Hospital Laboratory Testing
Influenced by the
Prospective Payment System

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ABSTRACT

The federal government has implemented the prospective payment system as a method of hospital reimbursement for all Medicare patients in an attempt to contain rising hospital costs. This paper examines the effect that the prospective payment system has on hospital laboratory testing. Data is gathered through manual review of charts from patients' medical records.
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CHAPTER I
INTRODUCTION

The rising cost of health care has brought economic concern to both consumers and providers of health care. In 1980, $230 billion was spent on health care in the United States. That is equivalent to $1,100 for every man, woman, and child. That is also 9.0% of the total gross national product. Government spending on health care has risen from $4 billion in 1965 to $66 billion in 1980, and a projected $71 billion in 1985.\(^1\)

The cost of hospital care has risen most rapidly, followed by payments made to physicians. The expenditures for hospital care of Medicare beneficiaries under the Hospital Insurance Trust Fund increased approximately 15% in 1982.\(^2\) These alarming figures have caused the Federal Government to implement methods of price containment in order to maintain the present Medicare system of hospital insurance.

A prospective payment system for Medicare patients requiring inpatient hospital services was formulated in 1983 to help curb the rising cost of hospitalization. Under this system of reimbursement, payment amounts to hospitals are established in advance of the provision of service. It is believed that this method of reimbursement will provide incentives to hospitals to contain costs, thus reducing the costs to the Medicare program. (A retrospective, cost-based reimbursement system was formerly used by Medicare to reimburse hospitals.)

Since the inception of the prospective payment plan much concern about the new system's impact on hospitals, the practice of medicine, and on the care of the elderly has been expressed. Studies show various trends on the effects of prospective payment systems on hospitals. Hospitals are laying off staff members and changing their methods of hospital organization
and administration. In the hopes of reducing cost, they are buying cost
calculating computers and driving hard bargains with medical supply companies.3

Hospital administrators and physicians are also working closer together
in order to develop methods of cost containment. Physicians are ordering
fewer tests and patients are using alternative facilities to inpatient hospital
care whenever possible. For example, hospitals are doing more of their
laboratory testing and surgery on an outpatient basis. More time is being
devoted to planning the discharge of the patient. Nursing homes have been
purchased or contracted by hospitals, so patients can be discharged from the
hospital with a place to go. Consequently patients are finding their hospital
stays to be shorter.4

The purpose of this study is to examine the effect the prospective payment
system has on the use of the hospital laboratory. Ancillary services provided
by hospitals, such as laboratory testing, are major contributors to the cost
of health care. This study determines if there is a significant change in
laboratory usage by physicians in order to control the cost of a patients
hospital stay.

This report investigates the effect of the prospective payment system
on the number and cost of laboratory tests performed within a hospital under
the new prospective payment system. The number of laboratory tests per
hospital day ordered by physicians and the total costs spent on these tests
are compared before and after the prospective payment system began. This
is done by reviewing patient medical records from a teaching osteopathic
hospital in Michigan. Patients charts are reviewed from five different
categories of diagnosis to determine if the prospective payment system has
reduced costs by the way in which ancillary services, such as laboratory
tests, have been utilized by physicians.
CHAPTER II
HISTORICAL BACKGROUND

The Rising Health Care Costs

There are several reasons for the increasing health care costs. One reason is the growth in public and private insurance. Insurance channels payment of medical expenses through third party payers. The patient pays very little of the total medical cost directly. There are no incentives for the insured patient or his doctor to economize in the use of medical resources since they are retrospectively reimbursed at cost by the third party insurance group.

The increase in medical care cost may be attributed to the advancement in medical technology. Advance treatments in health care are very expensive. The cost of utilizing modern technical equipment for diagnosing and treatment encompasses both the cost of the equipment and the cost of trained personnel to operate the equipment. This in turn increases the total cost of the patient's medical care costs.¹

The size and age of the population has also contributed to the increase in health expenditures. In 1950 only 8% of the American population was over 65 years of age. In 1982 the population over 65 years of age had risen to 11%.² As the nation's population becomes older, greater expenditures on health care can be expected since the aged have more complex diseases, which require more expenditures.
Background of the Medicare Program

The Medicare Program was enacted by Congress in 1965 under Title 18 of the Social Security Act, to provide insurance protection for elderly people against the costs of health care. Medicare is a Federal Program with uniform eligibility and benefit structure throughout the United States. People who reach age 65 and are entitled to Social Security retirement benefits are automatically entitled to Medicare Hospital Insurance. The program has broadened its coverage since then to include some disabled persons and individuals who receive dialysis treatments of kidney transplantation for end-stage renal disease. In 1985, 27 million aged beneficiaries and 3 million disabled individuals were entitled to the benefits under the Hospital Insurance of the Medicare Program.

Medicare benefits consist of two parts. Part A is the hospital insurance that helps pay the costs of inpatient hospital services, nursing facility services, home health services, and hospice care. Part B Medicare is the Supplementary Medical Insurance which helps pay for physician's services, outpatient services, laboratory services, and other medical related services.

Benefits Under Medicare Hospital Insurance

In 1985 Medicare pays for ninety days of inpatient hospital care subject to a $400 deductible. A daily co-payment of $100 in 1985 is required for the 61st day through the 90th day. An additional lifetime reserve of 60 days may be drawn upon when an individual exceeds 90 days in a benefit period which is subject to a $200 a day co-payment. Hospital insurance will pay for up to 100 days in a nursing home facility. After the first 20 days, beneficiaries must pay a daily co-payment charge of $50. Home health care is also provided through Medicare Part A with no deductibles or co-insurance. Hospice service for the terminally ill are also covered. A beneficiary
may elect to receive services for two 90 day periods and one 30 day period during his lifetime under Medicare Part A. Electing to receive services through a hospic prevents the beneficiary from receiving any other Medicare benefits.

**Financing of Medicare Hospital Insurance**

The funding source for Medicare Part A is from an increase in payroll Social Security taxes that applies equally to all employers, employees, and self-employed persons. This increase in workers taxes is paid into a special trust fund reserved for Medicare Hospital Insurance. A individual's Medicare Hospital Insurance contributions are computed on annual wages, up to a specific maximum annual amount. The maximum taxable earnings amount is changed automatically by law each year in order to reflect changes in the general level of wages in employment subject to Social Security taxes.

Part of the financing of Medicare Part A is obtained by the beneficiary in terms of deductibles and co-payments. Deductibles are paid by the patient before the plan pays anything and co-payments are portions of the remaining charges for which the patient is responsible.

The funding for Medicare depends largely on the relationship between the number of workers paying Social Security taxes and the number of retired workers. Part of the financing problem with Medicare is the declining worker to beneficiary ratio. The government has borrowed $12.4 billion from the Medicare Trust Fund to bail out the old age benefit program. It is projected that by 1987 the Medicare Fund will also be depleted. The Medicare Trust Fund has been steadily declining. In 1981 the fund had a year end balance of $18.7 billion. In 1985 the balance is projected to be $5.1 billion.
By 1987 the Medicare Trust Fund is projected to be depleted with a deficit of $7.6 billion if the trend continues.7

The government has been regularly raising deductibles and co-payments for Medicare Part A beneficiaries to help maintain the trust fund. Deductibles have increased from $40 in 1966 to $400 in 1985 for the first sixty days of hospitalization. Co-payments have increased from $10 per day to $100 per day for the 61st through 90th day. Nursing home co-payments have increased from $5 to $50 from 1966 to 1985.8

Along with the increasing of deductibles and co-payments, the government has also raised the Social Security tax that employees and employers pay into the Medicare Part A Trust Fund. These taxes have increased from 1.35% to 1.45% in 1986 to a projected 2.38% by 1995.9

The funding for Medicare Hospital Insurance will continue to be in jeopardy as long as the elderly receiving health insurance benefits grows faster than the number of workers who will support them through payroll taxes. Coupled with this problem is the type of reimbursement system Medicare uses for payment of medical services. This type of system is known as the retrospective, cost-based reimbursement system. Retrospective means that payment is made for the costs of services which have already been provided. This system can be viewed as inflationary, since it provides no incentives for hospitals to control costs or operate more efficiently. The more services the hospital provides, the greater will be its Medicare reimbursement.10 One example of how the retrospective payment system is abused is seen in a hip replacement operation. Medicare has paid from $2,100 to $8,200 for this operation with no obvious difference in the quality of patient care.11 The longer hospitals keep their patients and the more services provided to them,
the more they are reimbursed because they are paid by reasonable costs.

