

September 1992

# HOSPITAL COSTS

## Adoption of Technologies Drives Cost Growth



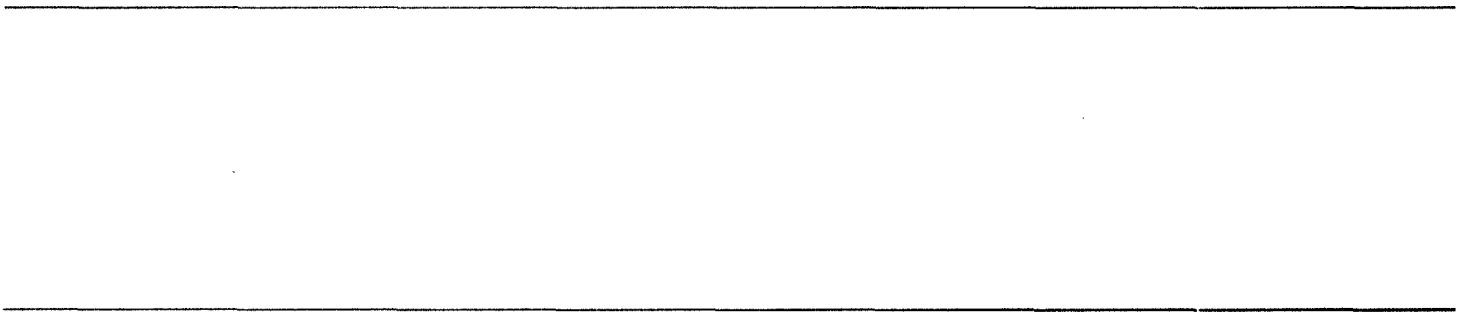
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**Human Resources Division**

B-249499

September 9, 1992

The Honorable Bill Archer  
Ranking Minority Member  
Committee on Ways and Means  
House of Representatives

The Honorable Nancy L. Johnson  
House of Representatives

From 1980 to 1989, Medicare hospital expenditures rose by half—from \$32 billion to \$48 billion—despite federal efforts to limit the growth of this portion of the budget.<sup>1</sup> In part, these increased expenditures resulted from the rising costs of providing hospital services. In the 1980s, costs rose faster than inflation, while many hospitals closed or discontinued some services. These events have led some industry specialists and policymakers to voice concerns that cost-containment efforts have threatened access to care.

You asked us to analyze factors pushing up hospital costs and, in light of these “cost drivers,” examine the adequacy of Medicare payments under its prospective payment system (PPS). In this report we document the extent to which total hospital operating costs rose in the 1980s, analyze the impact of PPS on the growth of these costs, and identify factors that have fostered their persistent rise.<sup>2</sup> This report also assesses the contributions of three specific factors that you asked us to examine: acquired immune deficiency syndrome (AIDS), malpractice insurance, and hospital administration. This examination of costs provides only a partial picture of hospitals’ financial health. A complete financial picture requires a look at revenues as well, but that lies beyond the scope of this report. The appropriateness of Medicare payment rates, and their adequacy for ensuring beneficiaries access to care, will be discussed in a subsequent report.

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<sup>1</sup>Spending on hospital services is stated in 1987 dollars.

<sup>2</sup>Unless otherwise noted, the terms “costs” and “cost growth” refer to total hospital operating costs. These costs are the expenses hospitals incurred for both inpatient and outpatient treatment, excluding capital costs. We do not attribute costs to specific payers, public or private. However, we pay special attention to cost growth before and after the implementation of PPS in 1983. This reimbursement system is a major federal effort to contain expenditure growth by encouraging the efficient provision of inpatient services—to contain Medicare expenditures by containing the cost of providing inpatient services. Private insurers also instituted reimbursement changes in the mid-1980s.

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## Results in Brief

From 1980 through 1989, hospital costs increased 63 percent after adjusting for inflation. While costs grew throughout the decade, their rate of growth slowed immediately after the introduction of PPS in 1983. By 1988, however, other changes in the hospital environment (such as the shift to outpatient services and the rise in case complexity) increased cost growth to near pre-PPS levels.

Several factors stimulated hospital cost increases and, although the impact of each cannot be quantified precisely, the single most important was the rapid adoption of new medical technology. Competition among hospitals and methods of reimbursement provided incentives for the rapid adoption of technological advances. Because hospitals do not compete for patients on the basis of price, hospital managers tried to gain a market advantage by offering the most up-to-date services available. Reimbursement methods that allowed the costs of these technologies to be passed on to third-party payers reinforced this medical arms race. As a result, the cost of care increased—hospitals offered new services, paid higher wages to workers, purchased more expensive nonlabor inputs, and devoted more resources to each patient.

The role of AIDS in driving hospital cost growth in the 1980s was modest, despite its frequent mention as a major cost driver. Nor were the costs for malpractice insurance a major source of the decade's rising costs. Administrative costs played a larger role, although their contribution could not be calculated with precision using existing data.

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## Objectives, Scope, and Methodology

Our analysis combined several approaches to determine the size and source of the increases in hospital operating costs.<sup>3</sup> To decompose this cost growth into its labor and nonlabor components, we used aggregate data from the American Hospital Association's (AHA) Hospital Statistics, 1990-1991. To quantify the relationship between costs and the hospital's market and operating characteristics, we estimated a multivariate regression using individual hospital data from Medicare cost reports.<sup>4</sup> To gain perspective on this statistical analysis and to supplement the information available from data bases, we reviewed the literature on hospital costs and interviewed hospital administrators and industry specialists.

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<sup>3</sup>In identifying these sources of cost increases, this report does not attempt to determine the socially and economically "correct" rate at which hospital costs should increase. It simply identifies the sources of the increases observed in the 1980s.

<sup>4</sup>We did not attempt to verify the accuracy of these data.

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Appendix I provides a detailed description of the forces in the U.S. health care system that increased costs during the 1980s. Appendix II describes our analysis of how AIDS, malpractice insurance, and administration have contributed to cost growth. Appendixes III and IV contain detailed descriptions of our methodology. All growth rates discussed in this report, unless otherwise noted, are adjusted for inflation using the implicit price deflator for gross domestic product (GDP).

We carried out this work between March 1991 and April 1992. Except where noted, we used generally accepted government auditing standards. We provided a draft of this report to AHA and the Prospective Payment Assessment Commission (ProPAC). We incorporated their comments as appropriate.

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## Principal Findings

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### Hospital Costs Increased Faster Than Inflation During the 1980s

From 1980 through 1989, hospital operating costs increased 63 percent above the general inflation rate. Thirty percentage points were contributed by increased labor costs, and 33 percentage points by rising nonlabor costs. These increases reflect not only higher compensation per employee and higher prices for nonlabor inputs but also increases in the quantity and quality of labor and other inputs. The measured rise in costs (through higher prices and quantities) largely results from innovations in medical technology intended to improve patient care.

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### Cost Growth Slowed After the Introduction of PPS

The growth of hospital operating costs slowed after the introduction of PPS. Throughout the decade, costs continued to grow faster than inflation, but at rates that varied considerably. For example, costs increased by about 2 percent in 1984, the first year of PPS, but the annual growth rate rose to nearly 7 percent by 1988. Unlike the cost-based system that preceded it, PPS embodies incentives for hospitals to provide care more efficiently. Under the cost-based system, hospitals were reimbursed for all the allowable costs incurred while treating Medicare patients. Under PPS, hospitals receive a fixed fee based on the patient's diagnosis, regardless of the actual cost of treating the patient. Consequently, hospitals have an incentive to provide care more efficiently than under the cost-based approach. Both the average length of a hospital stay and the number of admissions declined after PPS was introduced. Declines in these factors

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made their greatest contribution toward moderating cost growth in the 2 years immediately after the inauguration of PPS.

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**Increased Use of  
Outpatient Services and  
Rising Case Complexity  
Increased Cost Growth**

While PPS restrained costs, other changes in the hospital environment raised costs. For example, over the 1981-89 period, reductions in admissions, beds, and length of stay coincided with a 39-percent increase in outpatient visits. This shift resulted in an increase in inpatient case complexity for the decade because the simpler cases were treated on an outpatient basis while the more complex cases were treated in the hospital.

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**Technological Innovation  
and Incentives Favoring  
Spending Drove Hospital  
Costs in the 1980s**

A number of studies have noted that the introduction of new technologies tends to increase hospital costs.<sup>5</sup> These technologies were often more costly than standard techniques and sometimes made new services available where no treatment or test existed previously. These new services were adopted rapidly because third-party payers, not consumers themselves, bore much of the cost of the innovation.<sup>6</sup>

The incentives faced by consumers, physicians, and hospitals along with innovations in medical technology resulted in rising input prices and increases in the quantity and quality of inputs used to produce hospital care.<sup>7</sup> These incentives encourage the use of hospital services by reducing cost-consciousness in several ways:

- Hospitals often compete for patients on the basis of services instead of price. Hospital managers, therefore, have an incentive to provide high-technology equipment to attract physicians, and hence, patients.
- Physicians, in ordering tests and procedures, are not typically rewarded for choosing less costly alternatives. Potential liability for malpractice encourages just the opposite—physicians may order tests and procedures to protect themselves financially. This behavior is known as defensive medicine.

