were formulated and validated through an empirical examination of 243 hospitals that had higher or lower mortality rates than expected for Medicare beneficiaries. The dependent variable for this study was death rates for 1984 Medicare patients in United States hospitals released in 1986 by the Health Care Financing Administration.

Structural equation models that portray the causal relation between organizational constructs and hospital mortality rate were formulated. This causal model was empirically validated. The findings suggest that the "size" effect on hospital mortality is a spurious one. Specialization was found to be negatively related to hospital mortality when the effects of other variables were simultaneously controlled. Hospitals having a higher degree

of specialization tended to have a lower mortality rate. The effect of service intensity on hospital mortality was statistically significant when control variables were added into the equation. Thus, a hypothesized positive relationship between service intensity and hospital mortality was confirmed; the greater the service intensity, the higher the mortality.

Ownership and crude death rate both had a negligible effect on hospital mortality. The only control variable that was statistically significant is "teaching status". The teaching hospitals had a lower mortality rate than non-teaching hospitals did when other organizational factors were controlled.

CHAPTER I

INTRODUCTION

The health care marketplace in the United States is volatile and has gradually been transformed from a state characterized by loosely coupled organization into a highly regulated industry. Moreover, increased competition in the medical market has led hospitals and their management staffs to develop specific competitive strategies. At the same time, they are concerned as well with critical issues pertaining to the quality of care.

Background

Health care costs are straining the federal budget and the budgets of many states and local governments.
Public sector spending on health care services increased seven fold, from $11 billion to $78 billion, between 1965 and 1978. Medicare costs have about doubled every four years, growing from $9 billion in 1972 to $34 billion by 1986; the percentage of GNP consumed by dollars flowing into health care tripled in the same time period, rising from 3.5% to more than 10.5% on a rapidly expanding real dollar base.

Corresponding to this increase in expenditures has been an increase in resources and services. The number of physicians per 100,000 population increased from 133 in 1940 to about 215 in 1981, and has continued to rise. During the same period, the number of nurses increased from 216 per 100,000 population to 583. The number of complement personnel in the health care system, including professional, allied health, and service workers, increased from one million in 1940 to 5.3 million in 1981 (Ginzberg and Ostow, 1985).

As a result of the spiraling cost of health care, cost containment has become a major policy concern. Policies implemented to contain costs range from rate regulation to competition among delivery systems (Luft, 1985).

Regulatory Response to Rising Costs

Regulation has been implemented at federal, state, and private levels; its targets include capital investment, utilization, prices, and new technologies. First, by 1968 every state had passed Certificate of Need (CON) legislation to constrain the expansion of hospital and nursing home capacity by requiring an institution to convince the local health planning agency that a planned investment was needed. The consensus on CON's effectiveness in containing cost is that the legislation did not curb hospital investment (Salkever, 1976).

A second program, the Economic Stabilization Program (ESP) was implemented in 1971. Its regulations for institutional health care providers included a price freeze for physicians and hospitals until 1974. Holahan (1978) found that as a result physicians classified visits into more expensive categories, thus increasing their revenues while ostensibly holding the line on prices.

A third major regulatory effort was the establishment in 1972 of Professional Standards Review Organizations (PSROs) to review hospital utilization for quality and appropriateness. PSROs reviewed hospital use paid for by Medicare, Medicaid, and Maternal and Child Health programs to identify unnecessary treatment, and also assured quality through chart review and auditing. However, local physicians could establish and control the PSROs, and even delegate the utilization reviews to the hospitals (Luft, 1985). There is no agreement regarding the effectiveness of PSROs. Some studies found that the savings to Medicare and Medicaid exceeded the cost of the program by 10 to 20 percent (HCFA 1980); but others concluded that the program's cost exceeded any savings it generated (Government Budget Office, 1981). PSROs have now been replaced by Peer Review Organizations (PROs) which monitor hospital use under the Medicare prospective payment system.

The most recent regulatory change in Medicare established a prospective payment system (PPS) for hospitals, using diagnosis related groupings (DRGs). Under this system hospitals receive a fixed amount for each Medicare patient with a given diagnosis, according to regionally and nationally based rates for each of the 467 categories. Whereas the old system had encouraged hospitals to utilize services and thereby raise costs, by ensuring reimbursement for every stay, the advance payment of a fixed amount is viewed as a powerful mechanism for encouraging efficiency and containing costs of hospital care (Levine, 1985).

Finally, efforts other than CON to control new technologies now exist at federal, state, and private levels. The Food and Drug Administration (FDA) controls the approval of new drugs and devices. Although approval is based on safety and efficacy rather than cost, delays in approval have cost implications (Luft, 1985). HCFA and private insurance are guided by the Consensus Development Conferences of the National Institute of Health in deciding whether to reimburse new technologies. The reports of these conferences evaluate new technologies, providing guidelines for health center managements to follow in pursuit of lower costs as well as good results (Luft, 1985).

Policies on Competition

Policies that encourage competition in the health care field, though less prominent than regulatory policies, include a wide range of designs, targets, and levels of government action (Luft, 1985). The establishment of prepaid health care through the Health Maintenance Organization Act of 1973 ensured access by federally qualified HMOs to employee groups, and established a formal program of grants and loans; recently the grant and loan program has been abandoned in favor of private investment. The cost containment goal of the HMO Act was to be achieved directly through enrollment in prepaid plans, and indirectly by encouraging conventional providers to maintain their market share by being more efficient and cost effective.

Another major stimulant to competition in the health care field was the Supreme Court's ruling that removed the ban on advertising by health care professionals; advertising by health care providers increased substantially, but the effect on cost reduction is not conclusive. Competitive behavior also arises from state programs that require bidding for contracts to deliver services to Medicaid beneficiaries (Luft, 1985). The Federal Trade Commission also supported competition by enforcing anti-trust statutes against hospitals and medical societies that attempted to prevent the entry of HMOs into the market, and by forbidding as price fixing the development by physician groups of Relative Value Studies that set comparative weights for services.

Major Perspectives Used in Quality of Care Research

With the combined pressures on hospitals to contain costs and compete vigorously, serious concern has arisen about how cost containment affects the quality of care. Thus quality of care has been a focus of investigation for some time. Researchers in health services have conducted numerous studies using one of three different perspectives (Scott et al., 1976; Shortell et al., 1976; Ware et al., 1980; Quick et al., 1981; Shortell and LoGerfo, 1981; Flood et al., 1982;

Kane et al., 1982; Shukla and Turner, 1982; Flood and Scott, 1983; Blumberg, 1986; Dubois et al., 1987; Wan, 1987; Wan and Shukla, 1987). Those researchers doing patient-centered studies, for example, investigate individual differences in patient status (Kane et al., 1982) or patient satisfaction (Ware et al., 1980). Other studies of quality of care focus on organizational factors, examining incidents reported (Wan and Shukla, 1987), post-surgical infection rates (Flood and Scott, 1983), repeated hospitalization (Wan, 1987), and mortality rates (Blumberg, 1986; Dubois et al., 1987). However, the range of studies made from each of the major perspectives - individual patient characteristics, community/environmental attributes, or organizational structural and functional factors - has as yet determined very little about the relative importance of each of these major groups of attributes in accounting for the variation in hospital performance. Hence, in order to understand the quality of care hospitals are delivering in a changing environment, an important research goal is to identify not only the differentials in hospital mortality but also the pertinent factors that affect such differentials.

<u>Hospital Mortality as a Measure of Quality</u>

The Health Care Financing Administration (HCFA) is the federal agency most concerned with the effect of cost containment efforts, particularly the PPS, on the quality of health care. In 1986 HCFA released a list of the nation's hospitals having mortality rates significantly higher or lower than the national average. The release of that information was intended to enhance competition by providing physicians and consumers with more information, while at the same time counteracting the incentive in the PPS to reduce Medicare patients' services without regard to the quality of care (Fottler, 1987). In addition, the release of comparative mortality rates strengthened PROs' role in supervising quality of care and making sure hospitals monitored quality carefully as they adopted cost containment strategies. However, the HCFA release stressed that a hospital's presence on the list does not necessarily mean it is a poor quality provider; hospitals may meet criteria for quality care, yet still appear on the list with high mortality rates. This may be because they are referral centers for difficult cases or because they serve a population mix of atypical age, socioeconomic status or ethnic background. In other words, although HCFA seems to be using hospital mortality as a proxy measure for quality-of-care assessment, such use is questionable since death is only one of many possible treatment outcomes; mortality review is only one of several important components in a comprehensive quality control program. Thus, mortality can only point to the possibility of quality problems (American Hospital Association, 1987).

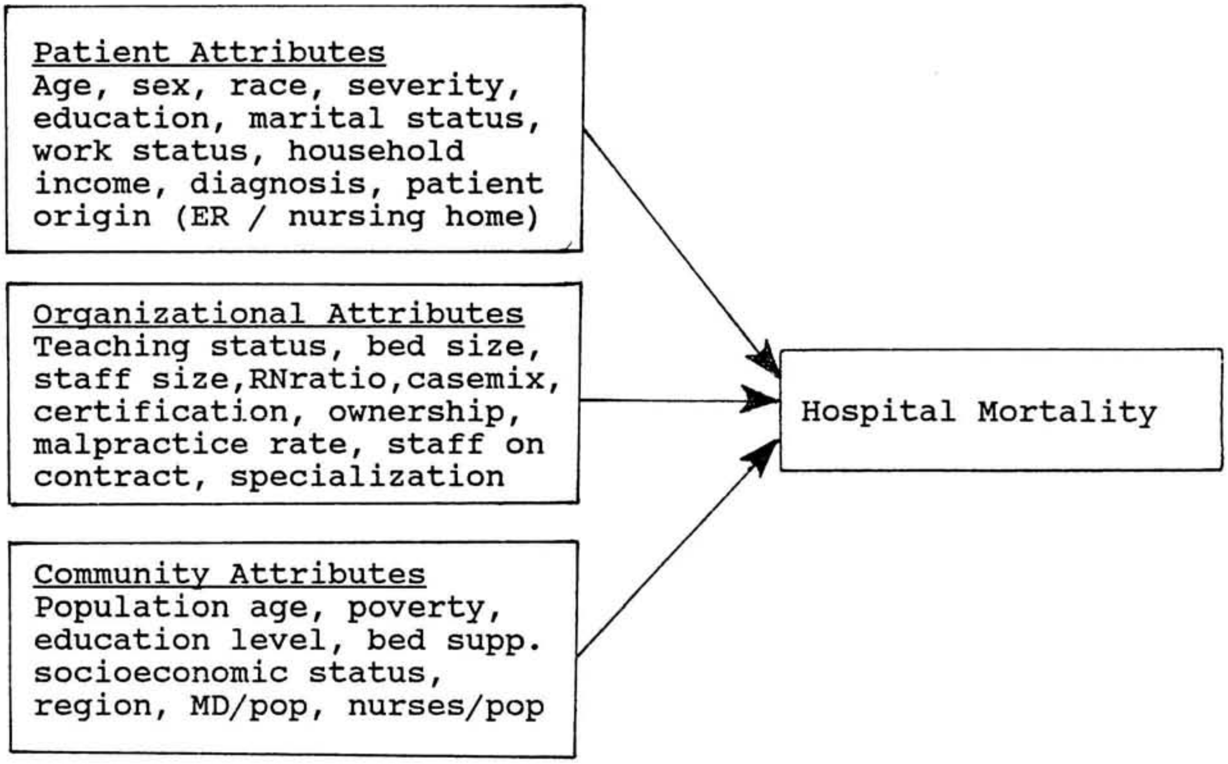
The mortality data are difficult to interpret and require further analysis, given the many factors that contribute to the variance the data show. Since it is not possible to infer quality differentials among hospitals solely from raw mortality statistics, it is essential to isolate the independent contribution made by each major factor. In particular, investigation of the contribution made by the hospital as an organization is an essential research goal.

<u>Major Factors in Generic Model</u>

As the foregoing survey of research has indicated, most factors contributing to the variance in hospital mortality statistics across hospitals can be reduced to three major categories: individual patient characteristics (P_i), hospital organization characteristics (O_j), and community attributes (C_k). Thus a generic model for investigating hospital mortality (HM) may be expressed as follows: $HM = f(P_i, O_j, C_k)$. A conceptual model for hospital mortality is presented in Figure 1. Since the particular problem of concern here is to isolate the organizational factors (O_j) that influence hospital performance, the other major factors must first be accounted for and controlled.

Individual patient characteristics (P_i) are important variables in predicting health care outcomes; indeed patient-centered studies of quality of care are more plentiful than hospital-level studies. Patient-centered studies of quality of health care focus on the patient as the unit of analysis.

Figure 1. A conceptual model of determinants of hospital mortality



They are concerned with evaluating patient functioning and patient satisfaction. A review of patient-centered research follows, to illustrate the importance of patient characteristics. However, it is important to note here that this study focuses on organizational determinants of hospital mortality and does not deal directly with individual patient attributes.

Zuckerman et al. (1980), in their study of patient care in a primary care setting, uncovered deficiencies in technical effectiveness. These included failures to order necessary tests and inadequate diagnostic work-ups, as well as deficiencies in psychosocial dimensions, such as patient dissatisfaction and physician-patient communication problems.

Wagner et al. (1983), in their study of the appropriateness of intensive care unit (ICU) admissions, found that for the hospitals studied roughly 13 percent of ICU admissions were at less than 5 percent risk of needing ICU care, an indication of inappropriate ICU admissions. Gertman and Restuccia (1981), using a standardized patient evaluation protocol to assess the appropriateness of patient admission, reported that inappropriate hospital patient days comprised over 10 percent of all hospital days.

Lubeck et al. (1985) compared the care of patients with osteoarthritis in three different types of health service: fee-for-service solo and group practices (FFS), the prepaid Kaiser Foundation Health Plan, and most significantly, in the experimental Midpeninsula Health Service (MHS), which charged fee-for-service but used salaried professional staff. MHS was comprised of a family health center offering comprehensive health and medical services, and a home care agency providing medical and hospice services in the home. MHS had four relevant purposes: first, provision of care to the maximum extent possible in the community and in the home; second, the elimination of redundant or indecisive diagnostic and therapeutic practices; third, an emphasis on health education, in order to provide supervised self-care; fourth, ownership and management by a Board of Directors elected by members. Lubeck et al. studied 241 patients over the age of 55 with osteoarthritis, whose regular source of care was either FFS, Kaiser, or MHS. The Health Assessment Questionnaire (HAQ) was used to measure satisfaction and utilization. Independent variables included sex, age, education, marital status, household income, work status, years with provider, and type of primary physician. Health status was indicated by self-reported functional disability, arthritic pain, overall health, and the presence of co-morbid conditions.