Measures to Contain Rising Health Care Costs

Several programs have been developed through the years to help contain the rising costs of medical care. In the early 1970's the Certificate Of Need Laws were passed which required hospitals to obtain planning agency approval before investing in new facilities or in expensive technologies. This was to limit unnecessary expansion in areas where potential benefits would not outweigh the costs.

Professional Standards Review Organizations were established through legislation as a way of monitoring the delivery of health care. It was a quality control effort with the intent to control costs.

In 1973 the HMO Act was passed to stimulate the growth of HMO's. Federal monies were provided to help fund Health Maintenance Organizations in hopes that this type of insurance program would compete with the fee-for-service insurance programs. This law required such comprehensive services to qualify as an HMO, that many were unable to compete. In 1979 the HMO Act was amended allowing more flexible coverage.

In 1976 the Health Manpower Bill passed which called for a halt to the increase in medical school enrollment. The rational for this was that physicians induce the demand beyond the optimal level of service. The bill also called for an increase in the number of physician assistants and nurse practitioners.12

The Prospective Payment System

The prospective payment system is based on Diagnostic Related Groups (DRGs), where providers are paid fixed fees in advance for their services
depending upon the diagnosis assigned to the patient at the time of discharge. The DRG system was developed at Yale University in the early 1970's. The principal diagnosis is used to group patients into broad categories called Major Diagnostic Categories, which are arranged according to the organ system. The Major Diagnostic Categories were then subdivided into DRGs based on variables such as age, sex, and secondary diagnosis. This system has been tested over a period of years in New Jersey Hospitals.\(^{13}\)

The state of New Jersey has implemented DRGs voluntarily. These rates apply to Blue Cross, Medicare, Medicaid, and commercial insurers. In 1981 65% of the New Jersey hospitals were operating under the DRG system. The costs per patient in New Jersey increased by 11.5% in 1981, compared to the United States average of an increase of 17.7%. The results are supportive of a slowing in the rise of hospital costs by the use of the DRG reimbursement system. It was also noted that patients were still being given quality care under the DRG system.\(^{14}\)

According to the prospective payment system adopted by the Federal Government, Medicare patients will be admitted into the hospital under one of 471 diagnostic groups. These groups are based on the principal diagnosis of the patient, the type of surgery, presence of complicating conditions, and the patient's age. The hospitals will receive a predetermined amount in payment for each DRG. More complex types of cases such as kidney transplants (DRG 302) would receive a higher payment than simpler cases such as hernia repair (DRG 161).\(^{15}\) The hospital is allowed to keep any portion of the reimbursement it does not utilize and must make up the difference if it utilizes more than the reimbursement cost. This system is intended to encourage hospitals to use resources in an efficient manner and give
them incentive to decrease expenditures through more effective clinical and financial management.

The system became effective October 1, 1983 and will be phased in over a three year period. For the first three years the reimbursement will be a blend of each hospital's own cost experience with the new DRG rate. For example, the first year each DRG will be reimbursed according to 75% of the regional hospital cost and 25% of the national DRG cost. By the fourth year, reimbursement will be 100% of the national DRG rate.16

The DRG system of reimbursement is set up according to nine regions in the country and within each region there is an urban and rural rate. Over a four year period these regional barriers will be broken and a set of national DRG rates for urban and rural hospitals will exist.17

In addition to the prospective payment rates per discharge, Medicare will also pay for outlier or atypical cases, which have either extremely long lengths of stay or high costs compared to most discharges classified in the same DRG. Additional payments are made to hospitals for medical education programs and psychiatric, children's, and rehabilitation hospitals are excluded from the prospective payment system and are reimbursed on the basis of reasonable costs.18

Peer review organizations have been organized nationally and are intended to keep patients from being underserved by monitoring patient care. Each hospital must contact a peer review organization as a condition for receiving Medicare payments. The organization has the task of reviewing the validity of the diagnostic information, the completeness, adequacy and quality of care provided, and the appropriateness of admissions and discharges.19

The prospective payment system provides incentives for hospitals to
contain total costs of a patient's hospital stay. One predetermined rate will be received to diagnose and treat a Medicare patient. The hospital must use that payment toward whatever services it provides. Since the hospital is able to keep any excess money, cost containment will be emphasized. Containing cost within the hospital will help contain the costs of the Medicare Hospital Insurance program.

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CHAPTER III
LITERATURE REVIEW

Overview

Medicine's dependence on the laboratory for patient screening, monitoring, and diagnosis is demonstrated by the high volume of tests being performed in the United States. Laboratory tests have been a major contributor to the rise in health care expenditures. Clinical laboratory testing accounts for about 25% of total hospital charges. Between 1975 and 1978 clinical laboratory services rose by 26.8%.

There has been a growth in the volume of laboratory tests used in treating common illnesses over time. This can be shown in Scitovsky and McCall's study. The average number of laboratory tests for perforated appendicitis increased from 5.3 per case in 1951 to 14.5 in 1964 to 31.0 in 1971. For maternity care, the number rose from 4.8 per case in 1961 to 11.5 in 1964 to 13.5 in 1971.

Several reasons have been suggested why so many lab tests are being ordered. Burke suggests there are four main reasons consisting of ready availability of tests, fear of malpractice, lack of training in proper use of the laboratory, and the desire to practice scientific medicine.

Now that hospitals are being reimbursed by the prospective payment system, incentives to cut costs are being formalized. Hospitals can be expected to reduce length of stay, as well as the volume and intensity of the ancillary services they provide. Since hospitals receive the same payment regardless of how long a patient stays, they will develop services aimed at reducing the length of stay; such as pre-admission testing, post-hospitalization home care, and long term placement. The survival of the
hospital also depends upon monitoring and modifying the behavior of physicians. It is the physicians who decide when to admit and discharge a patient and how to utilize hospital resources.\(^4\)

Hospital administrators are urging physicians to think twice before admitting patients and be quicker in discharging them. They are urging doctors to reduce patient tests.\(^5\)

**Studies of Overutilization of Laboratory Tests**

Several studies have been conducted to show that clinical laboratory tests have been overutilized and do not improve patient care. One such study was done by Paul F. Griner, M.D. Griner collected data pertaining to laboratory studies from the computerized billing system for hospital inpatients for a three month period in 1970. Laboratory data was collected and arranged to show:

1.) Common tests performed in order of frequency, which included:
   A) Urinalysis.
   B) Complete blood count.
   C) Blood urea nitrogen.
   D) Glucose.

2.) The average number and range of tests per patient per hospitalization. This showed that the total number of different tests performed on each patient was directly related to length of hospitalization.

3.) The average number of times each test was performed. Electrolytes, blood urea nitrogen, and complete blood count were repeated every two to three days.

4.) Lab use according to level of care. Patients in intensive care units received more than twice as many laboratory tests than patients not in intensive care units. This can be expected
since intensive care patients are usually in a critical physical condition.

5.) Lab costs in relation to other hospital costs. The rate of increase in laboratory costs exceeded that for total hospital costs for each three years. That data gathered for this three year study of costs for various patient care functions were from patients hospitalized with the diagnosis of diabetic ketoacidosis.

The results of this data collection showed that there were specific patterns of laboratory overuse at this institution. One such finding was that urinalysis cultures exceeded the number of urinalysis. This seems abusive since the need for a urine culture would depend on the result of the urinalysis.

Other findings showed that patients averaged 7 laboratory tests per day for the first week of hospitalization and 4.5 tests per day by the beginning of the third week of hospitalization. After three weeks the number of laboratory tests tend to remain constant irrespective of the length of stay. The number of laboratory tests after three weeks of hospital stay showed no increase or decrease.

Simultaneously, Griner conducted an additional study comparing laboratory costs to other hospital costs for patient care, such as dietary, pharmacy, housekeeping, and total hospital costs for the years between 1965 and 1970. The rate of increase in costs for each hospital function was determined by comparing costs for 1966, 1968, and 1970 with the costs of 1965. The three year survey of costs of patient care functions illustrated that laboratory costs rose 229%. The rise in chemistry laboratory tests rose 95%, which would account for most of this total rise in laboratory
costs. This study showed that laboratory costs are rising faster than the costs of other patient care functions, contributing to the total cost of hospitalization.

Once the results were formalized an attempt was made to inform attending physicians, house staff, and students by distributing cumulative patient bills and discussing the data presented in the report at conference and grand rounds. Feedback obtained from the physicians expressed an unawareness of the economic impact of laboratory use and of the examples of laboratory overuse.

The physicians took the initiative and developed rational guidelines for optimal applications of lab tests. Laboratory utilization had remained constant rather than continuing to increase after nine months, once those guidelines were issued on the use of the laboratory.6

Griner conducted a follow up study in 1977 at the same hospital to determine the long term trends in the use of laboratory testing. The average number of tests per patient per hospitalization were compared with similar data on patients hospitalized in 1970, 1971, and 1976 and matched for a distribution of length of hospital stay.