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<sup>5</sup>See app. I for specific references.

<sup>6</sup>In addition to a more detailed discussion of input prices, input productivity, and the impact of PPS, app. I provides further analysis of the impact of technology and financial incentives and provides quantitative estimates of the impact of these factors. App. IV contains a technical description of the estimation process.

<sup>7</sup>Inputs refer to all labor, materials, and equipment used to produce hospital care.

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- Consumers covered by health insurance pay only a portion of the cost out of pocket. This payment scheme encourages the use of medical services because insurance lowers the price of care to the consumer.

As a consequence of these incentives and the adoption of new technologies, hospitals used more labor and materials, driving up their cost.

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### AIDS Was Not a Major Source of Hospital Cost Growth

The role of AIDS in driving hospital cost growth in the 1980s was modest, despite its frequent mention as a major cost driver. The chief impact of AIDS on costs occurred when hospitals adopted infection control procedures that followed the Centers for Disease Control (CDC) guidelines, but the additional cost per case attributable to these control procedures was small. Furthermore, these procedures did not account for persistent increases in hospital costs. As these procedures were adopted, costs expanded, but once the procedures were incorporated into hospitals' routines, they did not account for further increases. The level of costs was permanently raised, not the rate of cost growth. The highest estimate of hospitals' annual cost of compliance with universal precautions is about \$299 million, 0.2 percent of 1980 total hospital operating costs. This increase represents an average annual growth in costs of 0.04 percent, out of the 6 percent average annual growth experienced between 1980 and 1989.

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### Increases in Malpractice Insurance Costs Cannot Explain Rapid Hospital Cost Growth

Despite the sometimes large increases experienced in the 1980s, increases in malpractice insurance costs did not account for the rapid growth of hospital costs in the 1980s. Malpractice insurance costs were a small share of total costs (about 1 percent in 1986); hence, even large increases had small effects on total cost growth. Between 1983 and 1986, malpractice costs grew at an annual rate of more than 20 percent. However, they contributed only about 0.2 percentage points of the 3.3 percent annual cost growth experienced over that period. Prior to 1983 and after 1986, the contribution was considerably smaller. The indirect costs associated with avoiding medical liability (defensive medicine) may have been more substantial—though hard data are lacking—but their impact on the trend in costs is unknown.

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**Administration Played a Significant Role in Hospital Cost Growth**

Administrative costs have contributed to the growth in total hospital costs. Administrative costs grew at an estimated average annual rate of 7 percent, accounting for about 13 percent of the growth in hospital costs from 1980 to 1989.<sup>8</sup> This contribution declined after the introduction of PPS. We estimate that administration accounted for 17 percent of 1980-83 average annual cost growth; its contribution declined to 10 percent of 1983-1988 average annual cost growth.<sup>9</sup>


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**Putting Cost Growth in Perspective**

Absent effective new policy initiatives, the prospect for moderation in hospital cost escalation is not promising, given the experience of the 1980s. While PPS slowed growth rates immediately after its implementation, cost growth had begun to increase again in the final years of the decade. The streamlining that occurred after the introduction of PPS appears to have played itself out as admissions stopped declining, the average length of a hospital stay began to increase, and the number of outpatient visits expanded. During the 1990s, cost growth is likely to be slowed by new Medicare rules for reimbursing capital outlays, but by how much is uncertain. Furthermore, the incentives that encourage cost growth remain in place.

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Unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from its issue date. Please call me at (202) 512-7119 if you or your staffs have any questions concerning the report. The major contributors to the report are listed in appendix V.

  
for Janet L. Shikles  
Director, Health Financing  
and Policy Issues

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<sup>8</sup>These estimates were based on data provided by Health Economics Research (HER), Inc. The numbers are based on the experience of the median hospital in a sample from Monitrends that covers the period 1980 to 1988. These estimates must be viewed with caution because they are based on a nonrandom, nonrepresentative sample of hospitals.

<sup>9</sup>App. II contains a more detailed discussion of the impact of AIDS, malpractice insurance, and administration on hospital cost growth. App. III describes the data used to analyze these factors.





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**Abbreviations**

AHA	American Hospital Association
AIDS	acquired immune deficiency syndrome
BLS	Bureau of Labor Statistics
CDC	Centers for Disease Control
FTE	full-time equivalent
GDP	gross domestic product
HER	Health Economics Research, Inc.
JCAHO	Joint Commission on the Accreditation of Healthcare Organizations
LPN	licensed practical nurse
MWTA	Medical Waste Tracking Act
PPS	prospective payment system
ProPAC	Prospective Payment Assessment Commission
RN	registered nurse

# Adoption of New Technologies Drives Cost Growth

Hospital costs increased at a rate faster than general inflation throughout the 1980s. Technological change, aided by such factors as hospital competition and reimbursement methods, stimulated hospital cost increases. These factors increased the cost of available services, and the adoption of new medical technology also added to costs of producing hospital care by expanding the menu of hospital services. Roughly half of the increase appeared as higher labor costs. While costs grew throughout the decade, their rate of growth slowed immediately after the introduction of Medicare's prospective payment system. An increase in the number of outpatient services and in inpatient case severity, in part due to the adoption of new technology, led to faster cost growth toward the end of the decade.

## A Conceptual Framework for Analyzing Hospital Costs Increases

After controlling for inflation, hospital costs rose by 63 percent during the 1980-89 period. A simple decomposition of these costs shows that labor costs account for about 30 percentage points of the increase, while the miscellaneous category called nonlabor costs accounts for 33 percentage points. However, a decomposition only describes the components of the overall increase and does not identify the factors at the root of cost growth.

Several underlying factors contribute to hospital cost increases. These factors operate within hospital markets, in the health care system at large, and even outside the health care sector. Factors within the hospital market are "first-level" explanations for rising costs. They contribute to rising costs, but to truly understand the sources of increases, one must delve even deeper. Often the first-level factors are consequences of broader changes within the health care system or of factors outside the system. For example, rising malpractice insurance costs are one source of hospital cost increases within the hospital market. To understand why costs are rising, however, one might look to tort law governing hospital liability. These laws are determined outside the hospital market. Several of the most important relationships affecting cost growth are described in the remainder of this appendix and in appendix II.

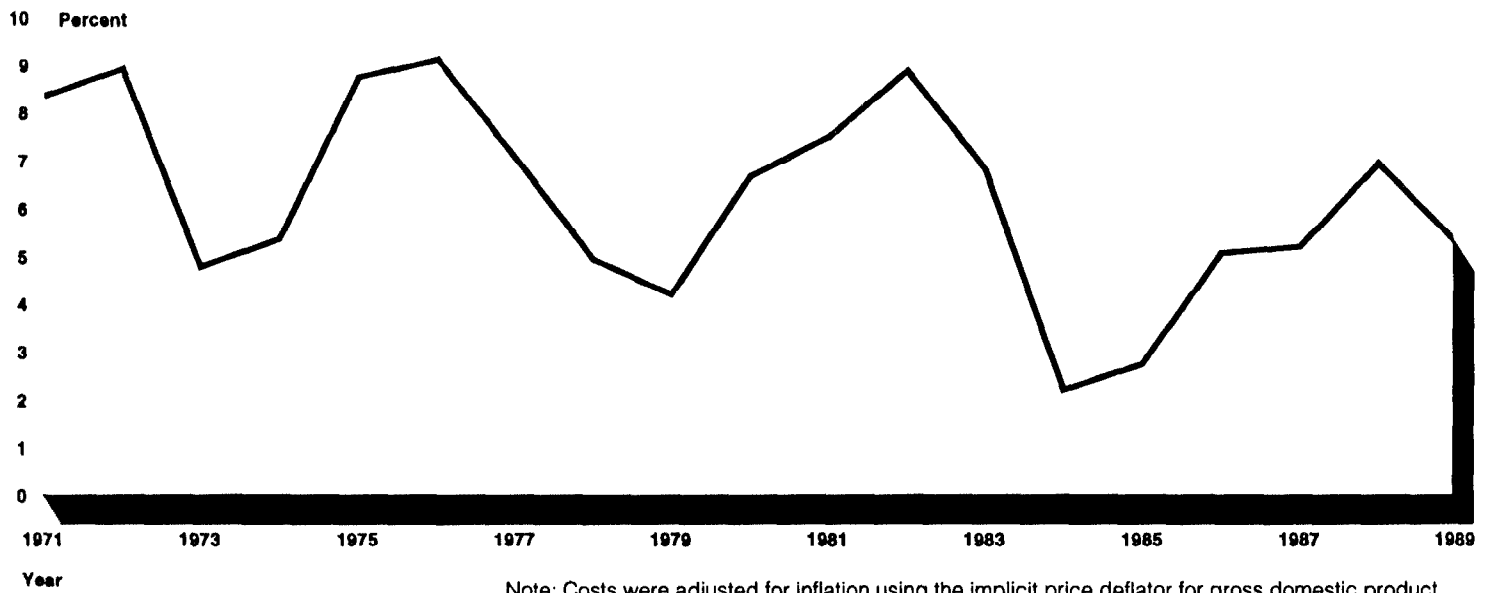
## Hospital Costs Have Grown Faster Than Inflation