MHS members reported the least disability, the least pain, and the highest overall health. They also had the lowest number of specialty visits, fewer physician-initiated visits, comparable number of patient-initiated visits, and fewer persons taking antiinflammatory drugs. Tentative conclusions drawn after 18 months of this five year study were that there existed alternative strategies for modifying financial incentives that contributed as well to the search for effective, efficient and satisfying health care.

Hobler et al. (1984) studied the relationship of cost and quality in three hospitals. Their sample included 400 patients discharged in 1980 who had biliary tract surgery at one of the three hospitals. Clinical data taken from the discharge abstract forms included principal diagnosis, secondary diagnosis, procedures, age, length of stay (LOS), sex, and discharge disposition. No significant differences in mortality rates or in complication rates were found among the three hospitals. However, hospital A had a longer average LOS than hospitals B and C, and LOS of patients discharged to nursing homes was higher than for other patients. The longer LOS in hospital A could not be explained on the basis of age, comorbidity, complication incidence, or mortality; the authors speculated that it was due to practitioner and/or hospital inefficiencies.

Wan et al. (1980) examined the effects of geriatric day care and homemaker services on patient outcome. They studied a sample of 1153 patients divided among three study groups: (a) 384 patients using day care services, (b) 630 patients using homemaker services, and (c) 139 patients using combined services. Patients in each of the three settings were randomly assigned into experimental and control groups.

Three outcome measures used were the Index of Activities of Daily Living (ADL), the Mental Status Questionnaire (MSQ), and a measure of contentment and general life satisfaction that measured the adequacy of role performance. The study analyzed five groups of variables: (a) socio-demographic factors (age, sex, race, marital status, and living arrangement), (b) prior levels of psychosocial functioning (contentment level, mental functioning, and activity level), (c) physical health status (dependency level, number of chronic conditions, bed disability days, and medical diagnosis), (d) prognostic measures (ADL prognosis, psychological functioning, social functioning, impairment prognosis, bed inability prognosis, and institutionalization prognosis), and (e) health services utilization (skilled nursing facilities, inpatient hospital days, day care use, homemaker services, home health care, hospital outpatient services, non-hospital ambulatory care, and site of study). The authors found that for the total sample the five most important predictors of survivorship were primary diagnosis, inpatient hospital days, day care use, study site, and use of non-hospital ambulatory care. They concluded that both geriatric service modalities had positive effects on patient outcomes and a strong effect on survivorship.

<u>Perspective of The Present Study</u>

This study did not examine individual patient characteristics as contributing factors to the variance in hospital mortality rates for several reasons. First, the most important patient factor, the need for health care as expressed by case mix, is available as an organizational hospital variable and was incorporated in the analysis. Second, because the Medicare patient population is a fairly homogenous one, other patient characteristics such as age and socioeconomic status have diminished importance. Third, HCFA, in computing the expected mortality rate, used a multiple regression model with Medicare inpatient mortality rates as the dependent variable, and predictor variables included average age of the discharged Medicare patient, proportion male, proportion black, proportion whose race was neither black or white, and proportion of Medicare discharges in each of fifty highest frequency DRGs (Fottler et al., 1987).

The present study focused on organizational characteristics. The growth of regulatory and legal constraints on health institutions has shifted the locus of concern for the quality of care to the organizational level. The shift reflects equally far-reaching changes in the structure of delivery, from the personal doctor-patient relationship to a process carried out within complex organizational settings - hospitals, clinics, physician groups, and emergency rooms; and change as well in method of payment, from direct exchange between provider and client to more complex structures of third party payers (Rhee 1983).

These three profound structural transformations in the health care system point clearly to organizational characteristics as the most important determinants of quality of care.

Organizations, however, do not function in a vacuum, but in their environments; they are therefore influenced by the attributes of the community in which they operate. Hence community factors were controlled for in the initial exploratory analysis, and were then accounted for in the confirmatory analysis.

A considerable literature has been devoted to the study of organizational determinants of quality of care in hospitals. This will be reviewed in detail in Chapter 2.

It should be noted here that a variety of indicators can affect hospital quality of care. Of particular importance is the mortality rate. Hospital mortality is obviously the most extreme outcome of care; the greatest effort is put forth to avoid or delay this outcome. Hence, death is one form of outcome that is tied more directly to organizational characteristics of hospitals.

The literature on organizational theory offers useful typologies of the essential characteristics of organizations. Rhee (1983), in a comprehensive review of the literature, identifies various organizational factors that studies have linked with the quality of care: goals; technologies; size; volume of service; specialization; formalization; decision making structure; coordination, control and integration;

visibility of consequences; and medical staff organization. Hospital goals included patient care, education, teaching and research, non-profit making, and the provision of high quality care. The author observed that formal commitment to teaching facilitated a higher quality of care than did commitment to patient care alone, but concluded that more research is needed to confirm this relationship. Absence of profit-making, as indicated by ownership, provided conflicting results, since ownership is confounded with differences in size, teaching status, casemix, and other variables that may be related to the measured quality of care. No definitive study was found of the impact of technology on quality of care. Some researchers found size related to higher quality of care, but others found no such relationship; Rhee states that it is difficult to separate out the unique effect of size since it tends to be associated with other powerful correlates of quality such as medical school affiliation, highly specialized physicians, advanced technology, and greater service volumes for certain conditions and diseases. The volume of service for specific types of conditions or diseases has itself been considered an important predictor of quality of care because, according to Rhee, a minimum caseload is essential to maintain the proficiency of staff and to support a hospital's specialized facilities, services, skills, and staff. Specialization, or the degree of division of work within an organization, was also positively related to quality of care, provided effective coordination existed.

Another typology of organizational characteristics is important for its support of the argument that technological characteristics of hospitals contribute most to the variance in mortality rates across hospitals. Daft (1983) characterizes organizational dimensions into two types: (a) structure, which pertains to internal characteristics of the organization; and (b) context, which characterizes the whole organization including its environment. Structural dimensions are static, providing a basis for comparison; they provide useful labels to describe organizational differences. Contextual dimensions, on the other hand, are important because they influence structure. The structural dimensions include: formalization, specialization, standardization, hierarchy of authority, decentralization, professionalism, and personnel configuration. Contextual dimensions include: (a) size, which refers to the number of people in the organization; (b) organizational technology, which is the nature of the production task; and the (c) environment, meaning all elements outside the boundary of the organization. In this study a subset of these will be utilized to develope organizational constructs. These include contextual dimensions such as size, organizational technology, and environment; and structural dimensions such as specialization. The size dimension was used to develop the organizational construct of size which includes hospital bedsize, the total number of hospital personnel, total expenditure, and the number of high tech services offered. The dimension of organizational technology, and specialization were used to develop the organizational construct of specialization which includes Rn-nurse ratio, percent board-certified physicians, case mix, and percent of surgical patients. The dimension of environment was used to develop control variables.

Purpose of the Present Study

The purpose of this research is two-fold. First, through a focus on hospital mortality, it examined organization structural and functional characteristics of hospitals that affect the differential in mortality; while simultaneously considering the effect of community attributes. Then, several analytical models of the determinants of hospital mortality are formulated and validated using a confirmatory approach.

Significance of the Study

The present study is significant for three reasons. First, since quality of care in hospitals is affected by a variety of hospital organizational factors and community characteristics, the investigation of multiple factors affecting hospital mortality can enhance our understanding of the variation in hospital performance. Second, sophisticated modeling techniques are available to capture the major organizational factors that may affect hospital performance. Third, this type of organizational study may yield information that will reveal differentials in hospital performance (i.e.,quality of care). This study provides useful information on organizational differentials in hospital mortality, but beyond that it offers a statistical adjustment procedure that can take into account important organizational and community characteristics in differentiating hospital performance. Thus, the present study can contribute to the development of a sound administrative strategy to correct the weakness of the current prospective payment system based on Diagnostic Related Groupings (DRG).

Outline of Remaining Chapters

Chapter 2 presents a review of the literature in two parts. The first section reviews organizational studies of quality of care, and the second reviews studies based on an integrated approach to studying quality of care. A brief critique of the studies is presented at the end of each section. Chapter 3 outlines the research design of this study and describes the methodology and data used. In chapter 4 results are detailed. Finally, in chapter 5 the results are summarized, conclusions are drawn and recommendations for further studies are presented.

CHAPTER II

REVIEW OF THE LITERATURE

The current pressures on health care organizations to contain costs make it essential to examine how issues of rising health expenditures affect quality of care. In order to do so, one must begin with a useful operational definition of quality of care. Donabedian (1980) states "quality of care is a property of, and a judgement upon, some definable unit of care, and that care is divisible into at least two aspects: technical care and interpersonal care." Technical care is concerned with the application of medical sciences and technologies to achieve optimal health care outcomes, whereas interpersonal care is determined by the degree of the conformity of the interpersonal relationship to socially defined values and norms which govern the physician-patient interaction.

It has always been a complex undertaking to judge whether or not increased health care expenditures produce substantially improved hospital performance. Furthermore, the implementation of the PPS has recently raised the level of concern about the quality of health care delivered in hospitals. Thus examination of performance criteria is a research issue of increasing importance.

One unexplored area is the potential utilization of hospital mortality rates as indicators of hospital performance. Since they measure only aggregate performance, mortality rates are too simplistic to be used as a sole outcome measure; multiple factors influencing hospital mortality need to be taken into account (Blumberg, 1987; Fottler and Slovensky, 1987).

Performance criteria may be categorized as either process criteria or outcome criteria. Donabedian (1980) offers an analysis of these two types of criteria. The major advantages of using process criteria are:

1. They reflect good medical practice.

2. Since medical records contain information about the process of care, it is accessible and timely; thus it may be used for preventive or interventive purposes.

3. Process criteria allow responsibility to be specifically assigned, which in turn allows for specific corrective actions.

The disadvantages of process criteria are:

1. There is little scientific basis for many accepted medical practices which are used today.

2. Process criteria tend to overemphasize technical care at the expense of the interpersonal process, because practitioners tend to be less concerned about interpersonal relations.

The major advantages of outcome criteria are:

1. Outcome criteria allow a more flexible approach to management.

2. Outcome measures are integrative measures of the quality of care provided by all practitioners.

The major disadvantages of outcome criteria are:

1. It is difficult to assess the extent to which an outcome can be considered a result of medical care.

2. It is difficult to pinpoint the responsibility for an outcome as reflecting a certain segment of care.

3. Information about outcomes is often not available in time for some types of monitoring.

4. An emphasis on outcomes fails to consider the presence of redundant or excessive costs of care.

To date a comprehensive outcome measure of hospital performance is not available, although a variety of case mix indexes have been constructed (Luke, 1979; Goldfarb and Coffey, 1987; Hornbrook, 1986; Pettengill and Vertrees, 1982; Rafferty, 1971; Fetter et al., 1980).

The following review of research literature is divided into two sections. First, organizational studies of the quality of care are summarized and their strengths and weaknesses are discussed. Second, a summary of studies employing an integrated approach for both organizational and community perspectives is presented. The integrated approach is the basic framework used to guide the present study.

Review of Organizational Studies on Health Care Outcome

Organization-centered studies on the quality of health care generally use the hospital as the unit of analysis, and are concerned with evaluating the organizational performance . In analysis at the hospital level, investigators measure the degree of efficiency, accessibility, and satisfaction with care that a hospital system achieves. A model that can predict well at the hospital level, however, may not predict well at the individual (patient) level because it does not easily account for varying patient characteristics.

Palmer et al. (1979) reviewed medical care literature to identify major characteristics of physicians and medical care institutions that may indicate the quality of medical care. They emphasized empirical studies that investigated the association between structural indicators and measures of quality of care, and studies that used data routinely available in records from any medical care facility. Physician variables included: (a) medical school performance, (b) type of medical school, (c) post-licensure training, (d) specialty certification, (e) site of medical practice,(f) graduation from a foreign medical school, (g) age and experience, (h) continuing education, and (i) specialization. Institutional variables include: (a) teaching status,(b) size, (c) volume, (d) ownership, (e) malpractice rate, (f) medical staff organization, (g) group versus solo practice, (h) ancillary and support services, and (i) organizational characteristics (coordination, differentiation, standardization). Specialization, measured for both physicians and hospitals, was found to have a significant impact on quality of care. None of the studies, however, indicated that staff physicians' medical school performance indicates quality of care. There was some evidence that graduates of medical schools with a strong emphasis on specialization or research provide a higher quality of care than did those from medical schools that are practice oriented. Training was found to be an important indicator of quality of care; however, the length of training was less important than either its quality or appropriateness.

The evidence on the relationship between certification and quality of care is conflicting, in that most studies did not report significant correlation between certification status and quality of care. No clearly defined relationship was found, either, between age of the physician and quality of care, or between participation in continuing education and quality of care. Teaching status of the hospital did emerge as an indicator of quality, but only provided that the variation in quality among geographic locations, and the type of ownership are taken into consideration.

Several studies (Neuhauser, 1971; Payne and Lyons, 1972; Rhee, 1976; Roemer, 1959) found size to be related to quality of care. However, the relationship is complicated because it is dependent on many other variables included in the analysis, among them medical school affiliation and volume. Volume of a given procedure or type of patient is shown to be necessary for a hospital to support specialized facilities, services, and skills. Although a less than adequate volume may detract from high quality of care, adequate volume alone does not guarantee higher quality.

The authors of these studies did not find significant association between ownership and quality of care. However, several studies suggest a number of variables as a starting point for research on quality of care. They are:

1. Proportion of medical staff from teaching or research-oriented medical schools.

2. Proportion of medical staff having undergone training appropriate to the current area of practice.

3. Proportion of medical staff whose postgraduate training took place in medical school-affiliated training programs.

4. Proportion of medical staff whose primary site of practice is a medical school-affiliated institution or who possess medical school or teaching hospital appointments.

5. Proportion of physicians-in-training graduated from U.S. medical schools.

6. The existence of key specialty departments or well-developed mechanisms for referral to such specialty departments.

7. The existence of a well-organized mechanism for

coordinating patient access to appropriate specialty care.

8. Teaching status of the hospital.

9. Adequacy of volume of given procedures or types of patient.

10. Malpractice rate.

11. Policies and procedures governing staff appointments and review of privileges.

12. Proportion of medical staff on contract.

13. Proportion of group practitioners to solo practitioners on the staff.

14. Proportion of registered nurses to practical nurses and aides in direct patient care roles.

Scott et al. (1976) examined the relationship between structural features of hospitals such as differentiation, coordination, power (defined as the extent to which members or subunits can influence organizational decisions) and staff qualifications, and the medical outcomes of selected types of surgical patients. They found that increased coordination and differentiation might increase the quality of care in the operating room, but not at the overall hospital level. Power of the medical staff, as measured by admission requirements for membership on surgical staff, was found to be positively related to the quality of surgical care. The qualifications of the nursing staff as indicated by RN ratio were found to be positively related to the outcome. On the other hand, although the qualifications of physicians as indicated by the proportion of staff surgeons who were board-certified were positively related to outcome, that relationship was not statistically significant.