Data was obtained from the computerized billing system as was done in the previous study. The findings showed a 83% increase in laboratory costs. The per patient increases in laboratory costs were less than the increases in overall hospital charges. This data indicated reduced numbers of chemistry tests and no growth in the numbers of hematologic and microbiologic tests ordered per patient per hospitalization. This data contrasts to the study between 1965 and 1970.

One possible flaw with this study is that test comparisons were made between groups of patients hospitalized before 1977 whose distribution
of length of stay was identical to that of the 1977 sample. This was to control for a progressive decline in length of hospitalization. Since the length of stay of these patients was shorter than that of the total sample for the respective year, it is likely that the patients in the years previous to 1977 were less ill than those hospitalized in 1977 with whom they were compared, resulting in an underestimate of fewer tests, by controlling for length of stay.

Overall Griner showed a long term trend stability in laboratory use. Some individual test patterns need continued attention, such as tests that tend to be ordered throughout the patient's hospital stay, specifically serum electrolytes. It can be claimed that a sustained reduction in excessive numbers of laboratory tests can be accomplished through various internal hospital strategies directed toward physicians.\(^7\)

A study demonstrating the overutilization of laboratory tests was done by John M. Eisenberg, M.D. using a computer based system in 1977. The computer based reporting system provided a daily list of patients who had three or more determinations of a given laboratory test in a short period. A panel of facility interns were used to establish a list of reasons for which multiple determinations of a test would be appropriate. A chart auditor would in turn review a chart to determine if the multiple determination met the acceptable criteria. If the test for LDH did not meet the criteria a letter was sent to the physician and the attending physician, telling them of the audit and inviting an explanation from the physicians. The same audit for the overutilization of calcium testing was not publicized to the physicians.

The results showed that 51% of the audited charts revealed overutilization.
During the second period of study after program notification and education, 65% of the audited charts revealed overutilization. The unpublicized calcium control also showed no significant difference in the frequency of inappropriate testing. It was concluded from the study that there was overutilization of laboratory testing, but the program of notification and education was not effective in altering physician testing patterns.\footnote{8}

Richard Dixon, M.D., and John Laszlo, M.D. conducted a study in two phases to estimate the effectiveness of utilization of the clinical chemistry laboratory. Effectiveness was measured based on criteria that resulted in directly affecting the management of the patient.

The method of this study was to randomly select charts and assess how often chemistry data altered the course of patient care. The logic for ordering the test was also assessed by its usefulness, such as the result generated an order for medication. It was shown that extravagant testing was being performed that did not improve patient care.

In the second phase of the study, physicians were limited to ordering eight tests per day per patient, which would require the physician to make a more careful selection of laboratory tests. Charts were again selected randomly, keeping the types of illness and length of stays similar in both phases of the study, to be reviewed.

The results of the study showed that the clinical chemistry laboratory was being used inefficiently. It showed that automated chemistry tests generate data that yields a low percentage of results that are useful. When a limitation was put on the number of tests, these extra tests were eliminated. If the commonly used tests like CPK, LDH, SGOT, calcium, and uric acid were available singly, the efficiency of lab time would be enhanced. The study
showed a 25% overall decrease in laboratory tests while increasing the clinical utility of the average test without eliminating essential information to patient treatment, when test ordering was restricted. A report from Health Care Strategic Management states that it is less costly to provide physicians with a large panel of results from a continuous flow analyzer. This contradicts Dixon's view that commonly used tests should be available as a single test.

This report by Craig Lehmann and Dr. Alan Leiken refers to two studies that showed that the medical staff must substantially cut the number of tests ordered if selective testing is to result in cost reduction. It is less costly to provide the physician with a whole panel of results when three or more chemistries are ordered. This type of technology performs cost effective testing and requires the least amount of labor. Therefore, high volume with a high number of tests per sample can be performed most efficiently by means of continuous flow analyzers that perform a battery of tests.

If there is a decrease in the number of laboratory tests, less medical information is provided, which may result in longer patient stay. Cost containment in the hospital laboratory does not necessarily have to be in the form of sample or test reduction. A reduction in the number of tests per sample for highly automated tests is an inappropriate approach to cost containment. Increasing laboratory productivity along with proper use of technology can have beneficial effects.

Michael Nathanson in Modern Healthcare presents two different views on laboratory strategies in coping with the prospective payment system. One view is that the use of profile testing is on the decline. Most of
the tests results end up being negative and are therefore wasteful. Profile testing will be replaced by smaller groups of tests that measure specific organ functions. There exists the possibility of developing specific test packets for each diagnostic related group category.

A second view is that mass testing might lead to earlier discharge of the patient which is a money saving strategy under the prospective payment system. Every minute cut from test turnaround time will cut a patient's length of stay and help a hospital keep its costs below the Medicare fixed rates.

Overutilization of laboratory tests can be seen in the studies conducted by Griner, Eisenberg, and Dixon. The increased number of laboratory tests and the repetition of testings has proven to have no clinical benefit to the patient. The best method for cost containment within the laboratory varies. It seems that limited test panels directed to organ specific functioning may prove the best method for clinical laboratories to adapt to the demands of the prospective payment system.

Studies on Methods for Modifying Physician Behavior on Test Ordering Patterns

Many studies have been conducted to modify the ways physicians order diagnostic tests. These methods have included setting limits on the number of tests ordered in a day, offering incentives to physicians for reduced ordering, educating physicians about the appropriate ordering of tests, auditing physicians test ordering practices with feedback to physicians about appropriate test ordering, and providing feedback of patients bills to the physician.

John M. Eisenberg showed that an educational program reduced the use of routine admission prothrombin time testing, but that physicians had
returned to their previous testing behavior within two years.

The study was designed to reduce the excessive use of prothrombin time by house staff physicians. The method of the study was manual chart review of patients from two parallel medical schools. One school served as the control group and did not receive a six week educational program on appropriate laboratory testing. A memorandum was distributed to all house staff members, urging them to reconsider the use of the prothrombin time test. After every three months, charts were reviewed for both the control and study group for a two year period.

The results of the study showed that the study group who received the educational program showed a decrease in the use of the prothrombin time determination. During the next year no educational program was offered and the use of the test gradually returned to its original level within six months. One possible flaw in this study could be the annual replacement of the house staff; the new house staff responsible for ordering had not received the educational program. It can be concluded from this study that repeated educational programs are necessary to induce behavioral modification.

Eisenberg conducted another study to determine if physician's test ordering patterns could be altered when exposed to prices of laboratory tests. The method of study was through a mailed survey. Questionnaires were mailed to physicians, residents, and interns who were randomly selected. The questionnaire consisted of eleven patient management problems. In each case a range of five different prices of tests were given as options to determine the physicians' perception regarding the relative value of the test.

The results of this study showed that 25% of the physicians, and 37%
of the residents and interns were willing to take price into account and to allow the price of the laboratory tests to influence their clinical decisions. One possible flaw of this study is how a physician would behave in actual situations. The study indicates that the education of physicians on cost may influence their ordering patterns of laboratory tests.

Albert M. Martin, M.D. evaluated the method of chart review with discussion and financial incentive simultaneously in his study to reduce unnecessary ordering of laboratory tests. The study was conducted by randomly reviewing charts to observe overall test ordering patterns. The test ordering patterns for each of the three teams of physicians were almost identical. All three teams were then given a lecture on testing strategies and test costs. One team was given a financial incentive to reduce the number of tests ordered. If laboratory tests were reduced by 20% collectively as a team, each member would receive $150 for books. The second team was met with weekly for chart review with individual discussion. The third team served as a control and received no further feedback other than the original lecture.

The results of this study found that repeated laboratory testing accounts for about 75% of all laboratory tests. Many of these repeated tests had previously normal results or contributed minimally to the patient's treatment. All three teams showed a decrease in the number of laboratory tests ordered. The chart review and discussion team decreased their laboratory tests ordered by 47%, whereas the other two teams decreased their laboratory tests ordered by 29%. During the follow up period the chart review team retained the reduction in ordering, whereas the other two teams
showed only temporary reduction in ordering of laboratory tests. The study suggests that any input to physicians may affect their approach to test ordering but chart review seems to be more longlasting.\textsuperscript{14}

Steven A. Schroeder used cost audit with feedback to physicians to achieve a 29.2\% decrease in the use of laboratory tests. Physicians were audited and given a list of laboratory prices. The mean annual lab costs for patients of each physician were compiled. The physicians were coded and ranked in order of increasing cost. The results were distributed to the physicians. Each physician knew only his own code and could not identify the others. A second audit was then performed showing a 29.2\% reduction in the use of the laboratory. One flaw in this experiment may be that physicians may have ordered fewer tests because they were more familiar with their patients. The study shows that cost audit with feedback to physicians can cause a reduction in the number of laboratory tests ordered by physicians.\textsuperscript{15}

Recalling the Dixon and Laszlo study, of limiting the number of tests ordered to eight per day per patient, it was shown the laboratory test ordering decreased by 25\%. This method can also be included as an effective way to modify a physician's laboratory test ordering pattern.