Increases in U.S. hospital costs have far outpaced the economywide inflation rate. Between 1970 and 1989, the growth in hospital costs exceeded the rate of inflation in every year. For example, hospital cost growth peaked in 1976, at an inflation-adjusted annual rate of 9 percent. Increases in patient volume cannot account for these differences—the

**Appendix I  
Adoption of New Technologies Drives Cost  
Growth**

growth in cost per admission also exceeded economywide inflation. (See  
figs. I.1 and I.2.)

**Figure I.1: Growth in Hospital Costs**



Note: Costs were adjusted for inflation using the implicit price deflator for gross domestic product. Therefore, a growth rate of zero means that hospital costs grew at the general rate of inflation.

Figure I.2: Growth In Costs Per Admission



Note: Costs per admission were adjusted for inflation using the implicit price deflator for GDP. Therefore, a growth rate of zero means that hospital costs grew at the general rate of inflation.

## Growth of Hospital Costs Slowed by PPS

PPS includes incentives for hospitals to provide care more efficiently than under the cost-based reimbursement system, which predated it. As a result, hospital costs, adjusted for inflation, grew more slowly after 1983.<sup>1</sup> The 1946-83 average growth rate of total costs was 8 percent per year but fell to 5 percent during 1983-89. (Costs per admission rose, however, because fixed hospital operating costs were spread over fewer admissions.)<sup>2</sup> These gains may have been a short-lived phenomenon, however. Costs grew about 2 percent the year following the introduction of PPS but returned to a growth rate of nearly 7 percent in 1988. The effects of PPS incentives may have been exhausted after the initial years of the program.

<sup>1</sup>We focus on hospital costs without distinguishing between costs by payer. See footnote 2 on p. 1.

<sup>2</sup>The annual growth of costs per admission averaged 6 percent for 1946-83 but increased to 8 percent for 1983-89. This increase occurred due to the drop in discharges after the start of PPS. Some elements of hospital costs are fixed, and while variable costs grew more slowly after 1983, fixed costs were spread over fewer cases. Consequently, the average cost per admission rose as the number of cases treated declined more rapidly than costs. (From 1983-89, discharges declined at an average annual rate of 2.5 percent, while costs still rose at an average annual rate of 5 percent.)

Decreases in hospital capacity, coupled with shorter stays, contributed to the slowdown in growth of total hospital operating costs. From 1983 through 1989, hospital capacity declined 8 percent, and the average length of stay declined from 7.6 days per admission to 7.1 in 1986. By the end of the decade, the average length of stay had begun to increase, however.

### Increases in Outpatient Visits and Case Severity Offset Some of Prospective Payment's Cost Restraint

Reductions in beds, admissions, and length of stay reduced the rate of cost growth, but their cost-restraining impact was mitigated by other changes in the hospital environment. Reductions in admissions and other factors coincided with a shift of services to an outpatient setting. Outpatient visits were increasing at an annual rate of 1.1 percent in the years 1980-83, but the rate increased to 5.1 percent per year for the period 1983-89. This shift was one source of the rising inpatient case complexity experienced in the 1980s—the simpler cases were treated on an outpatient basis while the more complex cases were treated in the hospital.

Approximately two-thirds of the increase in case severity from 1986 to 1987 resulted from true increases in resource requirements. The remainder was due to changes in the coding of diagnoses.<sup>3</sup> We estimate that a 10-percent rise in inpatient case severity increases operating costs by nearly 9 percent, controlling for other factors.<sup>4</sup> Taken together, these estimates imply that, of the 5.2-percent rise in costs from 1986 to 1987 (see fig. I.1), about one-fourth—1.4 percentage points—occurred as a result of rising inpatient case severity.

### Increases in Hospital Costs Reflect Higher Input Prices and Greater Use of Inputs

Input prices, both labor and nonlabor, increased faster than economywide inflation, while additional labor and nonlabor inputs were used to produce hospital care. Labor costs increased as hospitals continued to hire more, and better-skilled, workers; this increased reliance on skilled workers is a response, in part, to rapid changes in available technology. Hospitals also had to pay more for their personnel, including the less skilled. Wages in the hospital sector increased more rapidly than in other industries. Hospitals have also increased their expenditures for the nonlabor resources they devote to patient care—medical supplies, prescription drugs, and the like.

<sup>3</sup>See Grace M. Carter, Joseph P. Newhouse, and Daniel A. Relles, "How Much Change in the Case Mix Index is DRG Creep?" *Journal of Health Economics*, Vol. 9 (1990), pp. 411-28. They note that the Medicare case-mix index rose 2.4 percent from 1986 to 1987. Their estimate means that 1.6 percentage points of the 2.4-percent increase result from true increases in case severity, the remainder from changes in coding diagnoses.

<sup>4</sup>See app. IV.

In general, increases in wages and fringe benefits have large effects on the growth rate of a firm's operating expenses because employee compensation accounts for a large share of costs; hospitals are no different. Labor costs made up 53 percent of hospital operating costs in 1989. Compensation per employee increased throughout the decade, with fringe benefits increasing more rapidly than earnings.

Even if employee earnings had remained constant, hospitals would have experienced cost increases. Despite the fact that admissions declined from 1981 through the end of the decade, hospitals continued to hire more employees as another type of hospital output, outpatient visits, increased by 39 percent over the same time period. From 1981 to 1989, the number of full-time equivalent (FTE) workers increased 8.8 percent, increasing labor costs even if earnings had remained constant.<sup>5</sup> This increase in the use of labor may have resulted from the increased severity of cases treated by the hospital in addition to the rising number of outpatient visits.

The adoption of new technology, along with greater inpatient case severity, increased hospitals' need for personnel with more education and specialized skills. Evidence of this rising skill mix includes the increasing proportion of registered nurses (RNs) employed by hospitals.<sup>6</sup> (See table I.1.) As a consequence, wages rose to attract skilled workers, increasing the cost of hospital care.<sup>7</sup>

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<sup>5</sup>Over the same period, inpatient admissions declined 14.7 percent and total inpatient days fell by 18.0 percent. Whether hospital productivity (output per worker) was declining or increasing is not obvious given the 39-percent increase in outpatient visits. The Prospective Payment Assessment Commission states, in its *Medicare and the American Health Care System: Report to the Congress* (June 1991), Washington, D.C., pp. 67-68, that net productivity rose 0.3 percent over the first six years of PPS.

<sup>6</sup>ProPAC, *Report to the Congress*, 1991. ProPAC shows that the proportion of professional employees also increased for occupational and physical therapy, although the ratio declined slightly for medical records and pharmacy. Gregory C. Pope and Terri Menke, in "Hospital Labor Markets in the 1980s," *Health Affairs*, Vol. 9, No. 4 (1990), pp. 127-37, note that skill levels generally rose for hospitals from 1980 to 1987.

<sup>7</sup>All else equal, skilled personnel receive higher wages, but higher wages need not result in higher costs. If the productivity (output per worker) of the skilled employees is sufficient, increases in output per worker offset the higher wages. While hospital productivity increased for each individual service produced, the number of services per admission (adjusted for outpatient visits and patient severity) rose over the decade. See footnote 5 of this appendix.



**Appendix I**  
**Adoption of New Technologies Drives Cost**  
**Growth**

**Table I.1: RNs as a Percentage of All  
Nurses Employed by Hospitals**

<b>Year</b>	<b>Percent</b>
1981	48.7
1982	50.5
1983	57.0
1984	60.0
1985	62.5
1986	64.6
1987	65.1
1988	64.9
1989	64.9

Source: ProPAC, *Report to the Congress, 1991*, p. 66.