Shortell et al. (1976) examined the impact of management and organizational variables on the quality of care as measured by post-surgical complication rate and medical-surgical death rate, after controlling for differences in hospital case mix. They found that regularly scheduled meetings between nursing, laboratory, and radiology staff members were associated with higher quality of care, and that department heads' participation in hospital-wide decision making was also similarly related. They also found that greater perceived medical staff autonomy was negatively related to quality of care. In the same study, the authors found that higher cost per case was significantly associated with a higher medical-surgical death rate, and concluded that some of the mechanisms designed to control costs may also be associated with higher quality.

Shortell and LoGerfo (1980) examined the relationship between the factors associated with hospital quality of care and the quality of care outcome for two medical conditions: acute myocardial infarction and appendicitis. The three explanatory factors considered were:

1. Hospital structural characteristics, such as bed size and teaching status.

2. Individual physician characteristics, such as

specialty and board certification status.

3. Medical staff organization characteristics, such as the degree of staff participation in hospital decision making, and coordination and control exerted through committees.

The outcome measures used for the two medical conditions were the standardized mortality ratio and standardized percent normal tissue removed. Shortell and LoGerfo found that the medical staff organization characteristics had more impact on the quality of care than hospital or physician characteristics, in that the involvement of the medical staff president with the hospital governing board, overall physician participation in hospital decision making, the frequency of medical staff committee meetings, and the percentage of active staff physicians on contract are all positively associated with higher quality of care.

In a study of the relationship between the structure of nursing care and patient satisfaction comparing primary nursing using all RNs versus team nursing using RNs, LPNs, and aides, Shukla and Turner (1984) found that the primary nursing structure was perceived by patients as having higher omissions in care for three out of six categories of care. The authors concluded that the effect of nursing care structure on patients' perception of care may be contingent on the efficiency of support systems and on the competency of the nursing staff.

Recently, Wan and Shukla (1987) studied the quality of nursing care in 45 community acute care hospitals in the United States. They used incident rates generated from hospital reports of the volume of:

1. Errors in medication.
2. Errors in intravenous line administration.
3. Patient falls.
4. Patient injuries.
5. Inappropriate diagnostic and therapeutic interventions as an outcome measure.

The influence of contextual and organizational variables on quality of nursing care was examined. Contextual variables, which are attributes of the hospital's region and community and are beyond the hospital's control, were used as independent variables. Also included were community attributes such as poverty level, educational level, percentage of the aged population in the hospital's catchment area, and the number of available acute care hospital beds and registered nurses in each hospital's catchment area. Organizational variables, which are structural variables but are also beyond the control of the hospital, include bed size, patient acuity index, and case mix. Design variables which are within the control of the hospital include number of nursing units, type of nursing model, nursing staff skill mix, nurse staffing level and efficiency of support system. The authors found strong correlations among the three quality-of-care indicators (medication errors, IV administration errors, and testing/treatment errors) and strong correlation between patient falls and patient injuries.

Neither nursing factors, hospital's physical design nor patient characteristics accounted for much of the variation in incident rates. Nursing staff mix, nursing model and nursing resources consumption also were not significantly related to quality. Interestingly, hospital bed supply in a community was directly related to the performance of hospitals. Age and education of the population were also found to influence outcome.

In summary, examination of the literature suggests that conceptual problems in the hospital-level analysis of quality of care are related to the difficulty of identifying domains of hospital or program performance. Methodological problems stem from the lack of large representative and longitudinal study samples and from inadequate causal analysis of the relationships between hospital attributes, hospital performance and quality. Furthermore, Blumberg calls attention to the fact that when an aggregate outcome such as hospital mortality rate is used, it is essential to consider multiple confounding factors that are likely to influence variation in hospital performance (Blumberg, 1986). However, when aggregate indicators are used in organization-based studies, process criteria for quality of care are not easily incorporated. Yet, as Donabedian (1980) has demonstrated one can not study outcome alone but must look at process indicators as well.

An Integrated Perspective

Ideally, a study that incorporates both patient-based and community attributes along with organizations' structural and functional characteristics would enhance our understanding of the factors affecting hospital performance. Such an approach is referred to as an integrated perspective. An example is the study by Flood et al. (1982), which assessed the quality of surgical care by measuring post-surgical status as the extent of morbidity occurring seven days after surgery, or death within 40 days, while adjusting for the patients' physical status, stage of disease, age, and sex. They found that characteristics of the hospital organization, and the component structure of the professional group were more strongly associated with differences in quality of care than were differences among individual surgeons.

In another integrated-perspective study, Goldfarb and Coffey (1987) examined the differences in casemix between teaching and non-teaching hospitals, using a total of 351 hospitals. Of those, 207 were non-teaching hospitals. The remaining 144 teaching hospitals were divided into three categories, depending on the degree of teaching commitment, as follows: 93 hospitals each possessing one or more AMAapproved residency programs; 42 hospitals belonging to the Council of Teaching Hospitals but not medical-school based; and 9 hospitals each medical-school based. The four variables used to analyze the differences between teaching and non-teaching hospitals were :

1. Mortality-weighted case-mix index, which measures the degree to which hospitals admit patients who are likely to die if they receive average quality of care.

2. The length-of-stay-weighted, and cost-weighted case-mix indices, which measure the degree to which hospitals admit patients requiring either more or fewer days of stay, or inputs for which the hospital must pay.

3. The surgery-rate-weighted case-mix index, which measures the degree to which hospitals admit patients for whom surgery is either a possible or the only mode of treatment.

The authors found no significant differences between nonmedical-school-based teaching hospitals and non-teaching hospitals. Medical-school-based teaching hospitals had a significantly more serious case mix than did both non-medical-school-based teaching hospitals and non-teaching hospitals. When case mix definition included measures of resource use or treatment patterns and the classification was based on DRGs, hospitals with any teaching program were found to have significantly higher case mix values than non-teaching hospitals. If the classification system was changed from DRG to Disease Staging, no significant differences in case mix were found among any of the hospital categories. It was also found that the presence of at least one residency program raised the surgery-prone case-mix index above that for non-teaching hospitals. Outcome differences between teaching and non-teaching hospitals in terms of inpatient death rates were found to be similar across all categories of hospitals.

Dubois et al. (1987), in a study of discharge data from 93 American Medical International hospitals located in the western, central and southeastern United States, used adjusted hospital mortality rates to explain the disparity among hospital death rates. They used multiple regression to estimate each hospital's death rate. Mortality was conceived as a function of age, origin of patient from the emergency department or nursing home, and hospital case-mix index. An adjusted death rate was obtained by dividing actual hospital death rates by predicted hospital death rate. Comparing plots of the crude death rate to the adjusted death rate, the authors found that 11 hospitals had death rates significantly exceeding those predicted, and 9 hospitals had death rates significantly below those predicted. The authors conclude that these adjusted death rates could be used in identifying hospitals at risk for delivering inadequate quality of care.

Blumberg (1986) reviewed the methods used to risk-adjust health care outcomes. He designated such statistical systems as "Risk-Adjusted Monitors of Outcome" (RAMO). He developed an outline for the RAMO approach comprising the selection of:

1. A universe for the study.
2. Clinical care subjects.
3. Dependent variables.
4. Independent variables.
5. Estimation techniques.
6. Relative weights for independent variables.
7. Analysis of observed and expected adverse outcomes.

Blumberg points out six potential applications of the RAMO approach:

1. It could identify specific providers that have outcomes that are either worse than expected or better than expected.

2. It could determine whether there are cross sectional differences in outcome by (a) type of provider (eg. teaching hospital, proprietary hospital,local government hospital), (b) alternate methods of paying providers (eg.,FFS,PPO,HMO), (c) area of the country; and (d) provider experience or volume.

3. By measuring trends in outcomes over time it could assess the impact of changes in payment or medical technology, and of activities of Peer Review Organizations.

4. The RAMO system could monitor outcomes to detect and investigate clusters of unexpected adverse outcomes.

5. The system could measure the relative risk of

adverse outcomes by patient characteristics, and by such variables as provider and payment sources.

6. The RAMO system could detect inconsistent data by noting unexplained changes in expected risk by time and place.

From this review, three hypotheses emerge to be tested. First, the larger the hospital size the lower the hospital mortality. Second, the greater the hospital specialization the lower the mortality. And finally, the higher the service intensity the higher the hospital mortality.

Assessment of quality of health care is an issue complicated by many conceptual and methodological problems. Quality of care may be addressed at an individual (patient) level, considered as a function of individual attributes. At the hospital level, quality of care varies within different organizational, community, and provider characteristics.

The integrated approach proposed here views quality of care as a joint function of all domains of individual patient, organizational, and community attributes. The relative importance of each of these factors must be determined in developing a methodology to confirm a comprehensive model of quality of care. This rationale leads to the development of the present study, which postulates that hospital performance as measured by hospital mortality is influenced equally by hospital and community characteristics. Specifically, this research addresses two questions: First, what is the relationship of hospital mortality rates to the organizational factors of size, specialization, service intensity and other structural characteristics? Second, should selectivity bias introduced by community attributes be adjusted for when hospital mortality is investigated? This second point is important because as Daft (1983) had pointed out in his typology of organizational characteristics, that organizational structural dimensions are influenced by contextual dimensions such as the environment, which includes all elements outside the boundary of the organization.

CHAPTER III

METHODOLOGY

This research is a cross-sectional study of the effect of organizational and community characteristics on hospital mortality rates, using the hospital as the unit of analysis. This chapter presents an analytic model, along with predictor variables and specification of the analytic components. The sources of the data are presented, measurement variables listed and defined, and, finally, an analysis plan discussed.

Analytical Model of Hospital Mortality

In 1986 the Health Care Financing Administration (HCFA) released a list of the nation's hospitals that have mortality rates significantly higher or lower than the national average. The agency computed the expected mortality rate using a multiple regression model with Medicare inpatient mortality rates as the dependent variable; the predictor variables included average age of the discharged Medicare patient, proportion male, proportion black, proportion whose race was neither black or white, and proportion of Medicare discharges in each of fifty highest frequency DRGs (Fottler et al., 1987). Although the mortality differential was presented by HCFA, no specific organizational and community attributes for these hospitals were presented. Based on the literature review cited in the previous chapter, it is apparent that hospital mortality can not be fully accounted for by patient characteristics alone. This study considers hospital mortality as a function of hospital organizational characteristics (O_i) and community attributes (C_j). Thus a generic model for investigating hospital mortality (HM) may be expressed as follows: $HM = f(O_i, C_j)$.

The detailed specification of study variables, presented in Figure 1, is derived from a systematic review of the research literature. Important results from hospital-based studies on quality of care are summarized in Table 1. They show several patient attributes that were important predictors of hospital quality of care: (a) sex (Hobler, 1984; Wan, 1980; Flood, 1974), (b) age (Dubois, 1986; Hobler, 1984; Wan, 1980), (c) education (Lubeck, 1985), (d) marital status (Wan, 1980; Lubeck, 1985;), and (e) race (Wan, 1980). Organizational attributes found to be important predictors of hospital quality of care include: (a) teaching status (Palmer, 1979), (b) bed size (Wan and Shukla, 1987), (c) percent of medical staff who are board certified (Scott, 1974), (d) case mix (Wan and Shukla, 1987), (e) nursing structure (Shukla, 1984), (f) percentage of the medical staff who are on contract with the hospital (Palmer, 1979; Shortell, 1980), and (g) hospital specialization (Palmer 1979). Finally, community attributes that were found to be important predictors of hospital quality of care include percentage of elderly population, poverty level, education

Table 1
Summary of empirical findings on the study of hospital quality of care (QoC)

Predictor variable	Author (Date)	Relationship
Patients attributes		
Sex	Hobler (1984); Wan (1980); Flood (1982)	+
Age	Hobler (1984); Wan (1980); Dubois (1987)	+
Education	Lubeck (1985)	-
Marital status	Lubeck (1985); Wan (1980)	-
Household income	Lubeck (1985)	-
Work status	Lubeck (1985)	-
Race (percent white)	Wan (1980)	-
ER or Nursing home	Dubois (1987)	+
Organizational attributes		
Specialty dept.	Palmer (1979)	-
Teaching status	Palmer (1979)	-
Malpractice rate	Palmer (1979)	+
Staff on contract	Palmer (1979); Shortell (1980)	-
RN/LPN and Aides Ratio	Scott (1976)	-
Nursing structure	Shukla (1984)	+
Bed size	Wan and Shukla (1987)	-
Case mix	Wan and Shukla (1987)	+
Cost/case	Shortell (1976)	+

Table 1 (cont.)
Summary of empirical findings on the study of hospital quality of care (QoC)

Predictor variable	Author (Date)	Relationship
Organizational attributes		
% Board certified	Scott (1976)	-
Med staff involvement		-
Specialization	Palmer (1979)	-
Community attributes		
Population age	Wan and Shukla (1987)	+
Poverty level	Wan and Shukla (1987)	+
Education level	Wan and Shukla (1987)	-
Bed supply	Wan and Shukla (1987)	-

Notes: + Indicates a positive relationship between a given variable and QoC indicator.
- Indicates a negative relationship between a given variable and QoC indicator.

level, and hospital bed supply (Wan and Shukla, 1987).

Data Sources

There are four sources of data available for this study. First, in 1986 HCFA released a list of death rates for 1984 Medicare patients in U.S. hospitals. The list shows 269 hospitals with "abnormal" mortality rates: 142 with death rates higher than average, and 127 with rates lower than average. For each hospital the number of patients (denominator) and the percentage of those who died are given. Each hospital's rate is compared to an average predicted hospital death rate based on national statistics. Ideally, the present study would use longitudinal hospital mortality data, but since the 1985 data are not yet available for public use, it focuses only on the hospital mortality experienced in 1984. Of the list of 269 hospitals, 26 were deleted for having missing data or because they had a large percentage of beds designated for long-term care. The final sample size was 243 hospitals.

Second, the American Hospital Association's (AHA) files describing 1984 hospital attributes.

