HOSPITAL EFFICIENCY AND FACILITY OBSOLESCENCE

A STUDY OF 68 MASSACHUSETTS HOSPITALS

by

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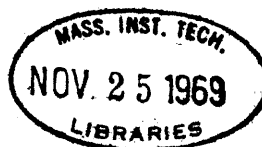　　　　　　　　　　　　　　　　　　　　　　　June 27, 1969

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ABSTRACT

HOSPITAL EFFICIENCY AND FACILITY OBSOLESCENCE:

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This study sought to substantiate the hypothesis that there
is a relationship between hospital services and the facilities and
equipment used in their production such that obsolete facilities
and equipment are a barrier to efficiency. Actually tested was
the null hypothesis that no such relationship exists. The study
used cross-sectional data for the year 1967 from a sample of 68
private, non-profit, general, short-term Massachusetts hospitals.

Obsolescence was defined by two measures: present value of
capital equipment per available bed and the ratio of beds not
conforming with Public Health Service facility standards to
licensed bed capacity. Efficiency was measured in terms of the
costs per patient day and per admission. The data were subjected
to least-squares linear regression analysis and Pearson product-
moment correlation analysis.

A second study compared the unit costs of recently built
clinical laboratories and departments of diagnostic radiology
with those of similar departments in older facilities.

The results did not warrant rejection of the null hypothesis.
There was a suggestion in the findings that there is a weak
positive association between higher costs and obsolescence as
defined by Public Health Service standards. However, when present
value of capital was used as the definition of obsolescence, a
weak negative relation between the variables was found for the

larger, more complex hospitals in the sample. This suggested that recent capital investment in the hospital industry may not have encouraged efficiency in production and that federal aid for hospital modernization should be reexamined.

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I HOSPITAL EFFICIENCY: AN OVERVIEW

The Aim of This Study

The aim of this study is to explore the contribution to cost control and efficiency which may be expected from an approach based on the modernization of facilities and an attempt to substitute capital for labor in the mix of inputs to hospital care. While there is an abundant literature devoted to both hospital costs and facilities, there has been curiously little work which interrelates the two in any concrete way. In large part, this must be due to the difficulties of trying to isolate the effects of facility and equipment quality from the host of other influences which affect the costs of any particular institution. The data do not in fact permit establishment of clear causation or detailed relationships. However, because of the size and importance of the problem, and the extent to which the modernization approach has been adopted, it is valuable to examine the large scale picture which a study of the available information can make available.

Health and Hospital Costs

The health sector of our economy accounts for approximately 6 percent of the Gross National Product, or for expenditures in the order of magnitude of $50 billion per year at current levels. The sheer size of this sector is enough to establish interest in

its study. But it is really its changing relation to the rest of
the economy and the shifting of components within the sector which
give an air of urgency to our understanding of its problems. The
current figures contrast sharply, for instance, with those of 1929,
when only 3.6 percent of the GNP were accounted for by health
expenditures.[1] And the rise in this proportion has not been at
an even rate; after holding at a relatively stable rate in the
1940's and early 1950's it has risen at an increasing rate since
1955.[2] The differential rates of increase of the Consumer Price
Index and its medical care component during the three decades since
1936 as shown in Table 1-1 illustrate this trend.

TABLE 1-1

Percentage Increases in Components of the
Consumer Price Index

Period	Medical Care	All Items
1936-1946	22	41
1946-1956	51	39
1956-1966	42	19

Source: U.S. Department of Health, Education and Welfare, Medical
Care Prices, 1967.

Hospitals, the subject of this study, are a major component of the health sector, representing approximately 35 percent of total expenditures in 1965.[3] That this is the most rapidly rising component of the Medical Care Price Index can be seen from Figure 1-1.