In addition to more skilled staff, the sources of labor cost increases included the competition by hospitals for a relatively small number of health care workers. During the mid-1980s, hospitals found they had to pay more to attract RNS and skilled medical personnel. For example, the wage gains of RNS outstripped those of the less-skilled licensed practical nurses (LPNS) and nursing assistants. In 1985, on an hourly basis, LPNS earned three-quarters as much as general-duty RNS. By 1989, LPNS earned only two-thirds as much as RNS.<sup>8</sup>

Nonlabor costs also rose faster than general inflation, contributing to the escalation in hospital costs. Increases in this cost category reflect, as do labor costs, increases in both price and quantity. Over the 1980s, nonlabor expenses increased relative to the number of discharges. Part of this increase can be traced to the growth in technology, but other factors, such as the protective materials required under the Centers for Disease Control infection control guidelines (known as "universal precautions"), are also at work. Inputs, such as prescription drugs, have experienced rapid price increases, further contributing to the rise in nonlabor expenses per discharge.<sup>9</sup>

<sup>8</sup>Pope and Menke, "Hospital Labor Markets," p. 133.

<sup>9</sup>John L. Ashby, Jr. and Craig K. Lisk, "Why Do Hospital Costs Continue to Increase?", *Health Affairs*, summer 1992, pp. 134-47.

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## Cost Growth Spurred by Advances in Medical Technology

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### The Role of Technology

In other industries, technological change is often considered to be a force that reduces costs, but in medical care generally and in acute care hospitals specifically, the net effect of medical advances has been an increase in costs.<sup>10</sup> A common effect of medical innovations is the introduction of new medical services. Many times these new services have offered an improved quality of life, or life itself, to patients, but with a concomitant increase in costs.<sup>11</sup>

Many medical innovations that are highly beneficial to patients still require substantial resources and, hence, generate financial costs to hospitals. Examples of such advances, all widely recognized as saving lives or improving the patient's quality of life, include radiation therapy, replacement of the hip and other joints, and neonatal intensive care.<sup>12</sup> The extra resources required for these advanced procedures raise the cost of operating a hospital.

Even if medical innovations tend to increase costs, such increases should not be interpreted as meaning that the innovations lack value and that they result in pure inflation. That is, not all cost increases are equal. A cost increase associated with a new, more effective treatment for hepatitis B would be viewed differently by many patients (and policymakers) than an equal increase caused by higher prices of the resources used in the existing treatment. The same point about quality holds in comparing the costs of treating a given disease over time. If the inflation-adjusted cost of a particular procedure increased between 1965 and 1992, part of the increase would reflect the greater labor and other costs associated with the methods in use in 1965. The remaining part of the cost increase would

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<sup>10</sup>Examples of cost-increasing and cost-reducing technical advances are discussed in Henry J. Aaron, *Serious and Unstable Condition: Financing America's Health Care*, (Washington, D.C.: The Brookings Institution, 1991); Gail R. Wilensky, "Technology as Culprit and Benefactor," *Quarterly Review of Economics and Business*, Vol. 30, No. 4 (1990), pp. 45-53; and Steven R. Eastaugh, "Financing the Correct Rate of Growth of Medical Technology," *Quarterly Review of Economics and Business*, Vol. 30, No. 4 (1990), pp. 54-60.

<sup>11</sup>Robert J. Maxwell, *Health and Wealth: An International Study of Health-Care Spending*, Lexington, Mass.: Lexington Books (1981), p. 40.

<sup>12</sup>Alain C. Enthoven, *Health Plan: The Only Practical Solution to the Soaring Cost of Medical Care*, Reading, Mass.: Addison-Wesley Publishing Company (1980), p. 30.

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reflect the extra costs associated with the more advanced methods and equipment used in 1992.<sup>13</sup>

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## Incentives for the Adoption of New Technology

### Nonprice Competition by Hospitals and Medical Liability

Several factors encourage the rapid adoption of medical technology. One is hospital competition. Generally, hospitals do not compete on the basis of price. As a result, they try to attract physicians, and therefore admissions, from their rivals by offering more sophisticated services; this strategy increases the rate at which hospitals adopt advanced medical technology.

A second factor favoring rapid adoption is medical liability. Under tort law, physicians whose techniques and equipment are not state-of-the-art may be vulnerable to malpractice suits, if the advanced techniques and equipment are considered the conventional standard of care. As a result, physicians may order more costly tests that require advanced diagnostic equipment; for similar reasons, physicians may undertake surgical and other medical procedures to avoid liability. Although malpractice insurance premiums, the direct costs of medical liability, constitute a small part of hospital costs, the indirect costs to hospitals of defensive medicine may be more substantial.

### Methods of Reimbursement

Methods of reimbursement also affect the rate at which new technology is developed and adopted. Before Medicare introduced PPS, private insurers paid hospitals on the basis of charges, while public payers (like Medicare) reimbursed hospitals on the basis of costs. The cost-reimbursement approach, which applied to most hospital care in the United States, extended to the acquisition of new technology. For the most part, hospitals passed on the cost of new technologies to third-party payers. As a result, the development of these technologies flourished, and their adoption was rapid.<sup>14</sup>

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<sup>13</sup>Henry Aaron, quoting Joseph Newhouse in Serious and Unstable Condition, makes a similar point:

"From artificial hips, to noninvasive diagnostic machines, to improved mortality rates for childhood leukemia, to TPA (tissue plasminogen activator) for heart attacks, we are not pricing a product whose characteristics do not change. Because a correction is rarely made for these improvements, part of what we term a price increase is instead improved quality. How much the improved quality is worth is a difficult issue, but the current index usually pretends it is not worth anything and that the additional expenditure is pure inflation."

<sup>14</sup>Gail Wilensky, "Technology as Culprit and Benefactor," p. 50.

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Even after 1983, PPS did not place direct restraints on hospital acquisition of capital. Instead, the target of PPS incentives for hospital efficiency was operating costs. Capital costs were still financed on a cost basis. Under PPS rules, new investments could reduce short-term profits and add some long-term uncertainty about returns.<sup>15</sup> Beginning in 1991, however, Medicare's financing of hospital capital shifted to a prospective payment scheme. As with hospital operating costs, this change is likely to reduce hospitals' capital spending when fully implemented, but the magnitude of this reduction is difficult to predict.

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## The Impact on Costs

The adoption of new technology alters the mixture of inputs over time, generally contributing to cost growth. As the technological composition of services has become more complex over time, hospitals have increased the skill level of their work force. In many cases, these skills are likely to complement the technological progress of the hospital, changing the cost structure of the facility. For example, managers may have less ability to substitute LPNs for RNs because the more skilled employees are needed for increasingly sophisticated services. If these changes do not sufficiently increase productivity, they may contribute to rising costs over time; indeed, our statistical analysis suggests this to be the case. For 1985-87, the period immediately following the introduction of PPS, we estimate that changes in the hospital cost structure increased costs by 6.8 percent for the 3-year period.<sup>16</sup> (See app. IV for a detailed description of these results.)<sup>17</sup>

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<sup>15</sup>Short-term profits are reduced under Medicare when new investments are undertaken. If new technologies increase the cost per case, short-term profits must fall because the payments are fixed under PPS. The long-term effect is not clear, however, because in the future Medicare may increase the payment to reflect the additional resources required for treatment if the new technology is widely adopted. See Wilensky, "Technology as Culpit and Benefactor," p. 50.

<sup>16</sup>Missing observations and reporting errors prevented us from using 1984 data in our sample.

<sup>17</sup>For 1985 through 1987, hospital operating costs rose about 3.1 percent after inflation. If there had been no change in the hospital cost structure between 1985 and 1987, changes in hospital characteristics, such as declines in length of stay and discharges, would have contributed to a decline in costs of 4.6 percent after inflation. The cost structure did not remain constant, however. Structural change increased costs by 6.8 percent. The net impact of all changes from 1985 through 1987 was the observed 3.1-percent increase—0.9 percentage points are a residual that cannot be accounted for by our model.

# The Impact of AIDS, Malpractice Insurance, and Administration

The role of the acquired immune deficiency syndrome and malpractice insurance in driving hospital cost growth in the 1980s was modest, despite the attention each factor received during the decade. The chief impact of AIDS was the increased costs of procedures to protect patients and hospital employees from infection. Malpractice insurance was not a major contributor to cost growth, even when insurance rates rose dramatically in the mid-1980s, because direct malpractice expenses make up such a small portion of hospital costs. Administrative costs played a larger role, although their precise contribution is difficult to calculate due to data deficiencies.