Third, the Area Resources File that describes community attributes is used. The county-level data described in this source were mostly compiled in the 1980 U.S. Census. Finally, a 1984 case-mix index for the study hospitals was compiled from the Federal Register. Case-mix measures are measures of the variation in case complexities, which are useful in evaluating hospital performance. There are indirect measures and direct measures of case mix; direct measures are more accurate and more generally accepted. The case mix measures include (a) the ICD-9-CM List A, (b) Diagnostic Related Groupings (DRGs), (c) Disease Staging, (d) Patient Management Categories, (e) AS-SCORE, (f) the Severity of Illness Index, and (g) MD-DADO (Plomann 1982). The case-mix index used for this study is the DRG-based case mix, which is the ratio of each hospital's DRG-weighted expected cost per case to the national DRG expected cost per case. Thus a hospital that has a case-mix index of 0.89 would on the average have a case severity 0.89 that of the average hospital (Wan, 1985). Since different hospitals produce different products in terms of patients they serve and services they provide, controlling for case mix permits comparison of mortality rates among hospitals (Plomann, 1982).

The unit of analysis in this study is the hospital. Hospital mortality rate is the dependent variable. Independent variables include organizational structure variables and community characteristics. Aggregate patient-based variables such as the percentage of surgical patients are available from the 1984 AHA file; the 1984 case-mix index is available from the Federal Register. Community attributes consist of age of the population, regional location, health manpower resources of the area, crude death rate, and other pertinent variables available from the Area Resources File. Organizational variables include bed size, staff size, percent board-certified physicians, teaching status and ownership, all available from the AHA file. A detailed list of the study variables with operational definitions is presented in Table 2.

Analysis Plan

The statistical analysis of the data was conducted in two phases. First, multiple regression analysis and correlation analysis were performed to examine the relationship of hospital mortality (HM) to selected organizational and community attributes. Ordinary least squares estimation technique was used for a continuous dependent variable. The primary purpose of employing regression analysis was to determine the relative influence of organizational factors on hospital mortality rates, examining HM as a function of organizational factors O_j. The regression equation may be represented as follows:

$$HM\ (Y) = a + b1\ O1 + b2\ O2 + \ldots + b12\ O12.$$

Furthermore, it was expected that the hospitals selected for this study might be affected by the variation of such community characteristics as health resources, socioeconomic status, and health status of the population - in other words, selectivity bias may exist. To accurately demonstrate the organizational differentials in hospital mortality, it was essential to control for that selectivity bias. Therefore

Table 2
List of variables used and their definitions.

Variable	Code	Definition
Community attributes (C_i)		
C1	MDs	physician population ratio(per 1000)
C2	NURSES	nurse population ratio (per 1000)
C3	BEDS	hospital-bed-population ratio (per1000)
C4	OA65	percent of population aged 65 and older
C5	DEATH	total number of deaths per 1000 population
C6	ONCDTH	total cancer deaths per 1000 population
C7	RESDTH	total respiratory deaths per 1000 population
C8	CAVSDTH	total cardiovascular deaths per 1000 population
C9	IHDDTH	ischemic heart disease deaths per 1000 population
C10	POVERTY	percent population below poverty level
C11	EDUCAT	percent of population not complete high school
C12	REGION	eastern U.S. versus other regions
C13	EMPLOYMENT	percent of population unemployed
Hospital/Organizational characteristics (O_j)		
O1	HITECHS	number critical care specialty services such as open heat and organ transplant
O2	RNRATIO	RNs per 100 nurses in a hospital
O3	BOARD	percent of board certified physicians
O4	TOTPERS	total full-time personnel

Table 2 (Cont.)
List of variables used and their definitions.

Variable	Code	Definition
Hospital/Organizational characteristics (O_j)		
O5	BEDSIZE	hospital bed size
O6	TOTEX	total non-capital expenditure
O7	ALOS	average length of stay
O8	CASEMIX	HCFA DRG-based hospital case mix
O9	OCCRT	occupancy rate
O10	SURG	percent surgical patients
O11	TCHSTS	teaching status=0, non-teaching=1
O12	OWNER	private versus public ownership
(ξ_1)	SIZE	hospital size (latent variable)
(ξ_2)	SPCLZN	hospital specialization (latent variable)
(ξ_3)	SERINT	service intensity (latent variables)
Y	HMR	HCFA hospital mortality rate (percent deaths of Medicare patients)

community attributes were considered as control variables.

Since intercorrelations among many of the predictor variables were expected, the second phase of the analytic strategy, was to use Linear Structural Relations (LISREL) approach.

The reasons for doing so are as follows: First, several key concepts are considered as underlying, unobservable constructs (latent variables) which can be measured by related indicators. For example, the concept of hospital specialization is not directly observable or measurable, since there is no agreed-upon measure for it. Nonetheless, the concept of hospital specialization (SPCLZN) may be measured by such proxy indicators or measurable variables as the RN-nurse ratio, the percentage of board-certified physicians, the percent of surgical patients, and case-mix index. This modeling approach allows one to estimate the measurement errors associated with the indicators. Second, LISREL can validate the measurement model's goodness of fit for the underlying constructs before they are incorporated in the structural equation. Third, the study of multiple causal factors often encounters correlated errors. In order to detect them, LISREL modeling should be used (Joreskog and Sorbom, 1979). A brief description of LISREL follows.

Linear Structural Relations

LISREL is a statistical technique for analyzing data according to specified causal models and systems of structural equations. The LISREL model is based on a general model with two major components. The first component, the measurement model, specifies the relations between the observed variables and the unobserved theoretical constructs or latent variables, including measurement errors. The second component, the Linear Structural Equation Model, specifies the causal relationship among the exogenous and endogenous variables, with possible reciprocal causation and correlated random disturbance terms in the structural equations.

(A) Proposed measurement model of key constructs. Certain health constructs may not be directly observable and measurable, but measured only indirectly by specific proxy indicators. An example is the organizational construct of hospital specialization. Jackson and Morgan (1982) state "Differentiation is specialization of people and units. The greater the specialization the greater the differentiation. People and units can specialize to take advantage of concentration on a smaller number of items in more detail." Robbins (1983) defines specialization as the most visible evidence of differentiation in an organization, and provides measures of the degree of differentiation, in turn reflecting the degree of specialization in an organization. Such measures include the number of departments, number of different job titles, level of training, extent of professional activity, degrees held, routineness of tasks, number of occupational specialties, and amount of professional activity. Robbins further states that the two most critical elements of specialization are the number of occupational specialties and the level of training. Thus hospital specialization (SPCLZN) may appropriately be measured by (a) the RN-nurse ratio, (b) the percentage of board certified physicians, (c) percent of surgical patients, and (d), case mix. Hospital size (SIZE) may be measured by (a) the number of beds, (b) staff size, (c) total non-capital expenditure, and (d), the number of high tech services offered. Hospital service intensity (SERINT) may be indicated by (a) average length of stay and (b) occupancy rate. Each of these constructs was verified by the specified measurement model presented in Figures 2 through 4. In addition, these latent variables are assumed to be correlated, and are presented as such in Figure 5.

(B) Structural equation model of hospital mortality.

The second component of the LISREL model is the structural equation model. It provides the causal linkage between the endogenous variable (e.g. mortality rate) and the latent variables factored from observed variables in the measurement model, and other exogenous variables that are considered external to the model. In this instance, we need to determine the causal linkages (a) between organizational constructs obtained from the measurement model and hospital mortality rate, and (b) between other directly observable and

Figure 2. Measurement model of the organizational construct hospital size (SIZE).

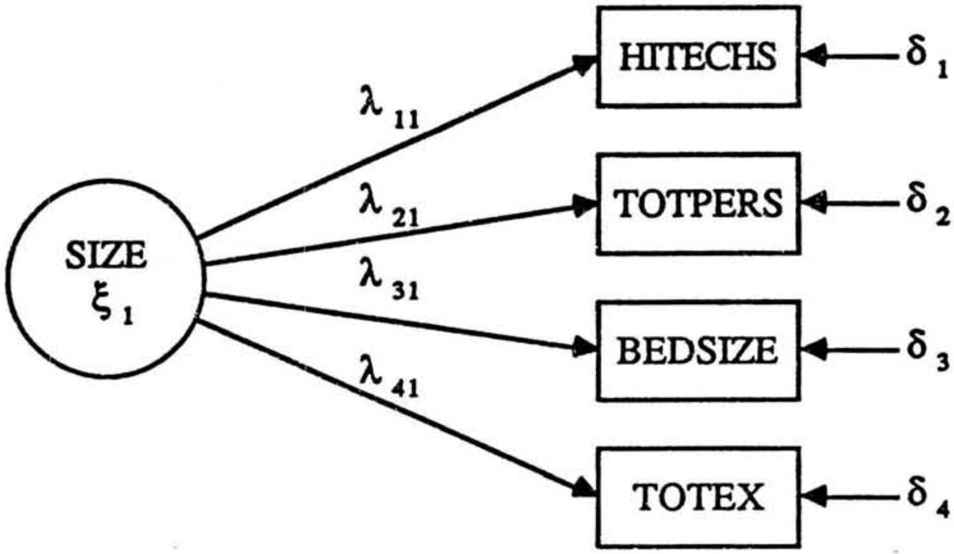


Figure 3. Measurement model of the organizational construct hospital specialization (SPCLZN).

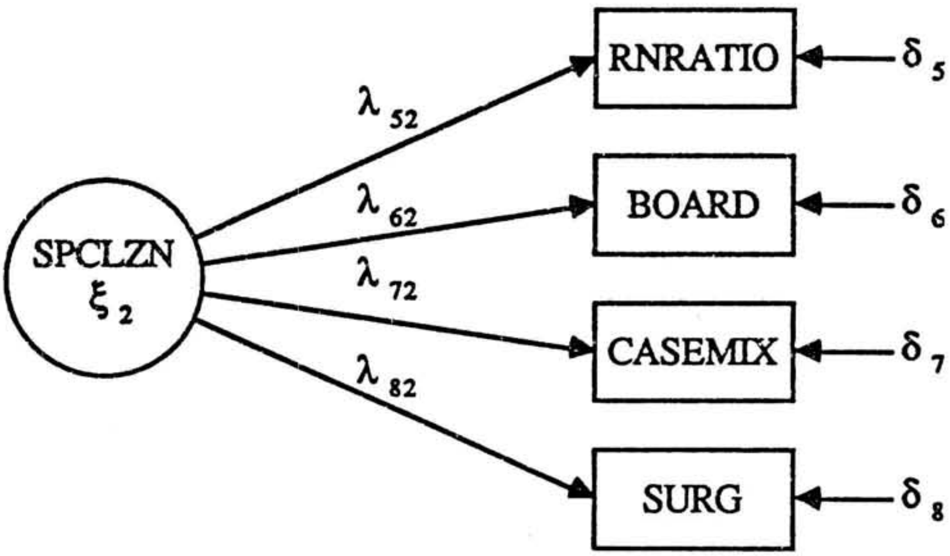


Figure 4. Measurement model of the organizational construct service intensity (SERINT).

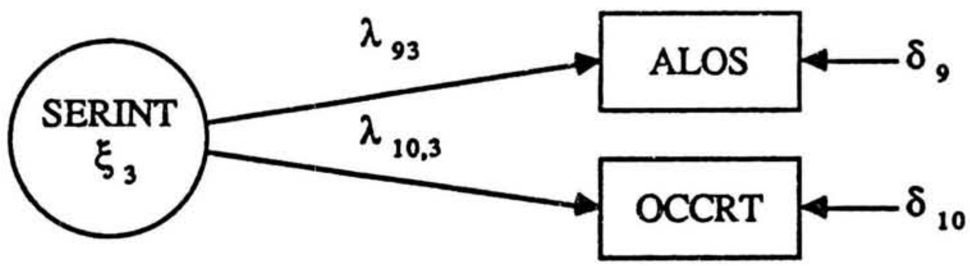
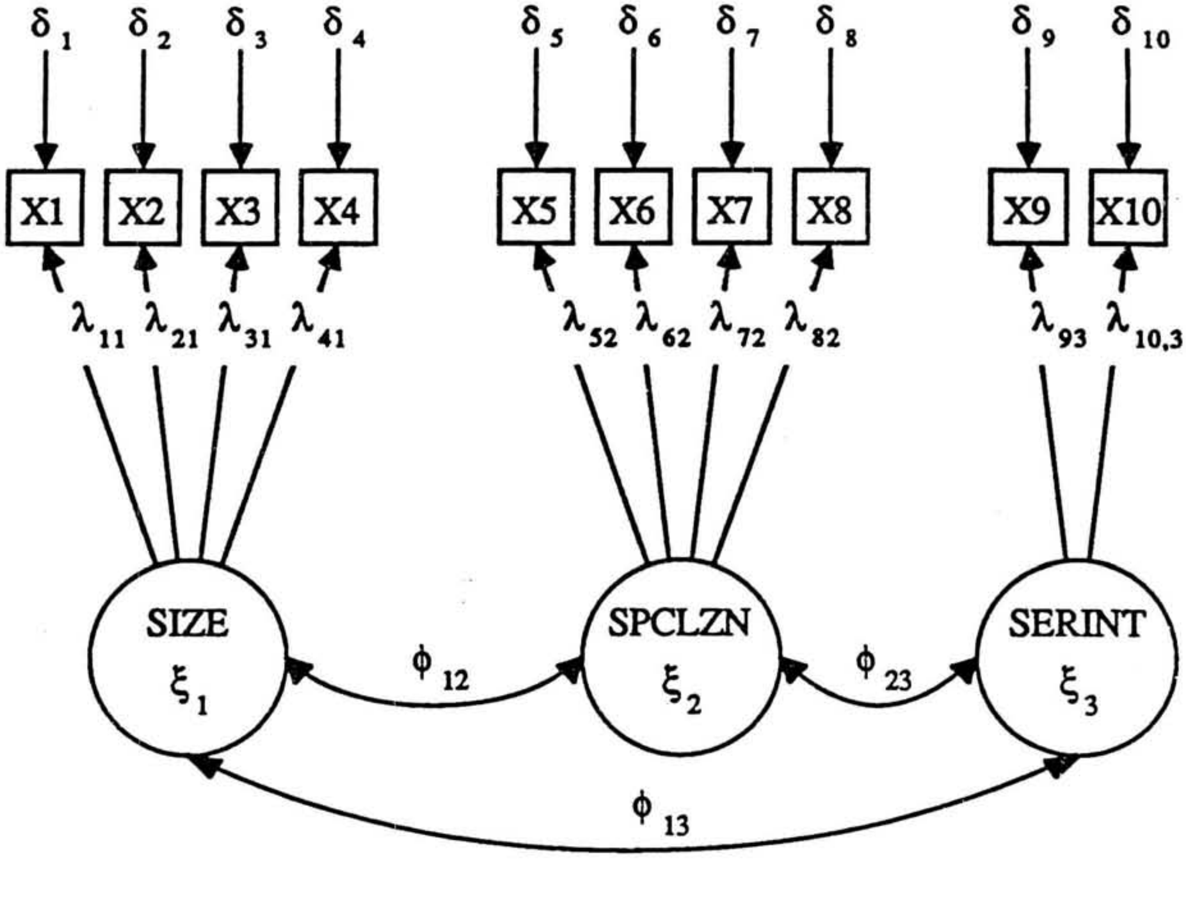


Figure 5. Measurement model for the three organizational constructs.