Many methods can be used to alter a physician's behavior on ordering laboratory tests. Auditing physicians test ordering behavior along with feedback concerning appropriate test ordering appears to be the most consistently effective method for modifying test order behavior. Providing a price list of laboratory costs could be the easiest method to modify ordering patterns.
Studies on Methods of Retaining Laboratory Costs

Steven A. Schroeder conducted a study to correlate laboratory use with variations in clinical productivity and clinical outcomes. Thirteen faculty internists were reviewed, using only hypertensive diagnosed patients. The setting was a prepaid and fee-for-service clinic. Data was collected on three different aspects: cost of laboratory use, clinical productivity, and outcome of care. Costs were calculated in mean cost per patient per year for each internist. Productivity was determined by the total patient load divided by the number of weekly scheduled clinic sessions. Outcome of care was determined by acceptable blood pressure levels.

This study revealed that the variation among annual lab costs per patients among internists ranged from $8 to $161. The study also showed that physicians with greater laboratory use are more expensive, but not more efficient. A flaw in this study is that the measurement for clinical productivity and outcome of care is not concrete. It is also not known whether the same findings would hold true in a setting other than a clinic.

K. Michael Cummings evaluated the effects of providing physicians' prices of diagnostic tests and their subsequent behavior in ordering laboratory tests. Cummings conducted his study by asking physicians to review four case studies in which the symptoms were given and a choice of laboratory tests they would order for each patient. One group of doctors received a price list of the laboratory tests with these cases and a control group received no price list. Three variables were analyzed from the survey. They were the number of tests ordered, the number within different categories of tests, and the cumulative cost of tests for each of the four cases.

The results of this study showed that the average number of tests ordered
were lower when the price list was given and that there was an average reduction in cumulative costs of tests ordered per patient of 31.1%. It can be asserted that information about prices of laboratory tests can alter physician's behavior in test ordering. It was observed that most of the cost savings was a result of a reduction in the number of tests ordered rather than selection of less expensive alternative tests. The study did not allow for additional test ordering after the results of the initial tests are obtained, which could alter these findings. Another flaw of this study is that it is not known whether the results obtained in case studies accurately reflect a physician's behavior.17

Referring back to Martin's study it was shown that inexpensive tests accounted for a much larger portion of the hospital bill than did higher cost procedures. Repeated use of low cost tests is more important in generating cost than is expensive technology.18

The price range for the cost of laboratory tests per patient varies greatly. The excessive cost is accounted for by repeat low cost testing or high cost expensive technology. By reducing the number of laboratory tests ordered, the cost to the patient in turn will be reduced. Providing price information to physicians has been shown to alter their test ordering patterns.

**Studies on Patient Length of Stay**

The Department of Health and Human Services reported that Medicare patients admitted to hospitals under the new prospective payment system spend an average of 7.5 days in the hospital in 1984. This is down from the average length of stay of 9.5 days in 1983. This suggests a reduction
of 2 days, or 21% in the average length of stay. The American Hospital Association reported a similar trend. \(^{19}\)

The average length of stay of hospitalized patients varies with the type of hospital. Schroeder conducted a survey to determine if the length of stay and use of diagnostic tests are different in a University and Community hospital. He did this by reviewing the medical records of thirteen internists who discharged patients from either hospital. In the University hospital the internists could order tests whereas in the Community hospital they needed approval from the attending physician before ordering tests.

The results of this study showed more tests were ordered in the University hospital. In this particular study the length of stay was slightly shorter in the University hospital than the Community hospital. This contradicts previous reports but this can be accounted for in that the type of patient or personal physician was not accounted for in this study. The study showed that the patient length of stay can vary depending on the type of hospital. \(^{20}\)

**Hospital Laboratory Strategies to Cope with the Prospective Payment System**

Laboratory tests have always been beneficial to the physician in patient diagnosing, treatment, and monitoring. Now the laboratory will have to be more efficient to accelerate turnaround time of laboratory test results in order to shorten the patient's length of hospital stay.

Hospitals must seek ways to shorten patient's hospital stay. Preadmission testing can be an important strategy. If a physician orders more specific tests on a preadmission basis, or even within the first day or two of a patient's hospitalization, the patient's length of stay can be shortened. \(^{21}\)
Some hospitals have eliminated mandatory admission tests or streamlined diagnosis screening panels, leaving the physician with more discretion to their laboratory test ordering.\textsuperscript{22}

Pathologists and physicians must work closer in terms of ordering patterns. Before a pathologist will approve a more expensive test, a simpler test is performed and some of the serum is reserved. If the results of that test are abnormal or indicative of further testing, the costlier test will then be performed.\textsuperscript{23} Pathologists also suggest further testing when an abnormal result is found instead of waiting for the doctor to order that specific test. This method decreases the number of single orders, minimizes the number of specimens and test duplication, and improves the total turnaround time, which helps reduce the patient length of stay.\textsuperscript{24}

No particular studies have been conducted on the effect of physician's test ordering patterns with the establishment of the prospective payment system. Since cost containment is the main theme of the payment system, the physicians ordering habits of laboratory tests will be expected to be altered.

* * *

\textsuperscript{22} Pathologists and physicians must work closer in terms of ordering patterns. Before a pathologist will approve a more expensive test, a simpler test is performed and some of the serum is reserved. If the results of that test are abnormal or indicative of further testing, the costlier test will then be performed. Pathologists also suggest further testing when an abnormal result is found instead of waiting for the doctor to order that specific test. This method decreases the number of single orders, minimizes the number of specimens and test duplication, and improves the total turnaround time, which helps reduce the patient length of stay.

\textsuperscript{24} No particular studies have been conducted on the effect of physician's test ordering patterns with the establishment of the prospective payment system. Since cost containment is the main theme of the payment system, the physicians ordering habits of laboratory tests will be expected to be altered.
CHAPTER IV
THEORETICAL FRAMEWORK

Conceptual Model

The conceptual model which is derived from existing literature allows for variables to be operationally defined. Measures of the dependent variables show the direction of the effects in relation to the independent variable.

The model for the effects that the prospective payment system has on hospital laboratory testing consists of an independent variable, the prospective payment system, and the effect that it has on four separate dependent variables. The dependent variables to be observed consist of the average number of laboratory tests performed per patient day, the number of laboratory tests performed in the first three days of hospital stay, the average length of stay, and the average dollars spent on laboratory tests per patient day. The dependent variables are a function of the independent variable. The effects of the independent variable on the dependent variables allow for the formation of hypotheses which can be justified from existing literature.

Operational Definitions of Variables

Observations are made before and after the prospective payment system went into effect. The prospective payment system is the form of reimbursement made to hospitals for all Medicare patients. The payment system went into effect October 1, 1983 or at the beginning of a hospital's fiscal year. The particular hospital used for this study started their fiscal year in October, so the prospective payment system went into effect then. Observations are limited to the months of April to September of 1983 and from April to September of 1985.
The dependent variables pertain to laboratory testing. The first dependent variable is the average number of laboratory tests performed on a patient per hospital day. The total number of laboratory tests performed on a patient are divided by the patient's length of stay to determine the average number of laboratory tests performed per patient day. Dividing by the length of stay standardizes the sample for variability in lengths of stay. A laboratory test is defined as an analysis from any one of the clinical departments of the hospital laboratory, including chemistry, serology, hematology, urinalysis, microbiology, and radio-immuno assay. Multiphasic testing, such as a SMA-12 is counted as twelve separate tests and one individual test ordered off the SMA-12 panel is counted as one test, since physicians have the option of ordering only one or all twelve of the tests. Individual tests ordered off a complete blood count such as a hemoglobin and hematocrit is counted as a complete blood count, and both are counted as one test, since most hematologic instruments give a whole set of results per specimen. Physicians therefore rarely order just a part of the complete blood count. A microbacterial culture performed on a patient is counted as one test, but any sensitivity testing performed on the culture is not counted as a test, but just included in the pricing of the culture, since a sensitivity is performed automatically if indicated by the culture results. The physician has no control over the performance of the sensitivity, it depends on the individual patient.

The number of laboratory tests performed in the first three days of a patient's stay is counted as mentioned above, but the day of performance of the test is noted.