## AIDS Infection Control Procedures Caused a One-Time Increase in Hospital Costs

The emergence during the 1980s of AIDS—the most visible new force affecting hospitals—raised the base cost of running a hospital, but thereafter did not markedly quicken the pace at which that base cost escalated. In response to the risk of infection by the human immunodeficiency virus, the Centers for Disease Control established guidelines to protect hospital employees and patients.<sup>1</sup> These guidelines, or “universal precautions,” led hospitals to incur greater costs by increasing purchases of protective materials and by training staff in risk-reduction methods. While these precautions were being adopted, cost growth increased, but once the precautions became part of standard operating procedure, hospital costs resumed their previous rate of increase.<sup>2</sup>

Estimates of the total annual cost (in the late 1980s) of hospital compliance with the universal precautions are as high as \$299 million per year, 0.2 percent of 1987 overall hospital costs. Universal precautions have raised the base cost of operating a hospital, but their impact on the rate at which costs rise has been modest and short lived. In subsequent years, the universal precautions would already be reflected in hospital operating costs and would not contribute substantially to further cost increases.

A specific example illustrates the generalizations made earlier. At one Iowa hospital in the 2 years following the introduction of the CDC guidelines, glove use increased by about 72 percent, from 1.64 million pairs to 2.81 million pairs annually; the number of containers for the

<sup>1</sup>These guidelines are also intended to prevent exposure to other infectious diseases transmitted by exposure to bodily fluids.

<sup>2</sup>The universal precautions spurred hospitals to buy more protective materials. This increased demand triggered a temporary rise in the prices of some supplies, such as protective gloves, according to industry specialists and hospital officials. Higher volume and prices translate into greater hospital spending on gloves, masks, and gowns, but prices subsequently fell as suppliers were able to respond to the shortage.

disposal of syringes and other infectious wastes (known as sharps containers) rose by 15,300; and disposable gown use increased by 4,000 annually. As a result of the CDC guidelines, this hospital increased its spending on protective goods by \$7.99 per inpatient admission per year. That increased spending represents 0.3 percent of the average hospital's cost per admission in 1985. The estimate of increased spending for this Iowa hospital is consistent with the national estimates cited above.

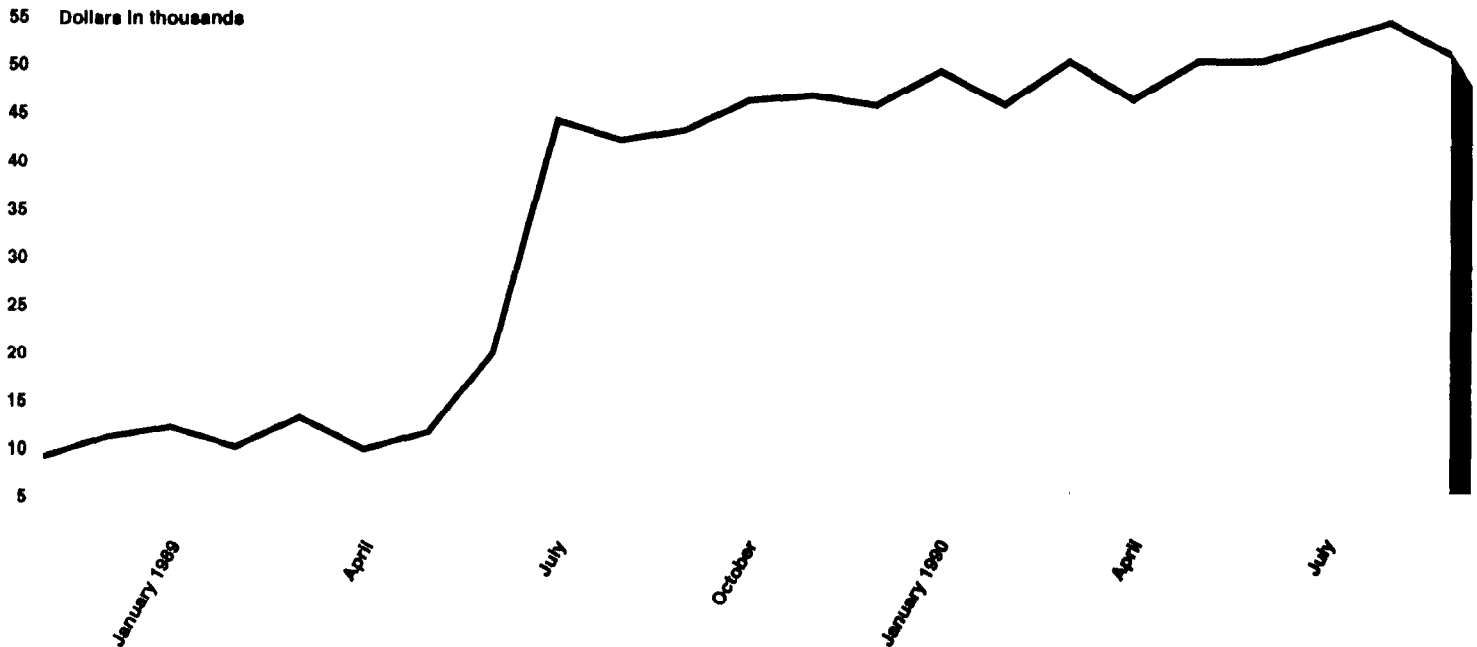
In addition to CDC universal precautions, the Medical Waste Tracking Act (MWTa) also raised hospital costs for handling medical waste. CDC guidelines increased the volume of waste that hospitals must treat as infectious. The MWTa required more rigorous methods of disposal and, thereby, raised the unit cost of waste disposal. Despite the new medical waste requirements, however, disposal costs still constituted a small percentage of total costs.

The experience at Yale-New Haven Hospital illustrates the magnitudes involved in MWTa compliance: At this 875-bed facility in 1989, expenditures for hauling and disposing of infectious waste increased from \$20,000 in June to \$44,000 in July. In 1990, Yale-New Haven's costs for handling and disposing of infectious wastes averaged close to \$50,000 per month, five times the cost before MWTa was enacted.<sup>3</sup> (See fig. II.1.) The hospital estimates that the ongoing additional costs of the act per year are \$687,312, or \$785.50 per bed. If this hospital were nationally representative, in 1989 the additional costs of complying with MWTa would amount to 0.5 percent of total hospital operating costs and, like CDC universal precautions, would represent a one-time increase in costs. We did not review the accuracy of the data or the methodology employed for obtaining the Yale-New Haven estimate, nor is Yale-New Haven likely to be nationally representative. These figures merely provide a perspective on the relative size of the costs of implementing the act.

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<sup>3</sup>Yale-New Haven Hospital, *The Impact of the Medical Waste Tracking Act at Yale-New Haven Hospital* (1991). This document was provided by AHA. The numbers taken from this study are not adjusted for inflation and, therefore, overstate to some degree the increase in costs associated with MWTa.

Figure II.1: Yale-New Haven MWTA Disposal Expenses (Nov. 1988-Oct. 1990)



Note: MWTA took effect June 22, 1989. The costs are not adjusted for inflation.

Source: Yale-New Haven Hospital, The Impact of the Medical Waste Tracking Act at Yale-New Haven Hospital January 1991. This document was provided by the American Hospital Association.

Although all hospitals have been affected by the new precautions, a minority of hospitals face higher costs due to AIDS treatment per se. AIDS patients use expensive new drugs. Additionally, AIDS patients are hospitalized for more days than the average hospital patient. Most evidence on these sources of greater operating costs is anecdotal, however. After the beginning of outpatient azidothymidine treatment in 1986, for example, Kaiser Permanente pharmaceutical costs per AIDS patient rose \$2,423 in 1986, and \$4,477 in 1987.<sup>4</sup> Furthermore, Kaiser's AIDS patients were hospitalized longer than other patients; the average length of stay for all patients in 1987 was 7.2 days while the average Kaiser AIDS patient was hospitalized for nearly 12 days.

<sup>4</sup>These numbers are not adjusted for inflation.

While regulations and more expensive treatments have increased the cost of each AIDS case, total hospital costs have also risen as the number of hospital admissions and outpatient visits by AIDS patients increased. Hospital data on AIDS patients are scarce, but AIDS appears to account for only a small share of total hospital admissions in the 1980s, adding little to hospital cost growth. In the 1990s, its contribution may be larger as the number of cases increases.

AIDS patients often need expensive services for which they cannot pay, and hospitals with AIDS patients may incur financial losses linked to this uncompensated care. Uncompensated care is an issue of reimbursement, however, not cost. Medicaid, a large payer for AIDS patients, reimburses at a relatively low rate. Hospitals frequently claim that these rates do not cover cost of patient care. Moreover, in urban areas that have high acute care occupancy rates and an insufficient number of long-term care beds, AIDS patients occupy acute care beds because there are no available facilities to which they can be discharged. In these instances, the hospital not only bears the costs of treating the AIDS patient but forgoes the revenue that would be received if the bed were occupied by a patient covered by another payer.