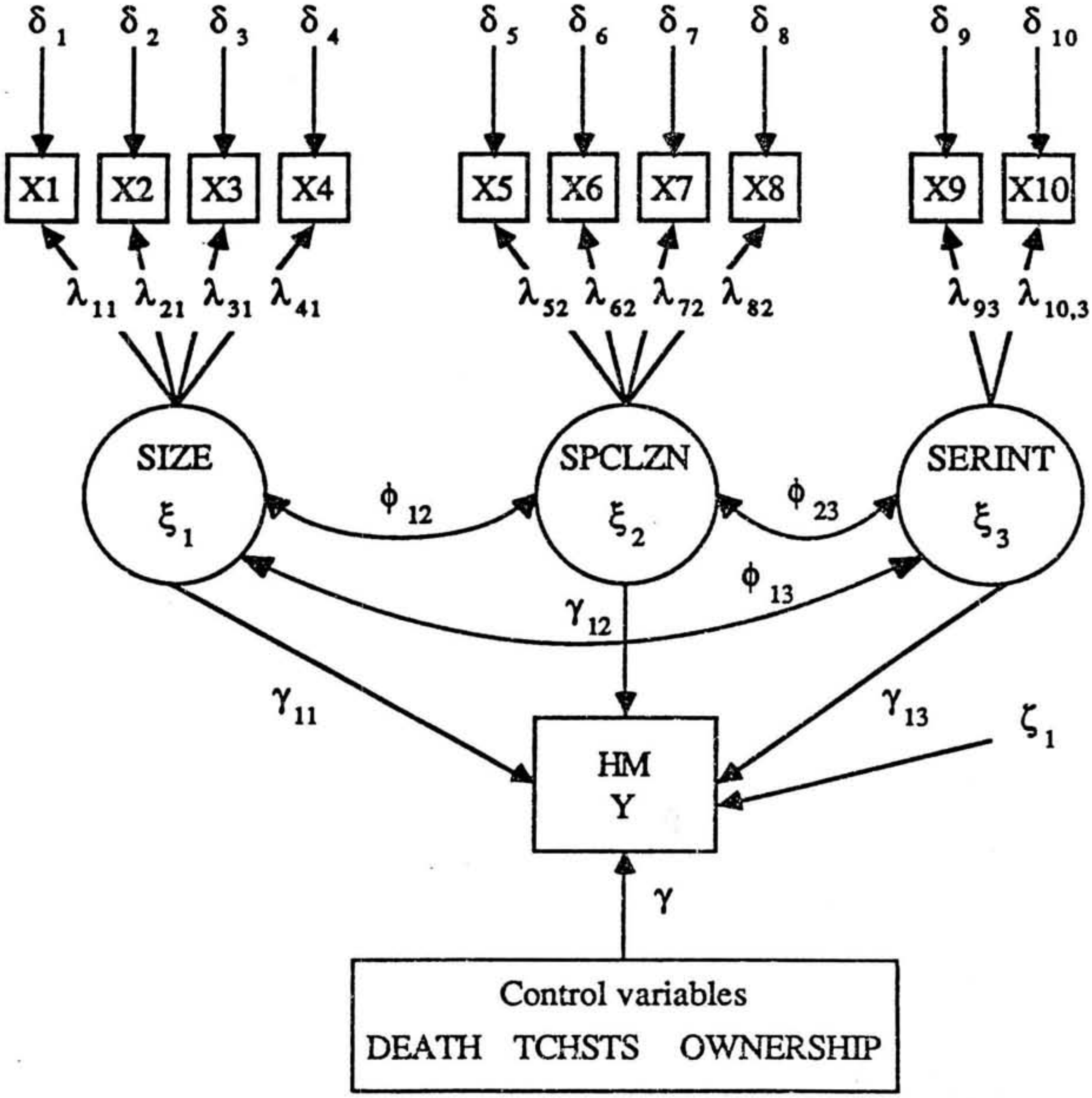
measurable hospital organizational characteristics and hospital mortality. Since the adjusted mortality rate produced by HCFA took into account only a few patient characteristics, an analytical model of hospital mortality using this approach would yield more useful information. This study postulates that hospital mortality rate varies by hospital characteristics and also by community attributes. Besides the three underlying constructs, exogenous variables measuring organizational characteristics including teaching status and ownership were introduced as control variables. The structural equation model is illustrated in Figure 6.

(C) Model specification. The statistical specification of the causal model is as follows: The LISREL model is a statistical model also referred to as the covariance structure model, the analysis of covariance structures, or the moment structure model (Joerskog and Sorbom, 1979).

Covariance structures attempt to explain the relationship between a set of observed variables and a smaller number of unobserved variables. The relationships among the observed variables are characterized by the covariance among them. It is assumed that underlying constructs can be modeled through the structural relationships among the observed variables (Long 1984).

The measurement model specifies how the latent variables or hypothetical constructs are measured in terms of the observed variables, and describes the measurement properties

Figure 6. Structural equation model (covariance structural equation model).



of the observed variables. The measurement model of exogenous variables consists of two kinds of variables and a measurement error variable. These are (1) the independent X-variables and the associated error variable delta (δ), and (2) the common factors or latent exogenous variables ksi (ξ). The model also uses the factor loading lambda (λ), which indicate how a change in a common factor (ξ) affects an observed variable.

In Figure 2 there are four independent variables (HITECHS, TOTPERS, BEDSIZE, and TOTEX) indicated by squares. Since the X-variables are not perfectly measured, the measurement error associated with each X-variable is included and is denoted delta (δ). The observed variables are caused by the unobserved latent or exogenous variable SIZE ksi ($\xi 1$) which is represented by a circle. Factor loadings lambda (λ) indicate how a change in an exogenous variable affect an observed variable. Similarly, in Figure 3 four independent variables (RNRATIO, BOARD, CASEMIX, and SURG) represented by squares, are caused by the unobserved latent variable SPCLZN ($\xi 2$), and in Figure 4 the observed variables ALOS and OCCRT are caused by the latent variable SERINT ($\xi 3$).

Figure 6 represents the LISREL model with its two components, the measurement model and the structural equation model. In the measurement model component the three exogenous variables ($\xi 1$), ($\xi 2$), and ($\xi 3$) are indicated by circles. ($\xi 1$) is causing X1, X2, X3, and X4; ($\xi 2$) is causing X5, X6, X7 and X8; (ξ3) is causing X9, and X10. The arrows from the circles (ξs) to the squares (Xs) indicate the effect of the exogenous variables on the observed variables. Lambda (λ), the factor loadings, have two subscripts each: the first is the subscript of the variable to which the arrow is pointing, and the second is the subscript of the variable the arrow is pointing from. The two headed arrows are denoted by phi (ϕ), which indicates correlation between exogenous variables. In this diagram there is correlation between (ξ1) and (ξ2); (ξ1) and (ξ3); and between (ξ2) and (ξ3). For each X-variable with an arrow pointing to it there is an equation where the X-variable is a left hand variable, for example, the equation for X11= (λ1,1)x(ξ1)+δ1. Thus the mathematical model for this measurement model is generated.

The second component of the LISREL model is the structural equation model, which specifies the causal effects on hospital mortality, of organizational variables factored from observed variables in the measurement model. In Figure 6 the three exogenous latent variables (ξ1- ξ3) predict the endogenous variable (Y), hospital mortality. In addition, three observed exogenous variables (DEATH, TCHSTS, and OWNER) also affect the endogenous variable (Y). These may be thought of as perfectly measured latent variables; they are denoted as (ξ4, ξ5, and ξ6). The observed variables are assumed to be perfectly measured and therefore no measurement error is associated with them. The causal linkages from the exogenous observed and unobserved variables to the dependent (endogenous) variable denoted Gamma (γ) each has two subscripts: the first indicates the subscript of the variable to which the arrow is pointing, which is Y; the second indicates the subscript of the variable from which the arrow is pointing. Residual error in the prediction of Y is denoted by zeta (ζ). The mathematical model for this part is formed by only one equation, where Y is a left hand variable as follows:

$$Y=\gamma 11\ \xi 1+\gamma 12\ \xi 2+\gamma 13\ \xi 3+\gamma 14\ \xi 4+\gamma 15\ \xi 5+\gamma 16\ \xi 6+\zeta 1.$$

The model was used to test the following statistical alternative hypotheses:

1. The larger the hospital size (SIZE), the lower the hospital mortality.

2. The higher the hospital specialization (SPCLZN), the lower the hospital mortality.

3. The greater the service intensity (SERINT), the higher the hospital mortality.

Each of these hypotheses was empirically examined in a one tailed test for its statistical significance at 0.05 or lower level. Since multivariate analysis was performed for the hypotheses testing, the conclusions drawn from the results can be stated as the net effect of a given predictor on mortality rate while other variables are being simultaneously controlled.

CHAPTER IV

RESULTS

The results of the analysis are presented in this chapter in three phases. First, descriptive statistics and analysis of variance are presented. Second, multiple regression analysis results are presented and discussed. Finally, the results of the LISREL analysis are presented.

Descriptive Statistics

Descriptive statistics for this study are presented in Table 3, which shows the mean, standard deviation, and variance of each of 13 community variables (C1-C13) and 12 organizational variables (O1-O12). These results indicate that in the communities of the 243 study hospitals the mean number of physicians per 1000 population was 2.38, of nurses 6.38, and of hospital beds 7.8, and that the rates of total deaths, and deaths from cancer, respiratory diseases, cardiovascular disease, and ischemic heart disease were respectively 9.11, 1.93, 0.25, 1.88, and 2.66 per 1000 population. Thirteen percent of the population were under the poverty level; 33 percent of the adult population had not attained high school level education; seven percent were unemployed. Forty one percent of the study hospitals were located in the eastern region.

Table 3
Descriptive statistics of the study variables

Variable		Mean	S.D.	Variance
Y	Mortality	6.18	3.51	12.36
Community attributes				
C1	MDs	2.38	2.05	4.20
C2	NURSES	6.34	2.35	5.50
C3	BEDS	7.80	9.73	94.75
C4	OA65	0.12	0.03	0.01
C5	DEATH	9.11	1.93	3.73
C6	ONCDTH	1.93	0.43	0.18
C7	RESDTH	0.25	0.08	0.01
C8	CAVSDTH	1.88	0.54	0.30
C9	IHDDTH	2.66	0.91	0.82
C10	POVERTY	0.13	0.06	0.01
C11	EDUCAT	0.33	0.10	0.01
C12	REGION	0.41	0.49	0.24
C13	EMPLOYMENT	0.07	0.02	0.01
Organizational characteristics				
O1	HITECHS	6.39	2.89	8.38
O2	RNRATIO	0.59	0.14	0.02
O3	BOARD	0.69	0.15	0.02
O4	TOTPERS	1257.00	1154.00	1333K
O5	BEDSIZE	354.63	258.91	67K

Table 3 (Cont.)
Descriptive statistics of the study variables

Variable		Mean	S.D.	Variance
O6	TOTEX	53559K	50799K	2.58+15
O7	ALOS	7.79	2.87	8.20
O8	CASEMIX	1.12	0.13	0.02
O9	OCCRT	0.72	0.14	0.02
O10	SURG	0.41	0.12	0.02
O11	TCHSTS	0.73	0.44	0.20
O12	OWNER	0.23	0.42	0.18

Notes:
S.D. Standard Deviation
K Multiplied by 1000
+15 Multiplied by 10^{15}

The organizational variables indicate that the study hospitals had a mean of 6.39 high tech services. Fifty nine percent of the nurses were RNs; 69 percent of the physicians were board certified. The average length of stay was 7.79 days, and the occupancy rate was 72 percent. Forty one percent of patients discharged were surgical cases. Seventy three percent of the study hospitals were non-teaching hospitals, and 23 percent were privately owned. The average hospital had 1257 fulltime personnel, and the average annual total non-capital expenditure was 53 million dollars.

Analysis of Variance

The comparative statistics presented in Table 4 are the results of one-way analysis of variance to examine the difference between the study hospitals and all other hospitals in the U.S in terms of each of the eight characteristics. The results show that the means for the study hospitals were statistically different from the means for other U.S. hospitals, in that the study hospitals were significantly larger in bedsize and total personnel and were located in areas with significantly more nurses, MDs and hospital beds. The study hospitals also had a higher percentage of publicly owned hospitals, and of teaching hospitals, and more of them were located in the eastern region.

Table 4
Comparative statistics for the study hospitals and other hospitals

Variable	Total Hospital Mean	Study Hospital Mean	Other Hospital Mean	Difference F-Value*
BEDSIZE	190.90	354.63	185.07	150.13*
TOTPHYS	88.56	229.46	83.55	265.26*
OWNER	0.38	0.23	0.39	25.14*
REGION	0.57	0.41	0.55	27.07*
TCHSTS	0.94	0.73	0.95	205.37*
MDs	1.52	2.38	1.49	107.72*
NURSES	5.05	6.34	5.02	77.96*
BEDS	6.60	7.80	6.56	9.11*

Notes:
* : Mean difference between the study and other U.S. hospitals is significant at 0.001 level

Multiple Regression Analysis

Multiple regression analysis was conducted to examine the relationship of selected organizational characteristics to hospital mortality rate and to determine the relative influence of community attributes on the variation in hospital mortality rate. First, after eliminating highly correlated organizational attributes, hospital mortality rate was regressed on eight selected organizational characteristics. These were RN-ratio, percent board-certified physicians, bedsize (total expenses, total personnel, and teaching status and number of high tech services offered were eliminated), average length of stay, case mix, occupancy rate, percent surgical patients, and ownership.

The results presented in Table 5 show that three of the eight variables used were significant predictors of hospital mortality rate, including RNRATIO, ALOS, and SURG. An increase of one percent in the RN ratio corresponded to a decrease of about six percent in the hospital death rate. Similarly, a one percent increase of surgical patient ratio corresponded to a decrease of about four percent in hospital mortality rate. An increase of one day in the average length of stay corresponded to an increase of about one four-tenths of one percent in hospital mortality rate.