The hospital figures are most telling because unlike those for gross total expenditures, whose enormity is difficult to relate to personal experience, they can easily be related to relatively familiar consumer items; costs per patient day and per hospitalization, which do have clear personal meaning. In 1946 the average expense incurred by short term, general and special hospitals for a single inpatient day was $9.39. The average cost per admission was $86.00.[4] In 1967, the latest year for which such figures have been made available, the costs were $54.08 and $443.46 respectively.[5] These are certainly dramatic increases, and their significance is heightened by the fact that the number of days of hospitalization per 1,000 population per year has also been rising as shown in Table 1-2. They have resulted in a doubling of the proportion of personal disposable income spent for hospital care: from 0.95% in 1950 to 1.80% in 1965.[6]

TABLE 1-2

Days of Hospitalization Per 1,000 Population
for Non-Federal Hospitals: 1950-1965

1950	1960	1965	Average Annual Increases	
			1950-1960	1960-1965
900	977	1,071	0.86%	1.93%

Source: Somers and Somers, Medicare and the Hospitals, 1967.

FIGURE 1 - 1

Selected Components of the Medical Care Price Index
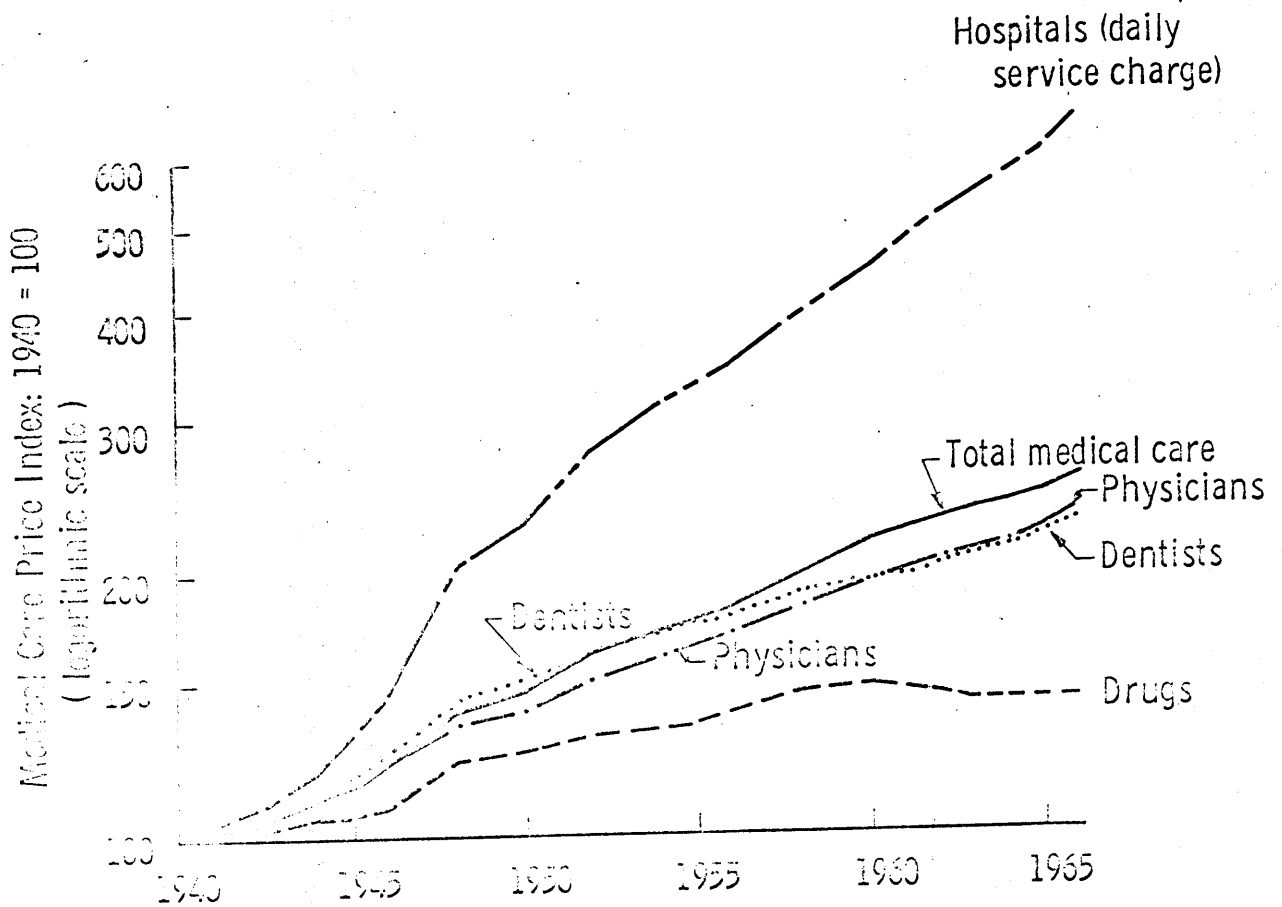
Set in the context of rapidly rising national expectations for medical care, growing awareness of the unequal distribution of health resources, and the pronounced shortage of funds for governmental welfare programs, these trends of rapidly rising health and hospital costs have become part of what is widely felt to be a crisis. The agonies of New York City's public hospital system and the retreat of Massachusetts from its earlier commitment to provide funds under the federal Medicaid program[7] are among the more severe symptoms, but lesser consequences are experienced by every citizen.