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### Limited Impact of Malpractice Insurance Due to Its Small Share of Costs

As a contributor to rising hospital costs in the 1980s, malpractice insurance costs were not significant. Even when hospital malpractice costs were rising rapidly, the effect on total hospital cost growth was small because malpractice costs were only a small portion of a hospital's costs. As a result, the large increase in malpractice costs in the mid-1980s had only a minor effect on the rate of hospital cost growth. Furthermore, malpractice insurance costs grew more slowly after 1986, diminishing in importance as a source of total cost growth.

Malpractice insurance costs contributed, at their peak, about 0.2 percentage points to average annual hospital cost growth. During 1983-86, when malpractice cost growth was highest, we estimate that malpractice insurance expenses rose over 20 percent annually, but they accounted for only 1 percent of total costs in 1986. From 1980 through 1983, inflation-adjusted malpractice costs were flat; from 1986 through 1990, the costs declined. Of possibly greater importance is that fear of litigation causes providers to practice defensive medicine—medically unnecessary tests and services that would not be provided if the threat of being sued were not present. But the impact is difficult to quantify, and we were unable to do so.



## Administrative Costs Were a Significant Contributor to Rising Hospital Costs

Administrative costs contributed to hospital cost growth in the 1980s, but the contribution was smaller after 1983—the year that Medicare implemented PPS. Unfortunately, available data on hospital administration provide only tentative estimates of administration's contribution to cost growth and do not permit disentangling quantitatively the separate roles of private insurers and Medicare.

According to hospital officials and others, hospital cost increases reflect a growing paperwork burden—significant increases in requirements and regulations that private insurers and public programs (like Medicare) impose on hospitals. Lacking direct measures of this burden, however, we looked at a proxy—administrative costs of hospitals.<sup>5</sup> These costs reflect, in part, the administrative burdens that are imposed on hospitals as well as those the hospital management chooses to undertake—management information systems or marketing strategies, for example.

Administrative costs have contributed to the growth in hospital costs, but estimates of that contribution are clouded by data deficiencies because they are based on a nonrandom, nonrepresentative sample of hospitals.<sup>6</sup> Administrative costs for the median hospital grew at an average annual rate of 7 percent, accounting for about 13 percent of the growth in operating costs from 1980 through 1988. This contribution declined after the introduction of PPS. Administration's share of total operating costs growth declined from 17 percent of the average annual growth for 1980-83 to 10 percent for 1983-88.<sup>7</sup>

The continued growth in administrative costs may derive from the greater number of administrative staff employed after 1983.<sup>8</sup> For example, employment in the category of medical records administrators and technicians increased while inflation-adjusted wages for this group showed little growth. This pattern suggests a rising administrative burden, but data for such a decomposition are available for this group of

<sup>5</sup>The term "administrative costs" refers to the hospital's costs for the following administrative services: general administration, general accounting, patient accounts and admitting, data processing, purchasing and stores, and medical records. Total administrative costs for hospitals were 15 percent of total revenues in 1988.

<sup>6</sup>Health Economics Research, Inc. provided Monitrends data, a survey of hospitals compiled by AHA. Large hospitals are overrepresented in the sample, but HER weighted the observations by the number of beds to reflect the hospital population. No adjustment was made for the nonrandomness of the sample.

<sup>7</sup>Administrative cost growth for the median hospital fell from an annual average rate of 9 percent for 1980-83 to 6 percent for 1983-88.

<sup>8</sup>Employees are measured as full-time equivalents.

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**Appendix II  
The Impact of AIDS, Malpractice Insurance,  
and Administration**

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administrative employees alone. These administrative employment and wage data, although incomplete, suggest that the post-1983 growth in administrative costs reflects a true increase in paperwork burden on hospitals rather than an increase in the cost of providing existing administrative services.

# Methodology and Data Sources

In this appendix, we describe the methods and data used to analyze the sources of rising hospital costs. The single exception is the regression analysis conducted to determine the impact of hospital characteristics on hospital costs. The methodology and results of that analysis are described in appendix IV.

## AIDS

To examine the contribution of AIDS to the growth of hospital costs, we conducted a literature review and held discussions with hospital representatives and researchers from the American Hospital Association.

## Malpractice Costs

To calculate the contribution of hospital malpractice costs to total cost growth, we used data from two reports. The first report was based on AHA Monitrend data from 1980 to 1986.<sup>1</sup> Our second source of data was a survey used in a previous GAO report.<sup>2</sup> We surveyed 1,782 randomly selected hospitals in 50 states and the District of Columbia and collected malpractice insurance cost information for the years 1983 through 1985.

To complete the picture of malpractice cost growth over the decade, we selected a large insurer and examined the rates it charges hospitals. The St. Paul Fire and Marine Insurance Company (The St. Paul), the largest medical malpractice insurer in the United States, underwrites over 1,500 hospitals across the country.<sup>3</sup> We used the company's premium rates as a proxy to estimate the growth in hospital malpractice insurance costs from 1986 through 1990.<sup>4</sup>

## Data Quality and Limitations

AHA's Monitrend cost data include the costs of self-insurance and of insurance purchased from both domestic and foreign-based insurers. One weakness is the nonrandom, nonrepresentative nature of the sample. The researchers compensated for the fact that large hospitals were overrepresented by weighting the sample by hospital bed size. They made no correction for the nonrandomness of the sample.

<sup>1</sup>Health Economics Research, Inc., "Treatment of Hospital Liability Insurance in the HCFA Market Basket," Contract No. T-31415512 RFP-01-85-ProPAC (Feb. 24, 1987).

<sup>2</sup>Medical Malpractice: Insurance Costs Increased but Varied Among Physicians and Hospitals (GAO/HRD-86-112, Sept. 15, 1986).

<sup>3</sup>It does not write policies in the District of Columbia, Hawaii, Massachusetts, or New Mexico.

<sup>4</sup>The St. Paul rates, taken from the company's annual hospital reports, from 1986 to 1990, are average nationwide rates for hospital liability insurance. These premium rates are proposed average acute care bed rates for coverage at \$1 million/\$3 million limits of liability.

The data we used from our 1986 malpractice report are based on a random sample of hospitals. Malpractice cost data include contributions to self-insurance funds as well as the cost of purchased insurance for the years 1983 through 1985. The fact that both the Monitrend and our data yield estimates in excess of 20 percent annual growth increases our confidence in the reliability of the estimates.

The St. Paul rates include only the premiums paid for its commercial policies by the hospitals that the St. Paul underwrites. These figures do not account for hospitals that self-insure or purchase liability insurance from foreign insurers rather than buy commercial coverage in the United States. More than half of the hospital beds in the United States are insured by nontraditional means.

## Administrative Costs

To calculate the rate of administrative cost growth relative to total hospital cost growth, we used cost information compiled by the Center for Health Economics Research from Monitrend 1980-88 data. From these costs we calculated compounded average annual changes for various department groups, including administration. The department groups include administration, general accounting, patient accounts and admitting, medical records, purchasing and stores, and data processing in "administrative services."

To examine the administrative share of total hospital cost growth, we calculated the average annual administrative cost growth as a percentage of total hospital cost growth from 1980 through 1983 and from 1983 through 1988.

To determine if the number of administrative hospital employees or wages paid to selected administrative employees influenced administrative cost growth, we calculated average annual growth rates, before and after PPS, for these two categories. We first considered the changes in number of nationwide full-time equivalent hospital personnel with administrative responsibilities. We compared the changes in number of administrative FTEs with changes in the number of total hospital FTEs from 1981 through 1983 and 1983 through 1988. We obtained FTE information from the Department of Health and Human Services' Health United States, 1986-90 publications.

We examined wages and FTEs for the categories administrators and assistant administrators and medical record administrators and

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technicians. AHA defines the administrator and assistant administrator category as

“... the top level position in the facility, the person in charge of policy development, activity coordination, procedural development, and planning of the institution. Also includes persons who work under the supervision of the facility administrator as department administration assistants for the areas of finance, organization, personnel, purchasing, accounting, and voluntary services.”

According to AHA, medical record administrators and technicians are those persons who

“... plan, design, develop, and manage systems of patient information, administrative and clinical statistical data, and patient medical records... Medical record technicians... assist the medical record administrator and perform the technical tasks associated with the maintenance and use of medical records.”

To evaluate if wages affected administrative costs, we examined changes in wage rates of full-time medical record administrators and full-time and part-time medical record technicians from 1981 to 1985 and from 1985 to 1989.<sup>5</sup> We used a weighted average to determine the nationwide average hourly wage for all metropolitan areas studied in 1981, 1985, and 1989. Wage information for administrators and assistant administrators was not available. We used data from the U.S. Department of Labor, Bureau of Labor Statistics (BLS) to determine average hourly wages paid to full-time and part-time hospital workers in selected occupations in certain metropolitan areas.<sup>6</sup> These data exclude “premium pay for overtime and for work on weekends, holidays, and late shifts, as well as the value of room, board or other perquisites provided in addition to cash payments.” Full-time employees are those who are hired to work a regular weekly schedule of 35 hours or more.