Table 5
<u>Hospital mortality rate regressed on selected organizational variables</u>

Predictor	r	B	T-Value
Intercept		8.295	3.614*
RNRATIO	-0.24*	-5.481	-3.300*
BOARD	-0.07	-0.497	-0.343
BEDSIZE	0.12	0.001	1.325
ALOS	0.38*	0.397	5.123*
CASEMIX	-0.11	-0.109	-0.623
OCCRT	0.15*	1.244	0.713
SURG	-0.25*	-4.383	-2.483*
OWNER	0.07	0.195	0.387
F-Value		9.008*	
R-Square		0.236	
Adjusted R-Square		0.209	

* Significant at 0.05 level or lower

B Unstandardized regression coefficient

r Zero Order Correlation between dependent and independent variables

Table 6 shows the results when hospital mortality regressed on six community attributes, after excluding highly correlated variables. The predictors include the nurse population ratio, hospital bed ratio, crude death rate, percentage of population under the poverty level, region (eastern = 0, non-eastern = 1), and percentage of the population unemployed. Physician population ratio was highly correlated with nurse population ratio and hence was eliminated. Similarly, cancer deaths, respiratory deaths,cardiovascular deaths, and ischemic heart disease deaths were eliminated for being highly correlated with the crude death rate. Percent of the population who did not complete high school was eliminated for having a high negative correlation with the nurse population ratio, and a high correlation with the percent of the population under the poverty level. Of the six community attributes only the crude death rate was found to be a statistically significant predictor of hospital mortality. An increase of one death per 1000 population increases hospital mortality by one-third of one percent.

The final multiple regression analysis on hospital mortality was conducted by including the organizational variables used earlier and the one significant community attribute, crude death rate, as predictor variables. The results, presented in Table 7, indicate that when organizational variables were taken into account, the crude

Table 6
Hospital mortality rate regressed on selected community attributes

Predictor	r	B	T-Value
Intercept		3.74*	2.57
NURSES	-0.17*	-0.17	-1.54
BEDS	-0.13*	-0.04	-1.47
DEATH	0.18*	0.34*	2.47
POVERTY	0.06	-3.70	-0.82
REGION	0.07	-0.05	-0.10
EMPLOYMENT	0.17*	17.17	1.77

F-Value	3.480*
R-Square	0.081
Adjusted R-Square	0.058

* Significant at 0.05 level or lower

B Unstandardized regression coefficient

r Zero order correlation between dependent and independent variables

Table 7
Hospital mortality rate regressed on selected organizational and community characteristics

Predictor	r	B	T-Value
Intercept		7.26*	2.75
RNRATIO	-0.24*	-5.40*	-3.24
BOARD	-0.07	-0.36	-0.24
BEDSIZE	0.12	0.001	1.26
ALOS	0.38*	0.39*	5.00
CASEMIX	-0.11	-0.09	-0.49
OCCRT	0.15*	1.03	0.59
SURG	-0.25*	-4.25*	-2.39
OWNER	0.07	0.22	0.43
DEATH	0.18*	0.09	0.80
F-Value		8.07*	
R-Square		0.238	
Adjusted R-Square		0.208	

* Significant at 0.05 level or below

B Unstandardized regression coefficient

r Zero order correlation between dependent and independent variables

death rate was no longer a statistically significant predictor of hospital mortality. Three organizational characteristics remained to be strong predictors of hospital mortality.

Since some of the multiple indicators were highly correlated with each other, some variables were not entered in the regression equation to avoid the problem of multicollinearity. This procedure does not utilized the maximum information that is available in the study. However, a confirmatory approach can overcome the limitations of regression, to present more meaningful causal links among the study variables, and to enable latent variables to be included in the analysis. Since regression analysis does not deal with the underlying constructs that affect hospital mortality LISREL analysis was used to take advantage of the explanatory power of correlated variables, as well as to measure the causal effects of underlying constructs on hospital mortality.

LISREL Results

Measurement Model

The first phase of this analysis is the formulation of a measurement model that specifies the relationship between the observed variables and the unobserved theoretical constructs (latent variables) proposed. The measurement model specifies how the latent variables are measured in terms of the observed variables, and is used to describe the measurement properties of the observed variables. In other words, the purpose of the measurement model is to describe how well the observed indicators work as a measurement instrument for the latent (unobserved) variables.

In the proposed measurement model presented in Figure 5, three organizational constructs were identified: size ($\xi 1$), specialization ($\xi 2$), and service intensity ($\xi 3$). The construct of size (SIZE) is a common factor shared by the observed indicators of the number of high tech services offered (X1), the total number of full-time hospital personnel (X2), the hospital's active bedsize (X3), and the total non-capital expenditure (X4). The construct of specialization (SPCLZN) is a common factor indicated by the observable variables of the RN-nurse ratio (X5), the percentage of board certified physicians (X6), case mix (X7), and the percentage of surgical patients (X8). Finally, the construct of service intensity (SERINT) is a common factor indicated by two observable variables, the average length of stay (X9) and the hospital's occupancy rate (X10). Measurement errors associated with the observed variables were also indicated since such errors occur from imperfections in the measurement instruments and procedures, and may cause severe bias in the estimation if not taken into account.

The results presented in Table 8 show that the observable indicators for the construct of size ($\xi 1$) are

Table 8
Initial measurement model of organizational constructs

Parameters		Indicator	Construct	T-Values*
Lambda (Factor Loadings)				
$\lambda_{1,1}$	0.592	(X1) HITECHS	SIZE (ξ_1)	11.409
$\lambda_{2,1}$	1.000	(X2) TOTPERS		------
$\lambda_{3,1}$	0.962	(X3) BEDSIZE		52.627
$\lambda_{4,1}$	0.982	(X4) TOTEX		74.176
$\lambda_{5,2}$	0.548	(X5) RNRATIO	SPCLZN (ξ_2)	------
$\lambda_{6,2}$	0.361	(X6) BOARD		4.283
$\lambda_{7,2}$	0.558	(X7) CASEMIX		6.344
$\lambda_{8,2}$	0.344	(X8) SURG		4.082
$\lambda_{9,3}$	0.382	(X9) ALOS	SERINT (ξ_3)	5.537
$\lambda_{10,3}$	0.958	(X10) OCCRT		------
Intercorrelations between constructs (ϕ)				
$\phi_{1,2}$	0.381	(ξ_1) and (ξ_2)		4.869
$\phi_{1,3}$	0.509	(ξ_1) and (ξ_3)		8.996
$\phi_{3,2}$	0.252	(ξ_3) and (ξ_2)		2.866
Measurement error of the indicators (δ)				
$\delta_{1,1}$	0.651	X1		11.016
$\delta_{2,2}$	0.001	X2		(N.S.)
$\delta_{3,3}$	0.078	X3		9.970
$\delta_{4,4}$	0.039	X4		7.877
$\delta_{5,5}$	0.692	X5		8.749
$\delta_{6,6}$	0.869	X6		9.908

Table 8 (Cont.)
Initial measurement model of organizational constructs

Parameters		Indicator	Construct	T-Values*
Measurement error of the indicators (δ)				
$\delta_{7,7}$	0.687	X7		7.259
$\delta_{8,8}$	0.881	X8		9.908
$\delta_{9,9}$	0.853	X9		10.745
$\delta_{10,10}$	0.074	X10		(N.S.)

Notes:

Chi Square with 35 df = 104.65

Chi-square-df ratio = 3.27

Goodness of Fit Index = 0.927

adjusted Goodness of Fit Index = 0.886

* : P at .05 level for a one tailed t-test (1.645)

lambda : factor loadings of indicators on the construct

phi : correlation between constructs

delta : measurement error of the predictor variables

----- : not estimated

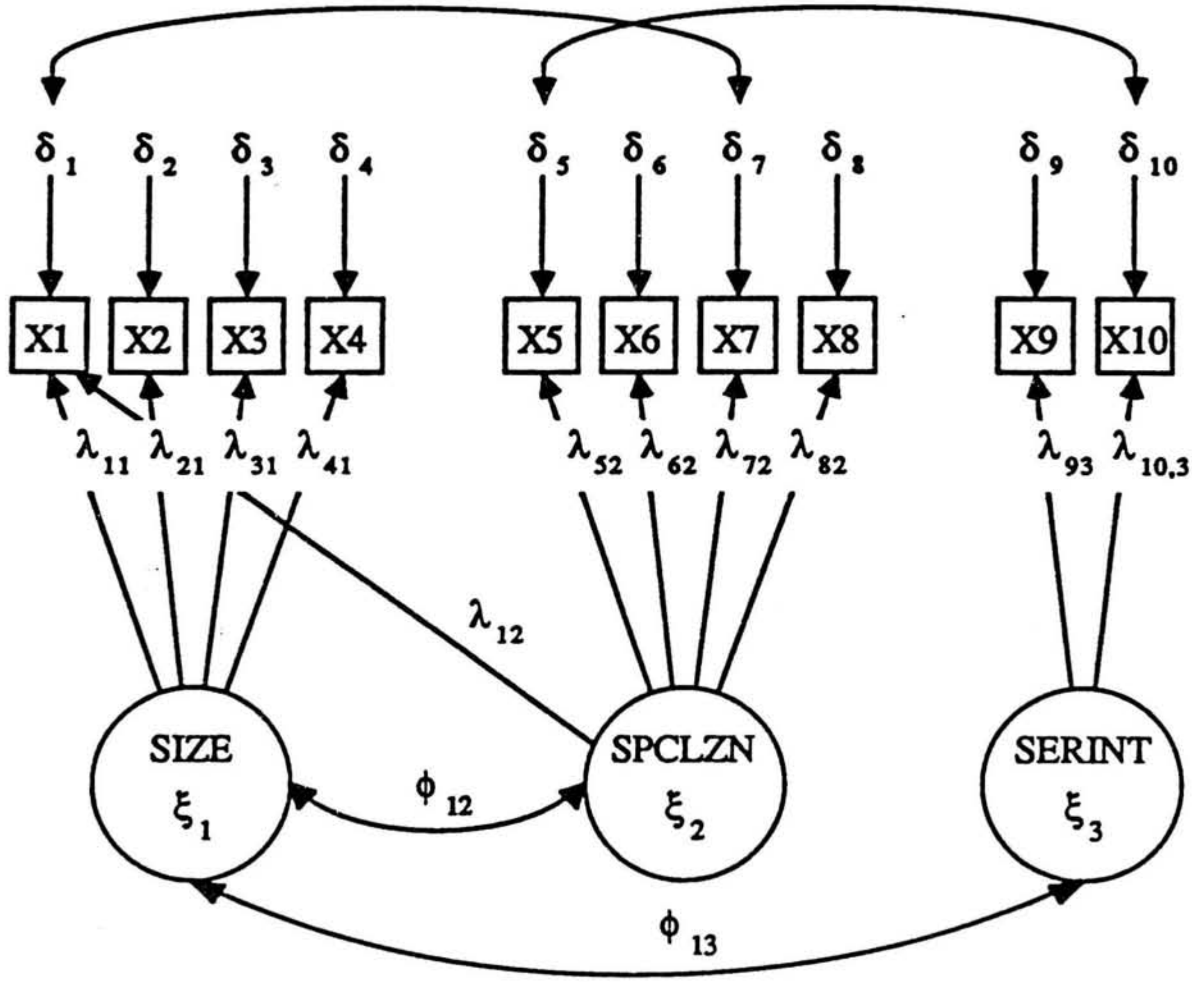
highly loaded on (or correlated with) this factor, as indicated by the statistically significant factor loadings lambda (λs) for all the measurable indicators (X1, X2, X3, and X4). Factor analysis showed that the number of the hospital personnel (X2) was the best indicator of size; as such, the factor loading was assigned a start value of one and was not estimated by the model. The remaining three indicators were estimated. They had factor loadings 0.982 for the total expenditure (X4), indicating that it is the strongest estimated indicator of size, followed very closely by bedsize (X3) with a factor loading of 0.962, and finally by the number of high tech services offered (X1) with a factor loading of 0.592, which was lower than the other indicators.

Four observable measures (RNRATIO, BOARD, CASEMIX, AND SURG) also showed statistically significant correlation with the construct of specialization, as indicated by the significant factor loadings (λs) of 0.558 for the case-mix index, 0.548 for the RN-nurse ratio, 0.361 for the percentage of board-certified physicians, and a somewhat weak loading of 0.344 for the surgical patient ratio. Finally, the observable measures "occupancy rate" and "ALOS" showed significant correlation with the construct of service intensity.

The model shows significant intercorrelation between latent variables, as indicated by the parameter phi (ϕ), particularly between the constructs SIZE and SPCLZN (ϕ12) and SIZE and SERINT (ϕ13). However, no significant correlation was found between SPCLZN and SERINT. The model also shows measurement errors of the observable indicators, represented by deltas (δs). Eight of the ten indicators used had statistically significant measurement errors. TOTPERS and occupancy rate were the only indicators that did not have a statistically significant measurement error. The goodness-of-fit measures of this model indicated that the Adjusted Goodness of Fit Index was 0.886 and the chi-square to degrees of freedom ratio was 3.27. These indicate that the measurement model of these latent variables is reasonably fitted to the data.

Although this measurement model was a valid one, further revision was needed. The revised measurement model depicted in Figure 7 shows that the number of high tech services offered (X1), in addition to being an indicator of SIZE, is also an indicator for SPCLZN. In fact, the measure of services of a highly technical nature was expected to be a good indicator of specialization as well. Furthermore, correlated measurement errors existed between the number of high tech services offered and case-mix index, and between RN nurse ratio and the occupancy rate. These too were expected because the higher the case mix the more such services were needed, and the higher the occupancy rate the more the demand for skilled nursing services.

Figure 7. Revised measurement model for the three organizational constructs.



The results for this model are presented in Table 9: The number of high tech services offered is a fair indicator for SPCLZN with a statistically significant factor loading of 0.250. There were statistically significant correlated measurement errors between X1 and X7, and between X5 and X10. All other results remain very similar to the original model, but the revised measurement model is a more valid one, as indicated by the lower chi-square to degrees of freedom ratio of 1.80, and the Adjusted Goodness of Fit Index of 0.925.

Causal Model

After validation of the measurement model for the organizational determinants, the LISREL causal model, the structural equation model was executed. The causal model postulated that causal linkages existed between hospital mortality rate and the organizational (constructs) factors derived from the measurement model of measurable indicators of organizational structural and functional variables. To validate the causal relationship between organizational factors and hospital mortality, this study formulated and tested two LISREL models.