Analysis of the causes of rising hospital costs is far beyond the scope of this study. But a brief survey of the various explanations which may account for the increases will shed light on the areas towards which we may look for possible relief.

Advancing Medical Technology

The dramatic advances of medical technology have resulted in significant improvements in the quality and complexity of hospital services. A day of hospitalization in 1929 was simply not the equivalent of a day in 1969. Hospital services today require larger quantities of more expensive skilled manpower, sophisticated equipment, drugs and building space. As a result they offer relief from previously untreatable illnesses as well as improved chances of recovery from almost all ailments. Improvements in medical care and other changes in hospital practice have also resulted in a long run

reduction in average length of hospitalization, so that a given day of inpatient care is accompanied by more intensive medical activity and higher costs than would otherwise be the case.

Lagging Labor Productivity and Rising Wages

Hospitals, like other service industries, have not been able to increase the productivity of their labor as has industry in general. In fact, by the measures most commonly used, the amount of labor per unit of output, the productivity of hospital personnel has been falling. In 1950 the average number of employees per patient was 1.8.[8] In 1967 the equivalent number was 2.65 and payrolls accounted for approximately 63 percent of total hospital costs.[9] At the same time that the number of employees per patient was increasing, their wages were increasing relative to other workers. Hospitals have traditionally paid low wages and a gap still exists, but as indicated in Table 1-3, the differential is getting smaller.

TABLE 1-3

Average Annual Hospital Wage as a Percent of the
Average Annual Wage of Manufacturing Employees

Year	Percent
1950	59.9
1960	69.5
1965	72.8
1967	74.9

Source: American Hospital Association, "Nation's Hospitals," p. 445.

The relative rise of hospital wages is probably due to the increase in training and skill levels required, the gradual introduction of unionization and collective bargaining into hospital labor relations, and shortages of numerous categories of workers.

A related factor, high personnel turnover (especially among nurses) contributes to reduced productivity despite the fact that some hospital administrators feel that it saves having to pay higher salaries to those with longevity. The turnover among nurses which is at least partly a result of the relatively low wages and generally poor working conditions has been found to be over three times the rate for female public school teachers.[10]

Non Profit Control

Ironically, the non-profit ownership of most hospitals is often felt to have an adverse effect on hospital costs. The profit motive, which is the most common incentive for efficiency in our society is largely absent, and may have been replaced by incentives to increase the level or quality of output,[11] or institutional prestige.[12] This problem is compounded by the practice of most private and governmental third party reimbursement plans to negotiate vendor payments on the basis of costs. Hence, efficient management which is successful in retarding the rise in costs will be rewarded not by profits but by relatively lower revenues. The extent to which U. S. hospitals are characterized by voluntary, non-profit sponsorship is outlined in Table 1-4.

TABLE 1-4

Distribution of Short-Term, Non-Federal
Hospital Beds By Control in 1965

Control	Percentage
State and Local Government	24%
Private, non-profit	70%
Proprietary	6%

Source: U. S. Department of Health, Education and Welfare, Medical Care Prices, 1967.