The length of stay of each patient is defined as the number of days
a patient spends in the hospital. This is determined by using the patient date of admission and date of discharge. The date of discharge is subtracted from the date of admission to determine the patient's length of stay.

The average dollars spent on laboratory tests per patient stay is determined by assigning a dollar value to each particular test counted. The total dollar value of laboratory testing per patient is divided by the patient's length of stay to determine the average dollars spent on laboratory testing per patient day. The fees assigned are obtained from the fee schedule for Medicare Region B outpatient hospital services. This fee schedule provides a listing of all codes incorporated in the Health Care Financing Administration Common Procedure Coding System. The fees are effective from July 1, 1985 through June 30, 1986. Outpatient prices are used since the inpatient laboratory fees are now incorporated into the total prospective payment amount.

Hypotheses and Rationale

Hypotheses

Hypothesis One.

The average number of laboratory tests performed per patient day has decreased since the prospective payment system went into effect.

Rationale: Hospital administrators will be stressing to physicians methods of cost containment. One way for physicians to contain costs would be to order only necessary tests. There is an overutilization of laboratory test ordering as noted from studies of Griner, Dixon, and Eisenberg. Studies have also shown the physicians can modify their test ordering patterns through methods of education as noted in Eisenberg's study, incentives, as seen in Martin's study, cost audit, as noted by Schroeder, and limiting
the number of tests ordered as shown by Dixon. Methods such as these can prevent unnecessary test repetition which accounts for most overutilization. Physicians may also be ordering more organ specific tests rather than routine panels which generate a low percentage of results that are useful. Dixon shows this in his study.

**Hypothesis Two.**

The number of laboratory tests ordered within the first 3 days of a patient's stay has increased.

**Rationale:** Physicians will order more tests at the beginning of a patient's stay in order to get results back and interpreted early, so the patient can be discharged earlier from the hospital. Griner found in his study that more tests are ordered the first week of hospital stay and then level off as the patient stays longer. Newer trends for hospitals since the beginning of the prospective payment system as stated by Brennan will result in more preadmission testing and testing at the beginning of hospital admission, so that a patient's length of stay can be shortened.

**Hypothesis Three.**

The average length of stay of the patient has decreased since the prospective payment system went into effect.

**Rationale:** Physicians must contain costs under the prospective payment system and shortening the length of hospital stay is a major way to reduce costs. The Department of Health and Human services have reported that Medicare patients spend an average of two days less in the hospital since the prospective payment system began.
Hypothesis Four.

The average cost spent on laboratory tests per patient day has decreased since the prospective payment system went into effect. Rationale: Reduction in the number of tests ordered will reduce the total cost of laboratory services. Most of the laboratory cost is from repeated use of inexpensive tests rather than the highly technical tests as shown by Martin and Schroeder. If the number of lab tests can be reduced, the cost can also be reduced and this can be done by simply making the physician aware of the price of individual tests as shown in Cummings study.

Limitations

There are several limitations which may influence the final outcome of this study. The total number of laboratory tests ordered by physicians could be influenced by other factors other than the prospective payment system. Several reasons for an increase in laboratory usage by physicians is ready availability of tests, fear of malpractice lawsuits, lack of training in proper use of laboratory tests, and the desire to practice scientific medicine. Laboratory results are readily available so the physician tends to rely on laboratory results rather than depending on physical symptoms. The number of laboratory tests ordered could be influenced by the physician's fear of malpractice lawsuits. The physician may find it necessary to order more laboratory tests to justify his medical actions in case a lawsuit should occur. The lack of training in proper laboratory use may account for further laboratory testing to verify and explain previous laboratory results. As more tests become available, the physician relies more heavily on the laboratory to facilitate diagnosis and management. The desire to practice
scientific medicine and make some type of correlation between laboratory results for specific illnesses may also cause an increase in the number of laboratory procedures.

The use of laboratory testing can also be influenced by the number of tests performed as an outpatient prior to the patient's hospital admittance. Laboratory tests would not have to be performed again if they were done just prior to admission to the hospital.²

Policy changes made by legislation can also have an effect on hospital policy. An example of this is where the law no longer requires syphilis testing for every patient admitted to the hospital. Syphilis testing is only done when requested by the physician. These specific types of policy changes can have a direct effect on the number of laboratory tests a physician orders.

The average length of stay of a patient can be influenced by things other than the prospective payment system. There is a general trend for home health care. Patients are being rehabilitated in the home where they feel more comfortable. There is also an increasing emphasis on preventive medicine which allows patients to be in a better condition of total health.³

The cost of laboratory testing is not solely dependent on the number of tests being performed. The cost of laboratory testing can be influenced by increased productivity and advanced technology. Instrumentation can allow for more laboratory tests to be performed at a lower price.⁴

**Methodology**

**Data Collection**

In determining how the prospective payment system of hospital reimbursement,
initiated by Medicare, affects the quantity of laboratory tests being ordered by physicians and the costs of tests per Medicare patient, a data analysis is made using charts from patients medical records. Of the 471 different Diagnostic Related Groups (DRGs), five DRG categories are reviewed. The DRGs chosen are cases with little or no complications so that the data is directly related to that specific DRG category. The categories are also selected according to patient volume. The selected DRG categories have enough cases available during a six month period to allow for an adequate sample of twenty cases to be reviewed. The five DRG categories being reviewed are lens procedures (DRG 39), simple pneumonia and pleurisy age greater than 69 and or complications (DRG 89), angina pectoris (DRG 140), esophagitis, gastroenteritis and miscellaneous digestive disorders age greater than 69 and or complications (DRG 182), and nutritional and miscellaneous metabolic disorders age greater than 69 and or complications (DRG 296).

The cases being reviewed are on patients between the ages of 65 to 80. Ages 65 and over were chosen because that is when most patients receive Medicare coverage. Age 80 was chosen as the cut off age because patients over 80 years of age can have many complications with their illness.

Three of the DRG categories needed to be chosen to get the patients in the proper age category. A patient put in that category because of complications rather than because of age will be omitted from the random sample. It can be determined if a patient has complications by looking at the extended length of stay.

Twenty different patient charts for each of the five DRGs selected are reviewed before and after the initiation of the prospective payment
system. These charts are randomly chosen using a computerized print out of all cases, listed according to the DRG category for a one half year period. Cases are selected that meet both the age and date of hospitalization specifications. Charts are reviewed between the time of April to September of 1983 and April to September of 1985. The prospective payment system took effect October 1, 1983 in the hospital where the data was collected. The same months are reviewed before and after DRGs began to allow for the same seasonal patterns of illness.

When reviewing the charts, the following information is obtained. The case number of the chart, in case additional information is needed later, and the DRG category is recorded for organizational reasons. The age is recorded to make sure the patient falls into the proper range of 65 to 80 years. Both the data of admission and the date of discharge is obtained to determine the patient's length of stay. The kinds of tests ordered and the date they are ordered will provide the total number of tests per patient per hospitalization and the number of tests that were ordered within the first three days of the patient's hospital stay. The type of tests ordered is needed so that a dollar value can be assigned to each test to determine the amount spent of laboratory tests per patient per hospitalization. The form used for data collection is included in this report as Table 1.

**Analysis Plan**

After manually reviewing a total of 200 charts, twenty different patients before and after the prospective payment system began, for each of five different DRG categories, computations are made to determine if there is a difference in lab testing patterns after the prospective payment system began.
<table>
<thead>
<tr>
<th>Tests Ordered / Date Ordered</th>
<th>Length of Stay</th>
<th>Date Discharged</th>
<th>Date Admitted</th>
<th>Age</th>
<th>DRG Category</th>
<th>Case #</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>7</td>
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<td>6</td>
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<tr>
<td>5</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 1
As mentioned earlier, each test of the chemistry automated panels are counted separately, but each test of the complete blood count is counted as one test.

The total number of tests is obtained for each patient and the total number of tests performed within the first three days of a patient's stay is also obtained. The length of stay for each patient is determined.

A dollar value for each test performed is assigned according to the fee schedule for Medicare outpatients. Dollar values for composite tests are assigned as follows: three or more tests from the automated chemistry analyzer SMA-12, is assigned with a single price value, categorized under automated multichannel tests, but is counted as three or more separate tests in the tally. If three automated tests are performed they are given one automated price. The following will hold true for tallying complete blood counts. When either a complete blood count or parts of a complete blood count, such as a hemoglobin and hematocrit, are ordered, they are counted as one test and are assigned the price of a complete blood count from the schedule. Microbacterial cultures where sensitivity identification is performed are counted as one test, but priced as a culture and a sensitivity jointly. The total dollar value per patient per hospitalization is then computed.