The first model (Model 1) includes the revised measurement model validated earlier, having three exogenous latent variables or constructs that predict the endogenous (dependent) variable Y, hospital mortality rate (Figure 8). The results for this model, presented in Table 10, indicated that a statistically significant but weak positive relation

Table 9
Revised measurement model of organizational constructs

Parameters		Indicator	Construct	T-Values*
Lambda (Factor Loadings)				
λ 1,1	0.478	(X1) HITECHS	SIZE (ξ1)	8.160
λ 2,1	1.000	(X2) TOTPERS		------
λ 3,1	0.962	(X3) BEDSIZE		53.548
λ 4,1	0.982	(X4) TOTEX		76.914
λ 1,2	0.250	(X1) HITECHS	SPCLZN (ξ 2)	2.791
λ 5,2	0.529	(X5) RNRATIO		------
λ 6,2	0.354	(X6) BOARD		4.264
λ 7,2	0.589	(X7) CASEMIX		6.667
λ 8,2	0.332	(X8) SURG		4.000
λ 9,3	0.386	(X9) ALOS	SERINT (ξ 3)	5.629
λ 10,3	0.958	(X10) Occrt		------
Intercorrelations between constructs (ϕ)				
ϕ 1,2	0.388	(ξ1) and (ξ 2)		5.005
ϕ 1,3	0.515	(ξ 1) and (ξ 3)		9.212
ϕ 3,2	0.147	(ξ 3) and (ξ 2)		(N.S.)
Measurement error of the indicators (δ)				
δ 1,1	0.602	X1		9.635
δ 1,7	0.175	X1 and X7		2.884
δ 3,3	0.078	X3		11.023
δ 4,4	0.040	X4		11.023
δ 5,5	0.717	X5		8.998

Table 9 (Cont.)
Revised measurement model of organizational constructs

Parameters		Indicator	Construct	T-Values*
Measurement error of the indicators (δ)				
δ 5,10	0.152	X5 and X10		2.797
δ 6,6	0.874	X6		9.886
δ 7,7	0.653	X7		6.768
δ 8,8	0.890	X8		10.043
δ 9,9	0.851	X9		10.771
δ 10,10	0.084	X10		(N.S.)

Notes:

Chi Square with 33 df = 59.49

Chi-square-df ratio = 1.80

Goodness of Fit Index = 0.955

Adjusted Goodness of Fit Index = 0.925

* : P at .05 level for a one tailed t-test (1.645)

lambda : factor loadings of indicators on the construct

phi : correlation between constructs

delta : measurement error of the predictor variables

----- : not estimated

Figure 8. Structural equation model for organizational determinant of hospital mortality (model 1).

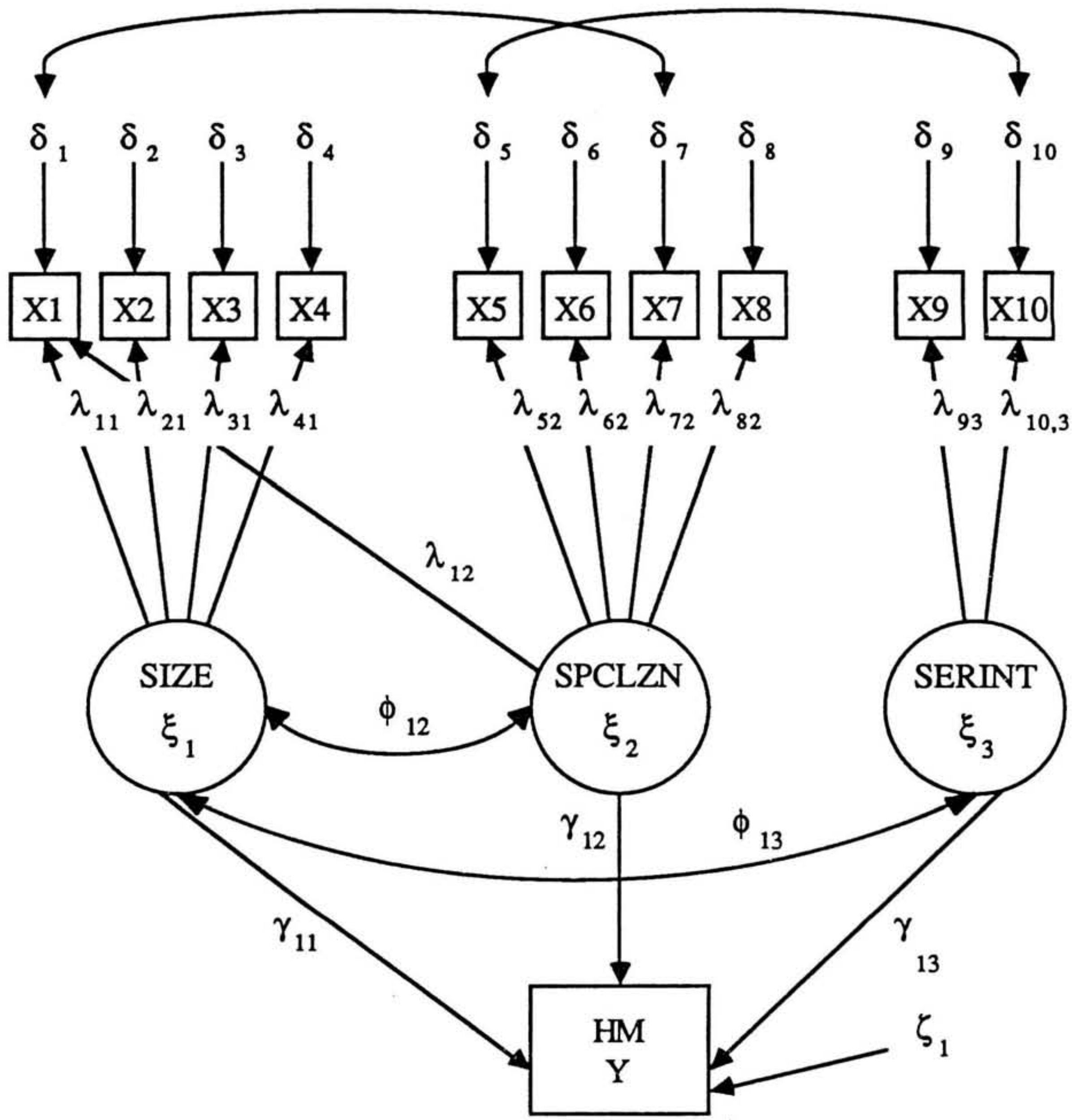


Table 10
Structural equation model of hospital mortality rate with three organizational constructs as predictors (model 1)

Parameters		Indicator	Construct	T-Values*
Lambda (Factor Loadings)				
λ 1,1	0.459	(X1)		8.144
λ 2,1	1.000	(X2)	SIZE (ξ 1)	------
λ 3,1	0.962	(X3)		53.548
λ 4,1	0.982	(X4)		76.914
λ 1,2	0.292	(X1)		3.658
λ 5,2	0.529	(X5)		------
λ 6,2	0.332	(X6)	SPCLZN (ξ 2)	4.120
λ 7,2	0.532	(X7)		6.513
λ 8,2	0.388	(X8)		4.837
λ 9,3	0.402	(X9)	SERINT (ξ 3)	5.754
λ 10,3	0.958	(X10)		-----
Effect of the constructs on hospital mortality Y (γ)				
γ 1,1	0.222		SIZE (ξ 1)	2.470
γ 1,2	-0.471		SPCLZN (ξ 2)	-4.971
γ 1,3	0.150		SERINT (ξ 3)	1.742
Intercorrelation between constructs (ϕ)				
ϕ 1,2	0.377	(ξ 1) and (ξ 2)		4.723
ϕ 1,3	0.532	(ξ 1) and (ξ 3)		9.460
ϕ 3,2	0.166	(ξ 3) and (ξ 2)		1.716
Measurement error of indicators (δ)				
δ 1,1	0.583	X1		9.630
δ 1,7	0.170	X1 and X7		3.060

Table 10 (Cont.)
Structural equation model of hospital mortality rate with three organizational constructs as predictors (model 1)

Parameters		Indicator	Construct	T-Values*
Measurement Error of indicators (δ)				
δ 3,3	0.078	X3		11.023
δ 4,4	0.040	X4		11.023
δ 5,5	0.698	X5		9.161
δ 5,10	0.133	X5 and X10		2.433
δ 6,6	0.889	X6		10.167
δ 7,7	0.714	X7		8.130
δ 8,8	0.848	X8		9.785
δ 9,9	0.845	X9		10.650
δ 10,10	0.125	X10		(N.S.)
Error term of dependent variable (ζ)				
ζ 1,1	0.773	Y		8.850

Notes:

Chi Square with 40 df = 98.84

Chi-square-df ratio = 2.47

Goodness of Fit Index = 0.930

adjusted Goodness of Fit Index = 0.885

R-square = 0.227

* : P at .05 level for a one tailed t-test (1.645)

lambda : factor loadings of indicators on the construct

phi : correlation between constructs

delta : measurement error of the predictor variables

----- : not estimated

existed between organizational size and hospital mortality. This result revealed that " the larger the hospital size the higher the mortality rate." Thus the original hypothesis was not supported. This may be explained by the fact that large hospitals tend to be more technically intensive, with more specialized services and personnel, and hence would attract more severely ill patients.

Service intensity was positively related to hospital mortality demonstrating that " the greater the service intensity the higher the mortality." This result confirms the original hypothesis.

A significant negative relation existed between organizational specialization and hospital mortality, demonstrating that " the higher the specialization the lower the hospital mortality." This suggests that hospitals with high specialization tend to have lower hospital mortality when other organizational factors were simultaneously considered. The model also indicates significant intercorrelation between the constructs of size and specialization, size and service intensity, and specialization and service intensity.

In order to further examine the predictability of the three organizational latent variables for hospital mortality rate, two additional organizational indicators; teaching status and ownership, and one community attribute (the crude death rate) were introduced as control variables in the

second model (Model 2) depicted in Figure 9.
Base on previous studies (Roemer, 1959; Neuhauser, 1971; Payne and Lyons, 1972; Rhee, 1976; and Palmer et al., 1979) these control variables should be included in the analysis so that the possible spurious relationships between organizational constructs and hospital mortality could be detected.

The results presented in Table 11 indicate that hospital size was no longer a statistically significant factor related to hospital mortality when other organizational factors such as specialization, service intensity, teaching status, and ownership were controlled for. Thus the analysis provides new evidence which questions the hypothesis " the greater the size the lower the mortality. " It also underlines the ambiguity of the effect of size on quality of care, as encountered in the literature.

Similarly, no significant relation was found between ownership and mortality rate, indicating that proprietary for-profit hospitals may not necessarily have a higher mortality rate than not-for-profit hospitals when other factors are simultaneously controlled for. Nor were the community crude death rate and hospital mortality significantly related, a result perhaps reflecting the fact that Medicare patients comprised the hospitals' population.

Service intensity, as expected, remained statistically significantly related to hospital mortality: The higher the

Figure 9. Structural equation model for organizational determinant of hospital mortality with control variables (model 2).

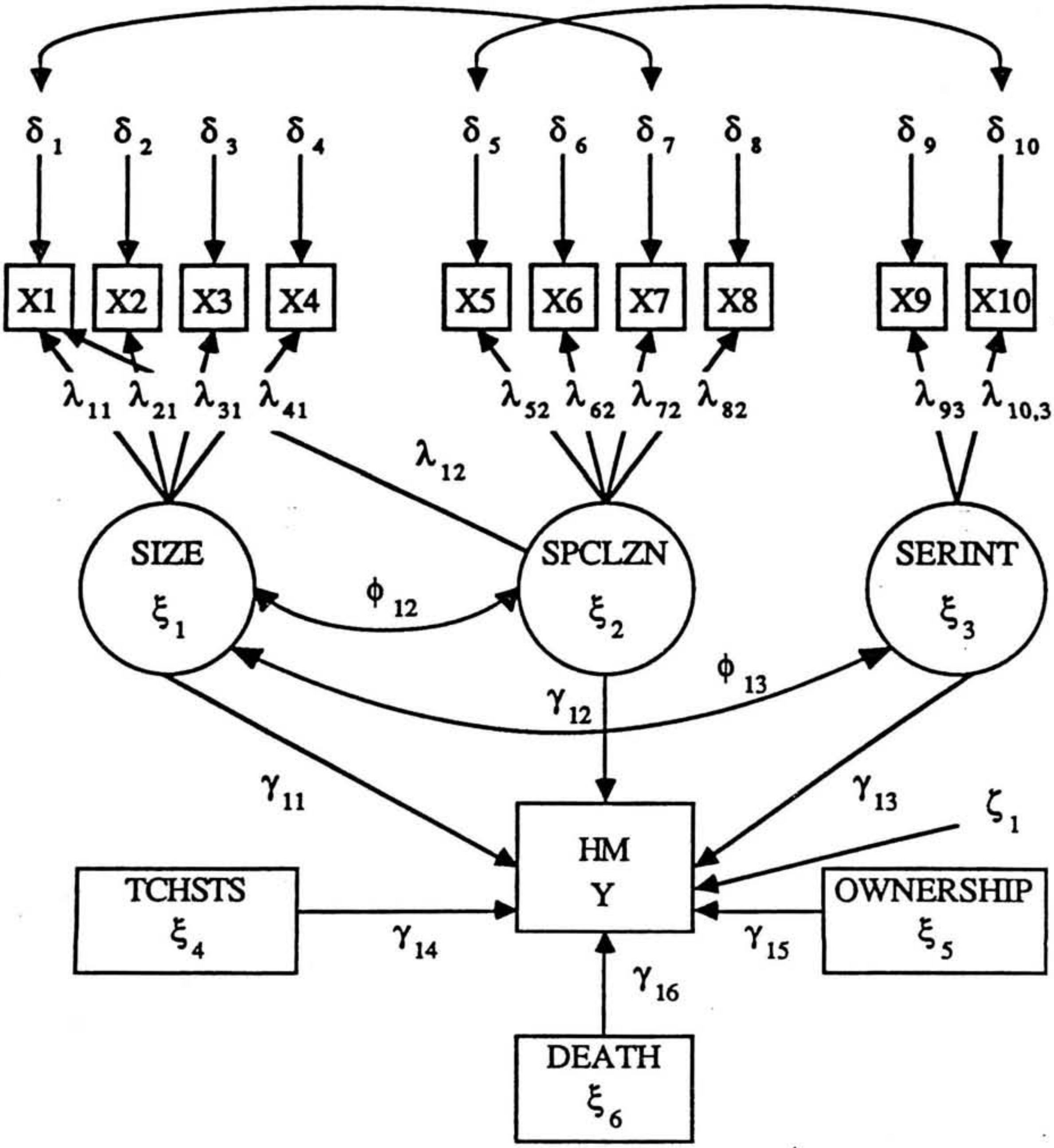


Table 11
Structural equation model of hospital mortality rate with organizational constructs and control variables (model 2)