A similar argument is used in relation to decisions affecting the location and capacity of hospital facilities. Funds for investment in capital equipment come in large measure from philanthropic and governmental sources with only a very small share coming from the commercial capital markets used by business (See Table 1-5.). While there is often a scarcity of such funds, when obtainable, their cost is very low.[13] Under these circumstances, it is believed, the hospitals do not make the kind of rational, economic decisions we expect of a business. Because they operate outside the market in this respect, they are not forced to pay the true opportunity cost of the capital and need not properly account for real returns to the community.[14] Such decisions may be further distorted where funds are earmarked by their donors for specific purposes such as construction. As a result there is a

tendency to build facilities where they may not be needed, a condition which gives rise to a number of upward pressures on costs including utilization of facilities simply because they exist over and above that which is medically necessary,[15] and the necessity to carry the heavy fixed operating costs of unused facilities.[16]

Obsolescence of Facilities

While they are accused of using capital funds inefficiently, hospitals are also recognized as being generally capital starved enterprises. The absence of profits which might be reinvested, and the prevailing practice of not using operating revenue as a source for capital funds forces many hospitals into dependence upon private philanthropy and governmental aid programs. (See Table 1-5.)

TABLE 1-5

Sources of Capital Input to Short-Term,
Non-Federal Hospitals in 1964

Source	Percent of Total
Philanthropy	38%
Federal Grants	6
Depreciation Funds	26
Excess of Income Over Costs	8
All Other*	18

*Includes state and local government grants.

Source: Somers and Somers, Medicare and the Hospitals, 1967.

As a result, it is argued, they have not been able to reduce their traditional labor intensity by the introduction of modern, efficient equipment and facilities. They have not been able to modernize their capital equipment at a pace commensurate with the rate of obsolescence implied by the rapid advancements in medical technology and industry in general. According to this view, the view which will be the main subject of this study, old, obsolete facilities and equipment are a barrier to efficient operation.

II HOSPITAL FACILITIES

Recent History

Hospitals have been a part of American medical practice since
colonial times. The earliest of them developed from the tradition of
alms houses and served those unable to command the private medical
services preferred by the rest of the population. Others, also serv-
ing the poor, were established as clinical training centers for
early schools of medicine in New York and New England. Stigmatized
as last resorts for the dying poor, the number of hospitals remained
small, and only 178 such institutions were counted in the first
census of hospitals in 1873. The end of the nineteenth century,
however, saw changes in attitude and in practice. A similar counting
in 1909 listed 4,359 hospitals; more than a 24-fold increase in
36 years.[1]

This great era of hospital building which developed the stock
of American hospitals to 6,850 in 1928 (there were 7,172 in 1967) was
brought to an end by the Depression when new construction practically
ceased and over 700 hospitals were forced to close. The cessation
of construction continued virtually uninterrupted until after World
War II. Then, after having been neglected for over 15 years, expan-
sion of the stock of hospital facilities became an important national
goal. Official status and considerable federal financial aid were
given to this goal by the 1946 Hill-Burton Hospital Survey and

Construction Act. This legislation provided that federal funds would
flow through newly established state hospital planning agencies
which were to inventory existing facilities, assess their relation to
local needs, and establish a statewide system of priorities. The
procedures were designed not only to provide upgraded hospital
facilities, but to locate them where the unmet needs were greatest.
In addition to hospitals, the program aided the construction of
nursing homes, clinics, rehabilitation centers, and state health
laboratories. Its popularity is well established and as Figure 2-1
shows, in terms of longevity, expenditures, and activity aided, it
is an impressive program. In the twenty year period 1947-1967,
the assets of American hospitals rose from under $7 billion to
$28 billion. The Hill-Burton expenditures during this period were
$2.5 billion and their effect was magnified by virtue of having been
only partial contributions to projects which actually totalled almost
$7 billion. At the same time, close to $2 billion were added to the
assets of the federally operated hospital system.