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## Quality and Limitations of Data

We examined the number of FTEs for all community hospitals, defined by AHA as nonfederal short-term general and special hospitals, excluding hospital units of institutions, whose facilities and services are available to the public. All FTE numbers include personnel with inpatient and

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<sup>5</sup>These wage rates are for regular hours and do not include overtime pay. They are referred to as straight-time wages.

<sup>6</sup>BLS, Industry Wage Survey: Hospitals. We used the October 1981, August 1985, and March 1989 publications. Data from the first two years document straight-time hourly wages. We computed hourly wage rates for 1989 by dividing average straight-time weekly earnings by average standard weekly hours.

outpatient responsibilities. We could not separate the number of FTEs for general accounting, data processing, patient accounts and admitting, and purchasing and stores because they are collected in one category, "all other personnel," in AHA's annual survey of hospitals.

BLS obtains wage data from a probability-based sample of investor-owned and private, nonprofit metropolitan hospitals with 100 or more employees. Wage information is collected only for metropolitan statistical areas as defined by the U.S. Office of Management and Budget; the counties included in the metropolitan areas vary between survey years, 1981, 1985, and 1989. Of the 3 years that we considered, nationwide data were collected only in 1989; in the other years, data were only available for specific major metropolitan areas. While wage information was collected for both full-time and part-time medical record technicians, data were not available for part-time medical record administrators, only for full-time.

# A Statistical Analysis of Hospital Costs

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To analyze the impact of various hospital characteristics on the cost of producing hospital services, we used regression analysis to estimate a simple cost function.<sup>1</sup> Cost functions, in their purest form, represent the sensitivity of costs to the price of inputs used by a firm and to the quantity of outputs it produces. In the case of a hospital cost function, input prices include the wages paid to labor as well as the price of other inputs, such as drugs or electricity. Outputs for hospitals could be defined in a number of ways. In this analysis, outputs are defined as the number of discharges, the number of outpatient visits, and the length of the average hospital stay.<sup>2</sup> The volume of discharges and outpatient visits may be viewed as the units produced by the hospital; the average length of stay serves as a measure of a hospital's "hotel services"—the room and food provided to patients. In the estimated version of the hospital cost function, other variables are included to capture the special nature of the market.

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## Estimation of the Cost Function

To estimate the cost function, we used a data set that combined information from the Medicare Hospital Cost Report Information System Minimum Data Set, the American Hospital Association's annual survey, and the 1988 Area Resource File from the Department of Health and Human Resources. Cost data were available for individual hospitals for 1985-87.<sup>3</sup> A complete list of the variables included in our regression model, along with their definitions, is presented in table IV.1. The regression results are presented in table IV.2, and the mean for each variable in each year is in table IV.3.

To estimate the hospital cost function, we regressed the natural logarithm of hospital operating costs on measures of output, input prices, regional location, patient severity, hospital capacity, ownership status, teaching status, and accreditation status. The hospital's outputs are given as the natural logarithm of annual discharges and of the annual number of outpatient visits. These two variables are multiplied together and entered as an additional variable. This variable, known as an interaction term, allows us to account for potential cost savings achieved by the joint

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<sup>1</sup>This technique allows us to examine the impact of each characteristic on costs, holding other factors constant. We are also able to estimate the contribution of changes in the cost structure to hospital cost growth by observing changes in the model's parameters over time.

<sup>2</sup>Alternatively, outputs could be defined in terms of services instead of discharges and outpatient visits. For example, the number of surgeries and cardiograms could be viewed as two outputs of a hospital. Taking this approach, the number of outputs quickly becomes too large for a statistical analysis. Moreover, the data are not generally reported at this level of detail.

<sup>3</sup>For more details on the contents of this data set, see Rural Hospitals: Factors That Affect Risk of Closure (GAO/HRD-90-134, June 19, 1990).

provision of these services.<sup>4</sup> We use the Medicare wage index as our measure of labor costs for the hospital. Unfortunately, Medicare cost reports do not provide additional input price information. Hence, we assume that other inputs are traded in a national market, available at the same price to all hospitals. We include variables indicating regional location to allow for cost differences by region.<sup>5</sup> To control for differences in patient severity by hospital, we include the natural logarithm of the 1987 Medicare case-mix index.<sup>6</sup>

In addition to the standard price and output variables usually included in a cost function, the hospital cost function includes a measure of hospital capacity and various institutional variables. For hospital capacity, we use the natural logarithm of the number of beds. This capacity has been used as a proxy for the hospital's capital stock because hospital size is usually correlated with the services offered by a facility. We retained that interpretation for this analysis.<sup>7</sup> The institutional variables—ownership, teaching status, and accreditation—are not part of the theoretical cost function, but in the hospital market, these variables are likely to explain significant portions of the differences in costs between hospitals. The ownership variable provides an example of how different incentives may affect hospital costs. Nonprofit and public hospitals face different incentives from proprietary hospitals, with possible cost differences in providing services.<sup>8</sup> Finally, dummy variables for teaching status and accreditation by the Joint Commission on the Accreditation of Healthcare Organizations (JCAHO) are included in the regression. Teaching hospitals experience higher costs of care because of the additional resources devoted to education as well as patient care. Accredited hospitals may experience higher costs in seeking accreditation.

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<sup>4</sup>These potential savings are referred to as economies of scope.

<sup>5</sup>This series of dummy variables indicating regional location may control for regional cost differences, but they may capture other factors we cannot measure. For example, physician practice patterns vary by region, and these regional dummies are likely to capture those differences in as much as they account for regional variation in costs. Dummy variables for the Northeast, North Central, and South were included in the regression. Pacific was the omitted category.

<sup>6</sup>The hospital's case severity could also be viewed as an output—the sophistication of treatment provided to patients.

<sup>7</sup>Under this interpretation, the cost function estimated here is a short-run cost function. This form of the cost function has been advocated in the literature in recent years because several studies have shown that the hospital market is not in long-run equilibrium, a condition necessary for accurate estimates of long-run costs. T. G. Cowing and others, "Hospital Cost Analysis: A Survey and Evaluation of Recent Studies," in *Advances in Health Economics and Health Services Research*, Vol. 4, pp. 257-303, edited by Richard M. Scheffler and Louis F. Rossiter (Greenwich, Conn.: JAI Press, Inc., 1983), provides an overview of the issue and an analysis of the empirical findings.

<sup>8</sup>To capture these differences, a dummy variable for nonprofit status was included in the regression. Similarly, a dummy variable was included for public status. Proprietary hospitals were the omitted category.



To estimate these cost functions, we estimated regressions separately for urban and rural hospitals. Chow tests for pooling these groups of hospitals indicated that pooling was inappropriate for each year of available data.<sup>9</sup> The standard errors presented in table IV.2 are based on consistent estimates of the covariance matrix for each regression because tests indicated heteroskedasticity in each of the regressions. When we discuss the effect of changes in these variables on cost growth, the effect is based on a weighted average of the estimates for urban and rural hospitals. The weighted estimates from all 3 years are then averaged to produce the average elasticity over the 1985-87 period.<sup>10</sup> To estimate the changes in cost growth over time due to the independent variables, we multiply the percentage change in the independent variable for the applicable time period by this average elasticity.

## Changes in the Hospital Cost Structure

In addition to estimates of the cost function for each year, these regressions allow us to examine the changing structure of hospital costs. If the cost structure of hospitals were stable over time, expected changes in costs would be attributable to inflation and changes in the determining factors. As hospitals adopt new technology, however, the cost structure of hospitals changes over time. As hospitals respond to these changes by altering the services and the quality of inputs used to produce those services, these changes should be observable from the estimated parameters of the cost function.

Changes attributable to this altered structure may be derived by decomposing cost changes into components: (1) changes in hospital characteristics, (2) changes in coefficients, and (3) unexplained residual changes. We performed this decomposition for the regressions shown in table IV.2. The results of the decomposition are summarized in table IV.4. They show that, based on changes in hospital characteristics and taking the 1985 cost structure as given, expected costs would have declined by nearly 5 percent between 1985 and 1987. If hospital characteristics had remained unchanged from 1985 levels, however, changes in the cost structure (the estimated coefficients of the cost function) would increase

<sup>9</sup>Note that the power of the Chow test is reduced in the presence of heteroskedasticity, which we find in these models. See Peter Schmidt and Robin Sickles, "Some Further Evidence on the Use of the Chow Test under Heteroskedasticity," *Econometrica*, Vol. 45, No. 5 (July 1977), pp. 1293-98.