Parameters		Indicator	Construct	T-Values*
λ 1,1	0.452	(X1)		8.126
λ 2,1	1.000	(X2)	SIZE (ξ 1)	------
λ 3,1	0.962	(X3)		53.548
λ 4,1	0.982	(X4)		76.914
λ 1,2	0.320	(X1)		4.397
λ 5,2	0.529	(X5)		------
λ 6,2	0.300	(X6)	SPCLZN (ξ 2)	3.960
λ 7,2	0.571	(X7)		7.651
λ 8,2	0.380	(X8)		5.065
λ 9,3	0.433	(X9)	SERINT (ξ 3)	6.243
λ 10,3	0.958	(X10)		-----
λ 11,4	1.000	(X11)	TCHSTS (ξ 4)	25.901
λ 12,5	1.000	(12)	OWNRSHIP (ξ 5)	22.253
λ 13,6	1.000	(X13)	DEATH (ξ 6)	22.455
Effect of constructs on hospital mortality (γ)				
γ 1,1	0.119		SIZE (ξ 1)	N.S.
γ 1,2	-0.536		SPCLZN (ξ 2)	-4.263
γ 1,3	0.179		SERINT (ξ 3)	1.846
γ 1,4	-0.178		TCHSTS (ξ 4)	-1.779

Table 11 (Cont.)
Structural equation model of hospital mortality rate with organizational constructs and control variables (Model 2)

parameters		Indicator	Construct	T-Values*
Effect of constructs on hospital mortality (γ)				
γ 1,5	-0.071		OWNRSHIP (ξ 5)	N.S.
γ 1,6	-0.052		DEATH (ξ 6)	N.S.
Intercorrelation among constructs (ϕ)				
ϕ 1,2	0.388	(ξ 1) and (ξ 2)		5.208
ϕ 1,3	0.550	(ξ 1) and (ξ 3)		10.278
ϕ 1,4	-0.72	(ξ 1) and (ξ 4)		-27.206
ϕ 2,3	0.181	(ξ 2) and (ξ 3)		1.961
ϕ 2,4	-0.387	(ξ 2) and (ξ 4)		-5.219
ϕ 2,5	-0.250	(ξ 2) and (ξ 5)		-3.248
ϕ 2,6	-0.274	(ξ 2) and (ξ 6)		-3.591
ϕ 3,4	-0.400	(ξ 3) and (ξ 4)		-7.039
Measurement error of indicators (δ)				
δ 1,1	0.653	X1		11.023
δ 1,7	0.233	X1 and X7		4.743
δ 3,3	0.078	X3		11.023
δ 4,4	0.040	X4		11.023
δ 5,5	0.675	X5		9.152
δ 5,10	0.117	X5 and X10		2.122
δ 6,6	0.893	X6		10.343
δ 7,7	0.728	X7		9.181

Table 11 (Cont.)
Structural equation model of hospital mortality rate with organizational constructs and control variables (Model 2)

Parameters	Indicator	Construct	T-Values*
Measurement error of indicators (δ)			
δ 8,8	0.865	X8	10.129
δ 9,9	0.824	X9	10.471
δ 10,10	0.182	X10	2.217
Error term of the dependent variable (ζ)			
ζ 1,1	0.791	Y	8.715
Chi Square with 68 df		= 159.23	
Chi-square-df ratio		= 2.34	
Goodness of Fit Index		= 0.917	
Adjusted Goodness of Fit Index		= 0.872	
R-square		= 0.248	

Notes:

* : P at .05 level for a one tailed t-test (1.645)

lambda : factor loadings of indicators on the construct

phi : correlation between constructs

delta : measurement error of the predictor variables

----- : not estimated

service intensity the higher the mortality rate, when other organizational and community factors were simultaneously controlled for. Thus the hypothesis that increased service intensity is associated with increased mortality rate was further supported. This finding is consistent with the literature in that service intensity was measured through average length of stay and occupancy rate, whereas longer length of stay was associated with higher mortality.

Hospital specialization had a significant negative effect on hospital mortality. This is not surprising, since specialization was measured by such indicators as (1) the number of high tech services offered (the availability of highly technical services being associated with lower mortality), (2) RN nurse ratio, (the use of more RNs being associated with lower mortality), and (3) percentage of board-certified physicians (associated with higher quality of care) and (4) case-mix index. Having a higher case-mix index predicts a higher degree of specialization in the hospital. Having a higher percentage of surgical patients reflects the volume of this service, which is associated with higher quality. This finding is consistent with the proposed hypothesis that the higher the specialization the lower the mortality rate when other factors, such as size and teaching status are controlled for. Controlling for the effect of other organizational and community variables, significant negative relation still existed between teaching status and hospital mortality; teaching hospitals have lower mortality. This is consistent with findings in the literature that a higher commitment to the teaching goal has significant association with quality of care.

The model also indicates significant intercorrelations between size and specialization, size and service intensity, size and teaching status, and size and crude death rate. Significant intercorrelation is also demonstrated between specialization and, respectively, service intensity, teaching status, ownership, and the crude death rate; between service intensity and both teaching status and the crude death rate; between teaching status and the crude death rate.

Table 12 presents summary statistics of goodness of fit measures for the two models. Model 2, which incorporated both organizational and community control variables explained about 25 percent of the total variation in hospital mortality differentials. Moreover, it provided statistical evidence that organizational variables were more important determinants of hospital mortality than community attributes. Further, the effect of size on hospital mortality rate is shown to be a spurious one when the effect of organizational specialization, the degree of service intensity and the teaching status of the organization are being simultaneously considered. The lower chi-square to degrees of freedom ratio of 2.34, as well as the adjusted goodness of fit index of 0.872 for Model 2, provide additional evidence to show that

Table 12
Summary statistics of the goodness of fit of the LISREL models

Measure	Model 1	Model 2
Chi-square/df	98.84/40	159.23/68
Chi-square-df ratio	2.47	2.34
GOFI	0.930	0.917
AGOFI	0.885	0.872
R-square	0.227	0.248

Notes:

GOFI : Goodness of Fit Index

AGOFI : Adjusted Goodness of Fit Index

Model 1: Three Organizational Constructs

Model 2: Organizational Constructs and Control variables

Model 2 is the better model in explaining the causal effects of organizational and community attributes on hospital mortality.

The findings suggest a new procedure for adjusting the organizational differentials that include organizational and community attributes to derive an adjusted mortality rate, and to provide corrections for biased estimated rates. Thus an adjusted rate may be expressed as follows:

$Y = \gamma 1\ O1 + \gamma 2\ O2 + \gamma 3\ O3 + \gamma 4\ C4 + \zeta 1$, where refers to the net effect of an exogenous (latent) variable on mortality rates; O refers to organizational latent variables, such as size, specialization, and service intensity; C refers to a community attribute (i.e. crude death rate); and ζ refers to the residual error term of the estimation equation.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to examine and identify hospital characteristics that affect the differential in hospital mortality, while controlling for the effect of community attributes. Analytical models for the determinants of hospital mortality were formulated and validated. The validation was completed through an empirical examination of 243 hospitals that had higher or lower mortality rates than expected for Medicare beneficiaries. The dependent variable for this study was HCFA released death rates for 1984 Medicare patients in U.S. hospitals. Hospital organizational characteristics were obtained from the 1984 AHA data file, and community attributes were obtained from the Area Resources File that provides county-level data for 1980. Finally, the 1984 case-mix index for the study hospitals was obtained from the 1985 Federal Register.

Multiple regression analysis was used in the first phase of the analysis to determine statistically significant organizational variables and community attributes that influence hospital mortality rates. In the second phase of the analysis, measurement models for three organizational constructs were formulated and validated, including hospital size, hospital specialization, and hospital service intensity. Then two structural equation models that portray the causal relation between the organizational constructs and hospital mortality rate were formulated and tested. This causal model was empirically validated and provided evidence to examine the following hypotheses:

1. The larger the hospital size, the lower the hospital mortality.

2. The higher the hospital specialization, the lower the hospital mortality.

3. The greater the service intensity, the higher the hospital mortality.

Summary of Major Findings

Regression analysis

When hospital mortality rate was regressed on the crude death rate (a community attribute) and eight organizational characteristics (RN nurse ratio, percent of board certified physicians, bedsize, average length of stay, case mix, occupancy rate, percent inpatient surgeries, and ownership) only three of those variables were statistically significant in accounting for the variance in hospital mortality rate. They were RN nurse ratio, average length of stay, and the percent of surgical patients.

The RN-nurse ratio was negatively associated with hospital mortality; the increase in RN-nurse ratio by one percent corresponded to a 5.4 percent decrease in mortality rate. This finding is consistent with previous findings cited in the literature. Scott et al. (1976) found RN-nurse ratio to be significantly related to the outcome of surgical patients.

Average length of stay was positively associated with hospital mortality. When the average length of stay was increased by one day hospital mortality rate increased by almost one half percent.

The percent of surgical patients was negatively associated with hospital mortality. When surgical patients increased by one percent, mortality rate decreased by about 4.4 percent. These findings suggest that hospitals with a high RN nurse ratio, shorter length of stay and a higher surgical patient ratio would have lower mortality rate.

It is important to note that these hospital indicators were highly correlated with other organizational variables that were excluded from the regression equation in order to avoid the problem of multicollinearity. Since regression analysis could not effectively examine the effect of correlated organizational variables on hospital mortality, a confirmatory approach was further performed to determine the causal relationship between correlated organizational factors (latent variables) and hospital mortality rate. The LISREL analysis of hospital mortality includes a measurement model and a structural equation model.

LISREL Analysis

A measurement model with three correlated organizational constructs (latent variables) was formulated and validated using a confirmatory factor analysis. The observable indicators for the three latent variables include: (1) hospital size indicated by the number of high tech services, the number of full time personnel, bedsize, and total non-capital expenses; (2) specialization indicated by the number of high tech services, the RN-nurse ratio, percent of board certified physicians, case mix, and the percent of surgical patients; and (3) service intensity indicated by average length of stay and occupancy rate. The goodness of fit test statistics, including the low chi-square to degrees of freedom ratio of 2.34, and an adjusted goodness of fit index of 0.872, indicated that the measurement model is reasonably fitted to the data.

Two structural equation models were developed to test the causal relationship between the three organizational constructs and hospital mortality, with and without control variables. The first model includes three organizational constructs (latent variables) as predictor variables of hospital mortality rate. The results indicated that a significant positive relation existed between hospital mortality and hospital size when the effects of specialization and service intensity were simultaneously controlled. This finding implies that the larger the hospital size the higher the mortality rate. Rhee (1983) in his comprehensive review of the literature, stated that some researchers found size to be related to higher quality of care, but others found no such relation. According to Rhee it is difficult to separate out the unique effect of size since it is associated with other correlates of quality such as teaching status, specialization, high technology, and greater volume of service.

Similarly service intensity was positively related to hospital mortality rate and indicated that the greater the service intensity the higher the mortality rate. This finding has confirmed findings reported in the literature that longer length of stay was found to be associated with lower quality of care.

A negative relation was found between hospital specialization and hospital mortality rate. This finding lends some support to previous research findings as cited in the literature reviewed (Palmer ,1979; Rhee,1983).

In the second causal model, in addition to the three organizational constructs used in the first model, three control variables were introduced: teaching status, ownership, and the crude death rate. The control variables were used to detect the possible spurious relationship between organizational constructs and hospital mortality. The results indicate that the effect of size on hospital mortality is negligible when these control variables were introduced. This suggests that the "size" effect on hospital mortality is a spurious one.

Specialization was found to be negatively related to hospital mortality when other significant variables were simultaneously controlled. Hospitals having a higher degree of specialization tended to have a lower mortality rate. The effect of service intensity on hospital mortality remained to be statistically significant when control variables were added into the equation. Thus, the hypothesized relationship between service intensity and hospital mortality is confirmed; the greater the service intensity, the higher the mortality. It is possible that longer stay patients tend to be sicker than those who had a shorter hospital stay.

Inspection of the data also revealed that ownership and crude death rate both had a negligible effect on hospital mortality when other organizational variables were simultaneously considered. Several researchers including Roemer (1959), Neuhauser (1971), Payne and Lyons (1972), and Rhee (1976), also found no significant relation between ownership and quality of care.

The only control variable that is statistically significant is "teaching status". The teaching hospitals had a lower mortality rate than non-teaching hospitals did when other factors were controlled. Palmer (1979) found that teaching status emerged as an indicator of quality when variation resulting from ownership and geographic locality were controlled. This was also found by Rhee (1983) who found that formal commitment to teaching facilitated a higher level of quality of care.

Limitations of the Study

The availability of mortality data for a limited number of hospitals may restrict our ability to fully examine the causal relationship between organizational determinants and hospital mortality. It would be desirable to analyze mortality data for all U.S. hospitals so that the findings can be better generalized. Another limitation imposed by data is the absence of the severity of illness measures. Although case-mix index was included in the analysis, it did not help us to control for the variation in hospital mortality that may be attributed to the type of patients treated. This study dealt only with in-patient mortality cases, and did not include cases in the post-hospitalization period. Mortality cases occurring thirty days after discharge may be more reflective of hospital performance, if they were made available for researchers.

Community constructs such as availability of health resources; socioeconomic status; and resource dependence on environment (competition) would be pertinent predictors of hospital performance, but they were not included in the present study because its primary objective was to examine major organizational determinants of hospital mortality.

Another limitation of the present study is that the stability of the measurement model over time has not been tested, since it requires a set of panel data. Finally, this study is a macro-level organizational study. Because process indicators of the hospital quality of care are not readily available for investigation, this study is further restricted in identifying completely the critical process factors that may affect the variation in hospital mortality.

Future Direction of the Research

Future research efforts in this area should be directed towards the development of a more comprehensive model for analysis that incorporates all the important components of organization ecology such as population characteristics, organizational characteristics, environmental attributes, and technology indicators. Future research should also include a multi-wave study design so that the stability of the measurements and causal structure can be ascertained. Further, consideration should be made to identify provider based outcome measures such as number of repeated admissions, number of omissions, and physician sanctions. These outcome measures by type of providers, and by different methods of payment may help to enhance our understanding of the impact of process indicators on hospital mortality. Finally, hospitals with a high mortality rate should be targeted for surveillance.

In conclusion this study has made several contributions.

It helps specify pertinent organizational determinants of hospital mortality. Specifically, it reveals the beneficial effect of hospital specialization and teaching status on hospital mortality. It also indicates that a higher degree of service intensity may lead to a higher hospital mortality rate. The study further shows a spurious relation existed between size and hospital mortality. Those substantive findings identify the theoretical importance of organizational constructs in the study of hospital mortality. Finally, the use of appropriate modeling techniques that help capture underlying, theoretical constructs has shed some light on the utility of rigorous multivariate analytic techniques in health services research. For example, previous research invariably used bed size to indicate organizational size, while this study used multiple indicators of size.

In the area of practical application the study offers a new strategy for adjusting organizational differences that affect the variation in hospital mortality. Thus biased estimations of crude hospital mortality due to organizational differentials can be corrected. This strategy will solidify the use of adjusted mortality rates as indicators of hospital performance.

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