The average number of tests per patient day, the average number of tests performed in the first three days of hospitalization, the average length of patient stay, and the average amount spent on laboratory tests per patient day, for each of the five DRG categories is then calculated. These values are compared for each DRG category before and after the prospective payment system began. A table similar to this is used:
A t-test using a 90% and 95% confidence level to see if the findings are significant is performed. From these results, it is determined if there is a statistical difference in the sample means, which will determine whether the prospective payment system influenced the number of laboratory tests performed per patient day, the number of laboratory tests being ordered within the first three days of hospital stay, the length of hospital stay, and the amount of money spent on laboratory tests per patient day.
CHAPTER V
EMPIRICAL RESULTS

Five different DRG categories were analyzed for four different variables before and after the prospective payment system went into effect. A total of twenty patients were randomly chosen to make up each sample. Each sample is considered to be representative of the total population. The significance of any apparent difference was examined by applying the t-test for the significance of differences between the means of the two independent samples. The t-test is used to correlate samples that are small in number. The t-value is calculated by using the following formula:

\[ t(df = n_1 + n_2 - 2) = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{n_1 SV_1 + n_2 SV_2}{n_1 + n_2 - 2}} \left( \frac{1}{n_1} + \frac{1}{n_2} \right)} \]

where the \( t \) represents the t-value, \( df \) represents the degree of freedom, which is the total number in sample 1 and 2, minus two. \( \bar{X}_1 \) and \( \bar{X}_2 \) are the sample means and \( n_1 \) and \( n_2 \) are the total number in each sample. \( SV_1 \) and \( SV_2 \) represent the sample variances for each sample.

Once the \( t \)-value is calculated, it is compared to a theoretical distribution, known as the \( t \)-distribution. A two tailed test is used here since the direction of the difference of the means has not been predicted. A 90% and 95% confidence level was used to determine the significance of the differences of the means of the two samples. The greater the confidence level, the more confidence there is that the effect observed is real and that the findings haven't occurred solely by chance. If the calculated \( t \)-value is greater than the value in the \( t \)-distribution table then the statistical differences in the two sample means are significant, indicating a positive or negative correlation between the two samples.
Derivation of Results

Lens Procedure (DRG 39)

The following information was calculated:

<table>
<thead>
<tr>
<th></th>
<th>Before DRGs</th>
<th>After DRGs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of tests per patient day</td>
<td>3.7</td>
<td>3.6</td>
</tr>
<tr>
<td>Average number of tests in first 3 days</td>
<td>7.1</td>
<td>6.6</td>
</tr>
<tr>
<td>Average length of stay</td>
<td>2.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Average dollar value spent per patient day</td>
<td>14.10</td>
<td>9.67</td>
</tr>
</tbody>
</table>

Relevant data used to derive the t-value for the correlation between the average number of tests per patient day for DRG 39 in 1983 and in 1985 is shown below:

Sample size

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>20</td>
</tr>
<tr>
<td>1985</td>
<td>20</td>
</tr>
</tbody>
</table>

Sample mean

\[
\bar{x}_1 = 3.7 \quad \bar{x}_2 = 3.6
\]

Sample variance

\[
SV_1 = 26.39 \quad SV_2 = 29.38
\]

\[
t(df = n_1 + n_2 - 2) = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{n_1SV_1 + n_2SV_2}{n_1+n_2-2} \left( \frac{1}{n_1} + \frac{1}{n_2} \right)}}
\]

\[
t(df = 20 + 20 - 2) = \frac{3.7 - 3.6}{\sqrt{\frac{20.26.39 + 20.29.38}{20 + 20 - 2} \left( \frac{1}{20} + \frac{1}{20} \right)}}
\]

\[
t(df = 38) = 1.71
\]

\[
t = +0.06
\]

The confidence level at 95% falls between the range of -2.024 to +2.24 and the confidence level at 90% falls between the range of -1.684 to +1.684. Since the t-value of +0.06 falls within the t-distribution range, there is no statistical difference in the sample means for the average number of tests per patient day for DRG 39.
Data used to derive the remaining t-values for DRG 39 is as follows:

### Average number of tests in first 3 days

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>(n_1 = 20)</td>
<td>(n_2 = 20)</td>
</tr>
<tr>
<td>Sample mean</td>
<td>(\bar{X}_1 = 7.1)</td>
<td>(\bar{X}_2 = 6.6)</td>
</tr>
<tr>
<td>Sample variance</td>
<td>(SV_1 = 63.25)</td>
<td>(SV_2 = 98.74)</td>
</tr>
</tbody>
</table>

\[ t = +0.17 \]

There is no statistical difference in the sample means for the average number of tests in the first 3 days.

### Average length of stay

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>(n_1 = 20)</td>
<td>(n_2 = 20)</td>
</tr>
<tr>
<td>Sample mean</td>
<td>(\bar{X}_1 = 2.4)</td>
<td>(\bar{X}_2 = 1.7)</td>
</tr>
<tr>
<td>Sample variance</td>
<td>(SV_1 = 0.94)</td>
<td>(SV_2 = 0.31)</td>
</tr>
</tbody>
</table>

\[ t = +2.8 \]

The t-value here indicates that there is a statistical difference in the average length of stay in a positive direction for both the 90% and 95% confidence levels.

### Average dollar value spent per patient day

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>(n_1 = 20)</td>
<td>(n_2 = 20)</td>
</tr>
<tr>
<td>Sample mean</td>
<td>(\bar{X}_1 = 14.10)</td>
<td>(\bar{X}_2 = 9.67)</td>
</tr>
<tr>
<td>Sample variance</td>
<td>(SV_1 = 304.58)</td>
<td>(SV_2 = 162.36)</td>
</tr>
</tbody>
</table>

\[ t = +0.89 \]

There is no statistical difference in the sample means for the average dollar value spent per patient day.
Simple Pneumonia and Pleurisy Age Greater Than 69 and or Complications (DRG 89)

The following information was calculated:

<table>
<thead>
<tr>
<th></th>
<th>Before DRGs</th>
<th>After DRGs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of tests per patient day</td>
<td>5.9</td>
<td>7.6</td>
</tr>
<tr>
<td>Average number of tests in first 3 days</td>
<td>31.4</td>
<td>36.3</td>
</tr>
<tr>
<td>Average length of stay</td>
<td>10.2</td>
<td>7.9</td>
</tr>
<tr>
<td>Average dollar value spent per patient day</td>
<td>23.92</td>
<td>32.96</td>
</tr>
</tbody>
</table>

Relevant data used to derive the t-values for DRG 89 is as follows:

Average number of tests per patient day

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>n₁ = 20</td>
<td>n₂ = 20</td>
</tr>
<tr>
<td>Sample mean</td>
<td>X₁ = 5.9</td>
<td>X₂ = 7.6</td>
</tr>
<tr>
<td>Sample variance</td>
<td>SV₁ = 13.91</td>
<td>SV₂ = 22.49</td>
</tr>
</tbody>
</table>

\[ t = -1.23 \]

There is no statistical difference in the sample means for the average number of tests per patient day.

Average number of tests in first 3 days

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>n₁ = 20</td>
<td>n₂ = 20</td>
</tr>
<tr>
<td>Sample mean</td>
<td>X₁ = 31.4</td>
<td>X₂ = 36.3</td>
</tr>
<tr>
<td>Sample variance</td>
<td>SV₁ = 324.12</td>
<td>SV₂ = 270.41</td>
</tr>
</tbody>
</table>

\[ t = -0.87 \]

There is no statistical difference in the sample means for the average number of tests in the first 3 days.

Average length of stay

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>n₁ = 20</td>
<td>n₂ = 20</td>
</tr>
<tr>
<td>Sample mean</td>
<td>X₁ = 10.2</td>
<td>X₂ = 7.9</td>
</tr>
<tr>
<td>Sample variance</td>
<td>SV₁ = 19.06</td>
<td>SV₂ = 13.49</td>
</tr>
</tbody>
</table>

\[ t = +1.76 \]
There is a statistical difference in the average length of stay at the 90% confidence level but not at the 95% confidence level in a positive direction.

Average dollar value spent per patient day

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>$n_1 = 20$</td>
<td>$n_2 = 20$</td>
</tr>
<tr>
<td>Sample mean</td>
<td>$\bar{X}_1 = 23.92$</td>
<td>$\bar{X}_2 = 32.96$</td>
</tr>
<tr>
<td>Sample variance</td>
<td>$SV_1 = 360.62$</td>
<td>$SV_2 = 489.02$</td>
</tr>
<tr>
<td>$t$</td>
<td>-1.35</td>
<td></td>
</tr>
</tbody>
</table>

There is no statistical difference in the sample means for the average dollar value spent per patient day.