The fourfold increase in dollar assets was not paralleled by a
similar movement in the number of hospital beds; the 1967 total of
1,671,000 beds was only 16% above the 1946 figure. As Public Health
Service officials like to point out, however, this relatively modest
increase in the total supply of beds does not tell the whole story.
The stock of beds at the end of World War II included a significant
proportion which were unacceptable according to the Hill-Burton
standards. Application of these standards indicated that in 1948,

FIGURE 2 - 1

Hospitals and Related Facilities : Value Put In Place Per Year and Hill-Burton Aid.
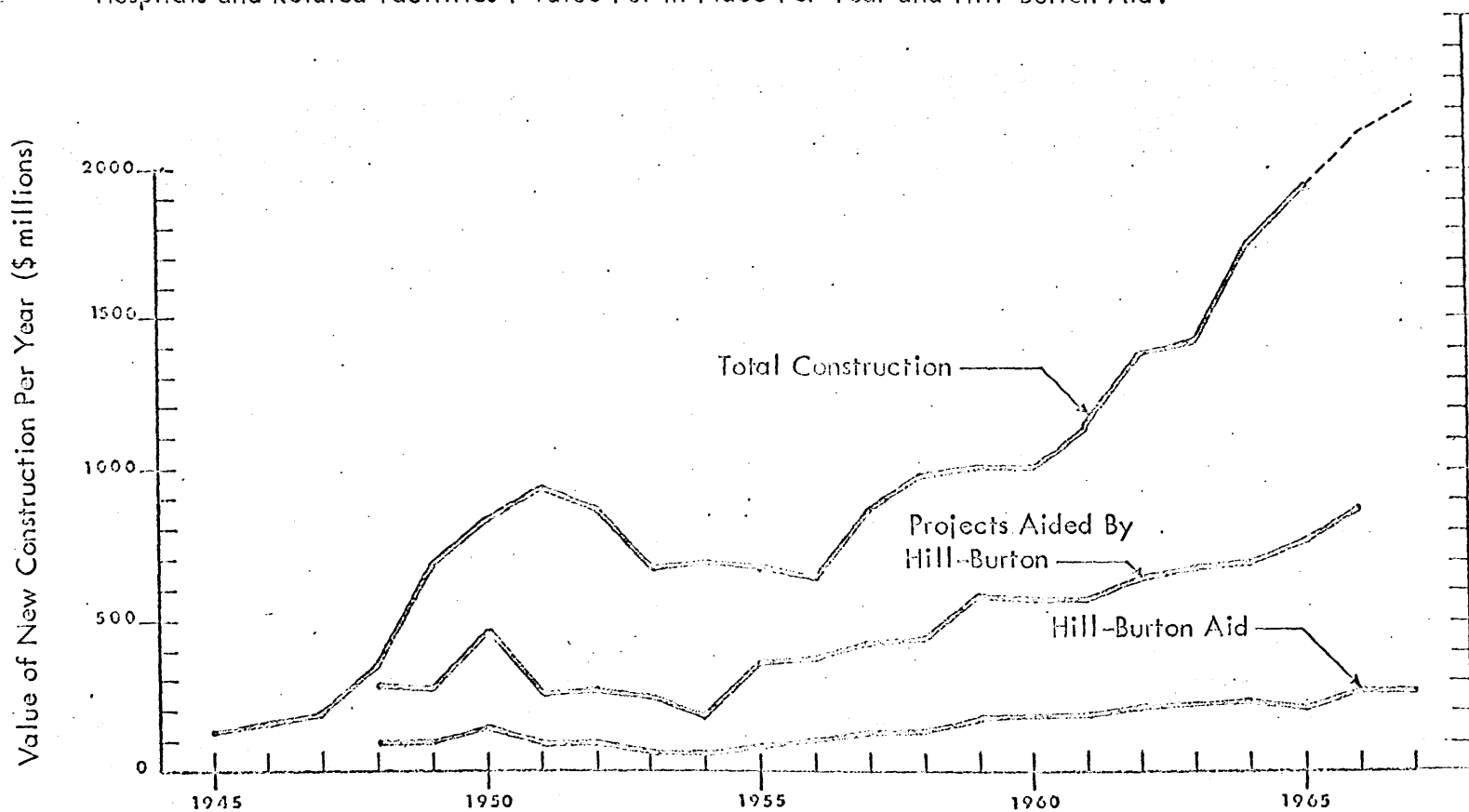
SOURCES : Total Construction – U.S.Congress, Joint Economic Committee. State and Local Public Facility Needs;
Hill-Burton Program – U.S.Department of Health, Education and Welfare. Hill-Burton Program Progress
Report : July 1, 1947 – June 30, 1967.