<sup>10</sup>An elasticity denotes the percentage change in the dependent variable (costs, in this case) for a 1-percent change in an independent variable.

costs by nearly 7 percent above the general inflation rate over the 3-year period.<sup>11</sup>

Our estimate of the changes in the hospital cost structure is not a pure estimate of the effect of the adoption of new technology. The prospective payment system was implemented in 1983, and hospitals were still adapting to the new incentives they faced. The learning curve for responding to PPS may have affected the hospital cost structure. Hence, the effects may be mixed with the adoption of new technology. We cannot disentangle these effects, although the cost-saving incentives under PPS suggest that changes in the cost structure may have been greater in the absence of prospective payments by Medicare.

**Table IV.1: Definition of Variables**

<b>Variable</b>	<b>Definition</b>
Discharge	The annual number of discharges from the hospital
Case-mix	The Medicare case-mix index
Wage	The Medicare wage index
Beds	The number of hospital beds
Length of stay	The average number of patient days per discharge annually
Outpatient visits	The number of outpatient visits received by the hospital annually
Subacute care beds	Dummy variable indicating the presence of subacute care beds
Accredited	Dummy variable indicating accreditation by JCAHO
Teaching hospital	Dummy variable indicating a teaching hospital
Nonprofit	Dummy variable indicating a nonprofit facility
Public	Dummy variable indicating operation of the facility by a nonfederal level of government
North Central	Dummy variable indicating the region of the hospital
Northeast	Dummy variable indicating the region of the hospital
South	Dummy variable indicating the region of the hospital

<sup>11</sup>About 1 percentage point of the actual 1985-1987 increase cannot be accounted for by the decomposition of the annual cost functions.

**Appendix IV  
A Statistical Analysis of Hospital Costs**

**Table IV.2: Estimated Cost Functions for Hospitals**

Independent variable	1985		1986		1987	
	Parameter estimate	Standard error	Parameter estimate	Standard error	Parameter estimate	Standard error
<b>Urban</b>						
Constant	7.670	0.448	8.445	0.507	7.663	0.342
Discharges <sup>a</sup>	0.768	0.051	0.658	0.062	0.734	0.044
Case-mix <sup>a</sup>	0.829	0.058	0.967	0.056	1.043	0.054
Wages <sup>a</sup>	0.901	0.042	0.852	0.042	0.824	0.044
Beds <sup>a</sup>	0.189	0.026	0.223	0.029	0.205	0.025
Length of stay <sup>a</sup>	0.634	0.034	0.584	0.043	0.571	0.032
Outpatient visits <sup>a</sup>	0.002	0.049	-0.043	0.048	0.048	0.033
Discharges x outpatient visits	0.002	0.005	0.008	0.005	0.001	0.004
Subacute care beds	-0.006	0.014	-0.003	0.012	-0.002	0.013
Accredited	-0.013	0.020	0.027	0.021	0.050	0.021
Teaching hospital	0.146	0.011	0.138	0.012	0.134	0.012
Nonprofit	-0.143	0.014	-0.108	0.014	-0.106	0.014
Public	-0.146	0.016	-0.103	0.016	-0.112	0.016
North Central	-0.120	0.015	-0.129	0.015	-0.109	0.016
Northeast	-0.216	0.019	-0.227	0.019	-0.200	0.018
South	-0.091	0.017	-0.091	0.017	-0.053	0.019
<b>Adjusted R<sup>2</sup></b>	0.961		0.963		0.962	
<b>N</b>	2,664		2,583		2,468	
<b>Rural</b>						
Constant	7.574	0.317	7.916	0.375	7.959	0.399
Discharges <sup>a</sup>	0.844	0.043	0.793	0.049	0.804	0.052
Case-mix <sup>a</sup>	0.652	0.070	0.837	0.070	0.881	0.071
Wage <sup>a</sup>	1.130	0.086	1.151	0.079	1.212	0.083
Beds <sup>a</sup>	0.164	0.023	0.165	0.023	0.140	0.027
Length of stay <sup>a</sup>	0.280	0.033	0.211	0.030	0.180	0.029
Outpatient visits <sup>a</sup>	0.035	0.034	0.031	0.039	0.035	0.041
Discharges x outpatient visits	-0.001	0.005	0.002	0.005	0.002	0.006
Subacute care beds	0.019	0.012	0.034	0.012	0.042	0.012
Accredited	0.084	0.012	0.075	0.014	0.088	0.014
Teaching hospital	0.114	0.033	0.115	0.032	0.127	0.034
Nonprofit	-0.177	0.020	-0.184	0.020	-0.136	0.019
Public	-0.180	0.020	-0.188	0.020	-0.135	0.019
North Central	-0.057	0.021	-0.021	0.020	-0.035	0.022

(continued)

**Appendix IV  
A Statistical Analysis of Hospital Costs**

<b>Independent variable</b>	<b>1985</b>		<b>1986</b>		<b>1987</b>	
	<b>Parameter estimate</b>	<b>Standard error</b>	<b>Parameter estimate</b>	<b>Standard error</b>	<b>Parameter estimate</b>	<b>Standard error</b>
Northeast	-0.050	0.025	-0.003	0.026	0.016	0.026
South	0.028	0.025	0.103	0.024	0.117	0.026
<b>Adjusted R<sup>2</sup></b>	0.956		0.956		0.955	
<b>N</b>	2,428		2,327		2,271	

Note: The dependent variable is the natural logarithm of hospital operating costs for the applicable year. The regressions are corrected for heteroskedasticity using the asymptotically correct covariance matrix.

\*The natural logarithm of this variable is used to estimate the model.

**Appendix IV  
A Statistical Analysis of Hospital Costs**

**Table IV.3: Means of Hospital Characteristics**

<b>Characteristic</b>	<b>1985</b>	<b>1986</b>	<b>1987</b>
<b>Urban</b>			
Discharges <sup>a</sup>	6,083	5,840	5,792
Case-mix <sup>a</sup>	1.20	1.20	1.20
Wage index <sup>a</sup>	1.08	1.08	1.08
Beds <sup>a</sup>	187	189	188
Length of stay <sup>a</sup>	6.18	6.15	6.21
Outpatient visits <sup>a</sup>	31,588	34,591	38,809
Subacute care beds	0.12	0.14	0.16
Accredited	0.91	0.92	0.94
Teaching hospital	0.30	0.33	0.33
Nonprofit	0.68	0.67	0.69
Public	0.14	0.15	0.14
North Central	0.24	0.24	0.24
Northeast	0.22	0.21	0.22
South	0.33	0.34	0.33
Costs <sup>a</sup>	\$19,120,549	\$19,993,660	\$21,605,331
<b>Rural</b>			
Discharges <sup>a</sup>	1,547	1,455	1,382
Case-mix <sup>a</sup>	1.05	1.05	1.05
Wage index <sup>a</sup>	0.86	0.86	0.86
Beds <sup>a</sup>	61	61	62
Length of stay <sup>a</sup>	5.17	5.24	5.37
Outpatient visits <sup>a</sup>	8,092	9,026	10,178
Subacute care beds	0.23	0.25	0.27
Accredited	0.59	0.62	0.63
Teaching hospital	0.02	0.02	0.03
Nonprofit	0.47	0.47	0.48
Public	0.44	0.44	0.44
North Central	0.37	0.37	0.37
Northeast	0.06	0.06	0.06
South	0.41	0.41	0.40
Costs <sup>a</sup>	\$3,032,194	\$3,090,424	\$3,194,174

<sup>a</sup>Numbers presented for this variable are the geometric mean of the variable. The geometric mean is computed by taking the natural logarithm of the variable, averaging the logged values, and computing the exponential of the average logged value of the variable. We show the geometric mean for the continuous variables because we used a double logarithmic regression model. It is also a better measure of the center of the variable's distribution than the arithmetic mean when the distribution is skewed.

**Appendix IV**  
**A Statistical Analysis of Hospital Costs**

**Table IV.4: Decomposition of Hospital Costs**

<b>Changes in</b>	<b>1985-86</b>	<b>1986-87</b>	<b>1985-87</b>
Costs	0.62	2.47	3.09
Parameter estimates <sup>a</sup>	4.01	3.03	6.82
Characteristics <sup>b</sup>	-3.26	-1.18	-4.63
Residual <sup>c</sup>	-0.13	0.61	0.90

<sup>a</sup>Shown is the change in costs (in percentage points) resulting from changes in the parameter estimates of the regression model between years. These increases result from changes in the hospital cost structure, which occur, in part, due to technical change.

<sup>b</sup>Shown is the change in costs (in percentage points) due to changing hospital characteristics (number of admissions or length of stay, for example).

<sup>c</sup>Shown is the change in costs (in percentage points) that cannot be explained by our model.

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