Angina Pectoris (DRG 140)

The following information was calculated:

<table>
<thead>
<tr>
<th></th>
<th>Before DRGs</th>
<th>After DRGs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of tests per patient day</td>
<td>7.7</td>
<td>9.4</td>
</tr>
<tr>
<td>Average number of tests in first 3 days</td>
<td>30.3</td>
<td>34.1</td>
</tr>
<tr>
<td>Average length of stay</td>
<td>5.3</td>
<td>5.2</td>
</tr>
<tr>
<td>Average dollar value spent per patient day</td>
<td>34.42</td>
<td>51.12</td>
</tr>
</tbody>
</table>

Relevant data used to derive the $t$-value for DRG 140 is as follows:

Average number of tests per patient day

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>$n_1 = 20$</td>
<td>$n_2 = 20$</td>
</tr>
<tr>
<td>Sample mean</td>
<td>$\bar{X}_1 = 7.7$</td>
<td>$\bar{X}_2 = 9.4$</td>
</tr>
<tr>
<td>Sample variance</td>
<td>$SV_1 = 13.44$</td>
<td>$SV_2 = 21.52$</td>
</tr>
<tr>
<td>$t$</td>
<td>-1.25</td>
<td></td>
</tr>
</tbody>
</table>

There is no statistical difference in the sample means for the average number of tests per patient day.
Average number of tests in first 3 days

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>$n_1 = 20$</td>
<td>$n_2 = 20$</td>
</tr>
<tr>
<td>Sample mean</td>
<td>$\bar{X}_1 = 30.3$</td>
<td>$\bar{X}_2 = 34.1$</td>
</tr>
<tr>
<td>Sample variance</td>
<td>$SV_1 = 199.08$</td>
<td>$SV_2 = 277.45$</td>
</tr>
</tbody>
</table>

$t = -0.75$

There is no statistical difference in the sample means for the average number of tests in the first 3 days.

Average length of stay

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>$n_1 = 20$</td>
<td>$n_2 = 20$</td>
</tr>
<tr>
<td>Sample mean</td>
<td>$\bar{X}_1 = 5.3$</td>
<td>$\bar{X}_2 = 5.2$</td>
</tr>
<tr>
<td>Sample variance</td>
<td>$SV_1 = 7.29$</td>
<td>$SV_2 = 19.26$</td>
</tr>
</tbody>
</table>

$t = -0.08$

There is no statistical difference in the sample means for the average length of stay.

Average dollar value spent per patient day

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>$n_1 = 20$</td>
<td>$n_2 = 20$</td>
</tr>
<tr>
<td>Sample mean</td>
<td>$\bar{X}_1 = 34.42$</td>
<td>$\bar{X}_2 = 51.12$</td>
</tr>
<tr>
<td>Sample variance</td>
<td>$SV_1 = 279.79$</td>
<td>$SV_2 = 682.02$</td>
</tr>
</tbody>
</table>

$t = -2.35$

The $t$-value shows a statistical difference in the sample means for the average dollar value spent per patient day in the negative direction at both the 90% and 95% confidence levels.
Esophagitis, Gastroenteritis and Miscellaneous Digestive Disorders Age Greater Than 69 and or Complications (DRG 182)

The following information was calculated:

<table>
<thead>
<tr>
<th></th>
<th>Before DRGs</th>
<th>After DRGs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of tests per patient day</td>
<td>6.3</td>
<td>7.4</td>
</tr>
<tr>
<td>Average number of tests in first 3 days</td>
<td>27.7</td>
<td>30.9</td>
</tr>
<tr>
<td>Average length of stay</td>
<td>6.6</td>
<td>6.1</td>
</tr>
<tr>
<td>Average dollar value spent per patient day</td>
<td>21.41</td>
<td>23.51</td>
</tr>
</tbody>
</table>

Relevant data used to derive the t-value for DRG 182 is as follows:

Average number of tests per patient day

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>n_1 = 20</td>
<td>n_2 = 20</td>
</tr>
<tr>
<td>Sample mean</td>
<td>( \bar{X}_1 = 6.3 )</td>
<td>( \bar{X}_2 = 7.4 )</td>
</tr>
<tr>
<td>Sample variance</td>
<td>SV_1 = 9.28</td>
<td>SV_2 = 25.87</td>
</tr>
</tbody>
</table>

\( t = -0.81 \)

There is no statistical difference in the sample means for the average number of tests per patient day.

Average number of tests in first 3 days

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>n_1 = 20</td>
<td>n_2 = 20</td>
</tr>
<tr>
<td>Sample mean</td>
<td>( \bar{X}_1 = 27.7 )</td>
<td>( \bar{X}_2 = 30.9 )</td>
</tr>
<tr>
<td>Sample variance</td>
<td>SV_1 = 119.93</td>
<td>SV_2 = 266.69</td>
</tr>
</tbody>
</table>

\( t = -0.71 \)

There is no statistical difference in the sample means for the average number of tests in the first 3 days.
Average length of stay

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>$n_1 = 20$</td>
<td>$n_2 = 20$</td>
</tr>
<tr>
<td>Sample mean</td>
<td>$\bar{X}_1 = 6.6$</td>
<td>$\bar{X}_2 = 6.1$</td>
</tr>
<tr>
<td>Sample variance</td>
<td>$SV_1 = 6.35$</td>
<td>$SV_2 = 10.55$</td>
</tr>
</tbody>
</table>

$t = +0.53$

There is no statistical difference in the sample means for the average length of stay.

Average dollar value spent per patient day

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>$n_1 = 20$</td>
<td>$n_2 = 20$</td>
</tr>
<tr>
<td>Sample mean</td>
<td>$\bar{X}_1 = 21.41$</td>
<td>$\bar{X}_2 = 23.51$</td>
</tr>
<tr>
<td>Sample variance</td>
<td>$SV_1 = 113.82$</td>
<td>$SV_2 = 236.10$</td>
</tr>
</tbody>
</table>

$t = -0.48$

There is no statistical difference in the sample means for the average dollar value spent per patient day.

Nutritional and Miscellaneous Metabolic Disorders Age Greater Than 69 and or Complications (DRG 296)

The following information was calculated:

<table>
<thead>
<tr>
<th></th>
<th>Before DRGs</th>
<th>After DRGs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of tests per patient day</td>
<td>5.4</td>
<td>8.1</td>
</tr>
<tr>
<td>Average number of tests in first 3 days</td>
<td>28.8</td>
<td>28.9</td>
</tr>
<tr>
<td>Average length of stay ...................</td>
<td>11.2</td>
<td>6.5</td>
</tr>
<tr>
<td>Average dollar value spent per patient day</td>
<td>18.44</td>
<td>27.78</td>
</tr>
</tbody>
</table>
Relevant data used to derive the t-value for DRG 296 is as follows:

**Average number of tests per patient day**

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>$n_1 = 20$</td>
<td>$n_2 = 20$</td>
</tr>
<tr>
<td>Sample mean</td>
<td>$\bar{X}_1 = 5.4$</td>
<td>$\bar{X}_2 = 8.1$</td>
</tr>
<tr>
<td>Sample variance</td>
<td>$SV_1 = 5.64$</td>
<td>$SV_2 = 6.83$</td>
</tr>
</tbody>
</table>

$t = -3.33$

The t-value shows a statistical difference in the sample means for the average number of tests per patient day in the negative direction at both the 90% and 95% confidence levels.

**Average number of tests in first 3 days**

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>$n_1 = 20$</td>
<td>$n_2 = 20$</td>
</tr>
<tr>
<td>Sample mean</td>
<td>$\bar{X}_1 = 28.8$</td>
<td>$\bar{X}_2 = 28.9$</td>
</tr>
<tr>
<td>Sample variance</td>
<td>$SV_1 = 163.18$</td>
<td>$SV_2 = 116.85$</td>
</tr>
</tbody>
</table>

$t = -0.03$

There is no statistical difference in the sample means for the average number of tests in the first 3 days.

**Average length of stay**

<table>
<thead>
<tr>
<th></th>
<th>1983</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>$n_1 = 20$</td>
<td>$n_2 = 20$</td>
</tr>
<tr>
<td>Sample mean</td>
<td>$\bar{X}_1 = 11.2$</td>
<td>$\bar{X}_2 = 6.5$</td>
</tr>
<tr>
<td>Sample variance</td>
<td>$SV_1 = 44.76$</td>
<td>$SV_2 = 12.65$</td>
</tr>
</tbody>
</table>

$t = +2.72$

There is a statistical difference in the sample means for the average length of stay in the positive direction at both the 90% and 95% confidence levels.
Average dollar value spent per patient day

1983 1985
Sample size \( n_1 = 20 \) \( n_2 = 20 \)
Sample mean \( \bar{x}_1 = 18.44 \) \( \bar{x}_2 = 27.78 \)
Sample variance \( SV_1 = 104.12 \) \( SV_2 = 166.28 \)
\( t = -2.48 \)

There is a statistical difference in the sample means for the average dollar value spent per patient day in the negative direction at both the 90% and 95% confidence levels.

**Analysis of Results**

The results of the data compiled collectively for the five different DRG categories is illustrated by the following table.

<table>
<thead>
<tr>
<th>DRG</th>
<th>39</th>
<th>89</th>
<th>140</th>
<th>182</th>
<th>296</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of tests per patient day</td>
<td>( \downarrow )</td>
<td>( \downarrow )</td>
<td>( \uparrow )</td>
<td>( \downarrow )</td>
<td>( \uparrow )</td>
</tr>
<tr>
<td>Average number of tests in first 3 days</td>
<td>( \downarrow )</td>
<td>( \downarrow )</td>
<td>( \uparrow )</td>
<td>( \downarrow )</td>
<td>( \uparrow )</td>
</tr>
<tr>
<td>Average length of stay</td>
<td>( \downarrow )</td>
<td>( \downarrow )</td>
<td>( \uparrow )</td>
<td>( \downarrow )</td>
<td>( \uparrow )</td>
</tr>
<tr>
<td>Average dollar value spent per patient day</td>
<td>( \downarrow )</td>
<td>( \downarrow )</td>
<td>( \uparrow )</td>
<td>( \uparrow )</td>
<td>( \uparrow )</td>
</tr>
</tbody>
</table>

The table shows the direction of impact that the prospective payment system had on the four variables for the DRG categories analyzed in this study. The average number of tests performed per patient day shows no significant change except for DRG 296, which shows an increase in the number of tests performed. The average number of tests ordered in the first 3 days of a patient's hospital stay remained unchanged for all five DRG categories. The average length of stay showed the most significant change. Three of the five DRG categories analyzed showed a decrease in the average length of stay. The average dollar value spent per patient day showed an increase in DRG categories 140 and 296.
Results Related to Hypotheses

Hypothesis One states that the average number of laboratory tests performed per patient day has decreased since the prospective payment system went into effect. The results of this study for the five DRG categories analyzed showed no change in the number of tests performed except in one DRG category. The change in DRG 296 showed an increase in the number of tests performed per patient day. This is inconsistent with the hypothesis and the increase may be due to other factors other than the prospective payment system. The number of tests ordered by physicians is also influenced by fears of malpractice lawsuits. Physicians may feel it is necessary to justify patient treatment by using laboratory test results. Physicians may rely more heavily on laboratory results to diagnose and treat patients as more laboratory tests become readily available. Laboratory testings are becoming more specific for certain types of illnesses. This could also explain the increase in the number of tests.

Hypothesis Two states that the number of laboratory tests ordered within the first 3 days of a patient's stay has increased since the prospective payment system went into effect. In all five DRG categories analyzed there showed no significant change in the number of tests ordered in the first 3 days of a patient's hospital stay. The prospective payment system seemed to have no effect here and can possibly be accounted for by the fact that most laboratory tests are ordered in the first part of a patient's hospital stay as cited in the Griner study.

Hypothesis Three states that the average length of stay of the patient has decreased since the prospective payment system went into effect. Three of the five DRG categories showed a decrease in the average length of stay and the other two showed no significant change in the length of stay. This
is consistent with the hypothesis and can be justified because of a major way to reduce hospital costs is to shorten the length of time the person stays in the hospital.

Hypothesis Four states that the average cost spent on laboratory tests per patient day has decreased since the prospective payment system went into effect. No significant change in the cost was observed in three of the analyzed DRG categories. DRG 140 and DRG 296 showed an increase in the amount spent on laboratory testing. This is inconsistent with the hypothesis and the increase may be due to increases in the total number of tests ordered per patient day. If the number of tests ordered are not being decreased, then it will be hard to decrease the amount spent on laboratory testing.

* * *
CHAPTER VI
CONCLUSIONS AND RECOMMENDATIONS

This report was designed to investigate the effect of the prospective payment system on the number and the cost of laboratory tests performed within a hospital under the new prospective payment system. The prospective payment system provides hospitals with a fixed rate of reimbursement based on the patient's diagnosis. It is then the responsibility of the hospital to contain hospital costs while providing adequate and quality of care to the patient. Limiting the use of laboratory tests will help contain the total cost of a patient's hospital stay.

The five DRG categories that were analyzed in this study showed that there was no particular effect on the number and cost of laboratory tests since the prospective payment system went into effect. There was no significant change in the average number of tests ordered per patient day, the average number of tests ordered in the first 3 days of patients stay, or the average amount spent on laboratory tests per patient day.

The average length of patient stay in this study showed a decrease since the prospective payment system went into effect. The inference made from this is that hospitals seem to contain costs by controlling the length of stay which is a major means of cost containment rather than controlling ancillary services, such as laboratory testing, which have only minor effects on total cost containment.

The results of this study are consistent with previous studies done showing that the average length of stay has decreased since the prospective payment system went into effect. No previous studies have been done to show what effect the prospective payment system has on laboratory testing,
but studies suggest that the number of laboratory tests ordered by physicians can be limited by various methods. It was expected that the test ordering patterns of physicians would be altered.

The data is this study is limited to five different DRG categories. The DRG categories studied represented a cross section of different types of illnesses. These diagnostic categories are different in respect to the types of laboratory tests that would need to be ordered. It is not clear whether the results obtained in this analysis would apply to other DRG categories.

The data is also limited in respect to the number of samples observed. For a more adequate assessment of sample mean differences, a larger sample of patient charts should be incorporated into the study. Using a larger sample of patients may alter the outcome of the results of the study.

Using an osteopathic hospital is a limitation of the data. It is not known whether the results of this study would be consistent with studies conducted in allopathic hospitals. It has been found that physicians in osteopathic hospitals perform significantly more laboratory tests than those in allopathic hospitals. This could cause the outcome of this study to be altered if conducted in a different hospital setting.

The prospective payment system was found to have no immediate effect on the number of laboratory tests performed and the amount spent on laboratory testing, on hospital inpatients. There was a tendency for the length of patient stays to decrease since the prospective payment system went into effect. Since the prospective payment system was implemented to force hospitals to contain costs, management and utilization of all hospital facilities must be evaluated. Hospitals may find it necessary to put pressure
on physicians in the future to retain unnecessary and excessive laboratory testing in order to contain additional hospital costs. Future studies need to be conducted to determine if the prospective payment system will have an effect on laboratory testing.

* * *
I. INTRODUCTION

1 Kenneth E. Warner and Bryan R. Luce, Cost-Benefit and Cost-Effectiveness Analysis in Health Care, Health Administration Press, Ann Arbor, 1982, p. 1.


II. HISTORICAL REVIEW


2 Kenneth E. Warner and Bryan R. Luce, Cost-Benefit and Cost-Effectiveness Analysis in Health Care, Health Administration Press, Ann Arbor, 1982, p. 6.


6 Ibid, p. 3.


8 "Almanac of the 89th Congress 1st Session ... 1965", in Congressional Quarterly Service, p. 239.


III. LITERATURE REVIEW


2. Ibid, p. 784.


8 John M. Eisenberg, M.D., Sankey V. Williams, M.D., Lois Garner, B.S., Richard Viale, PhD., and Helen Smits, M.D., "Computer-based Audit to Detect and Correct Overutilization of Laboratory Tests", in Medical Care, Vol 15, No 11, November 1977, p. 915-920.


11 Michael Nathanson, "DRGs Demand Co-operation Between Lab Chief, M.D.s, and CEO", in Modern Healthcare, September 1983, p. 104-106.


16 Steven A. Schroeder, M.D., and Marcian Daniele, B.S., "Variation Among Physicians in Use of Laboratory Tests", in Medical Care, Vol 15, No 6, June 1977, p. 482-487.


IV. THEORETICAL FRAMEWORK


2. Leslie Brennan, "DRG Opportunities Knock for Reference Labs", in Medical Laboratory Observer, April 1984, p. 32.


V. EMPIRICAL RESULTS

VI. CONCLUSIONS AND RECOMMENDATIONS
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Schroeder, Steven A., M.D., Schlifftman, Alan, B.A., and Piemme, Thomas E., M.D., "Variation Among Physicians in Use of Laboratory Tests: Relation to Quality of Care", in Medical Care, Vol 12, No 8, August 1974, p. 709-713.