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in the category of short-term, general beds, only 59% of the 4.5 beds

felt to be needed per 1,000 population were available. By 1964, the

stock of acceptable beds met 83 percent of the nation's needs.[2]

Furthermore, application of its need criteria on a relatively fine

scale regional level and establishment of priorities based on magni-

tude of unmet regional needs had caused hospital facilities to be

more evenly distributed among urban and rural areas.

In 1964, when the Hill-Burton legislation was discussed by

Congress for renewal, evidence was presented which led to changes

in the system of priorities and a shift of emphasis in the whole

program. Statements of administration officials indicate the under-

standing of the hospital problem which led to the enactment of the

Hill-Harris Amendments.

> With long usage and little improvement during the
> economic depression of the 1930's and the war years
> of the 1940's, the physical plant and equipment of
> our urban hospitals in many instances have become
> obsolete and increasingly inefficient. Such an
> environment has made it more difficult to provide
> quality hospital services on an efficient and
> economical basis. The Hill-Harris Amendments are
> geared to present day needs and designed to re-
> direct emphasis of the program toward modernization
> of our quality care hospitals and other health
> facilities giving special consideration to those
> located in our more densely populated areas.[3]
>   Anthony J. Celebrezze, Secretary
>   of Health, Education and Welfare
>
> Many of our big city hospitals are becoming obsolete
> and increasingly inefficient to operate.
>
> There is no more urgent need in the hospital field
> today than the modernization of these facilities.[4]
>   Luther Terry, Surgeon General

More concretely, it was stated that a study by the U. S. Public
Health Service in 1960 determined that the capital needs for hospital
modernization then amounted to $3.6 billion, with 78 percent of the
need in the category of general hospitals.[5] These figures, extra-
polated forward to the time of the Congressional hearings, indicated
that $4.6 billion were then needed for modernization and replacement
over and above the requirements for the expansion of capacity gener-
ated by increases in utilization and population.

The Congress responded by adopting the Hill-Harris Amendments
which included, for the first time, authorizations (See Table 2-1.)
specifically earmarked for modernization. These earmarked funds, in
addition to a revised set of priorities based on a newly established
set of national standards for facility evaluation[*] and an increased
weighting of the needs in dense, urban areas, led to a change in the
flow of Hill-Burton funds. In its earlier years, two-thirds of the
grants went for what was considered to be the urgent need for new
facilities; principally in rural areas. Since the 1964 amendments,

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[*]Prior to 1964 facilities were evaluated against a federal standard
for safety hazards plus individually contrived state criteria.
There was, therefore, considerable variation in evaluation standards.
The Hill-Harris amendments directed the Public Health Service to
establish a uniform and comprehensive set of criteria which is now
used by all state Hill-Burton agencies. The criteria include
measures of structural fire resistance, safety of mechanical and
electrical equipment, and functional adequacy of nursing and
special service areas.

a larger share has gone to urban areas and more than 80 percent has

been devoted to modernization and expansion of existing facilities.[6]

TABLE 2-1

Hill-Burton Program Authorizations

Fiscal Year	Total Authorization[*]	Modernization Funds[*]
1965[**]	$252.5	---
1966	265	$20
1967	275	35
1968	285	50
1969	285	55

[*]In millions of dollars

[**]Last year before Hill-Harris authorizations.

Source: Graning and Reichert, Hill-Harris Amendments, p. v.

Application of the new national standards for hospital facilities,

along with rising construction costs and the continuing progress of

obsolescence have caused an upward revision of the estimates for

needed plant modernization. In 1966 the Public Health Service

appraised the existing need at $6.8 billion and projected (See Table

2-2.) average annual increases of $400 million until 1975. To this

need for modernization, they added their estimate of $4.9 billion

for needed facility expansion to arrive at a predicted need for the

TABLE 2-2

Capital Needs for Health Facilities 1966-1975

($ Millions)

	Total	Modernization	Expansion
Backlog as of June 30, 1965	$8,457.5	$6,795.0	$1,662.5
Annual Increments			
1966	642.5	355.0	287.5
1967	655.0	362.5	292.5
1968	670.0	372.5	297.5
1969	687.5	382.5	305.0
1970	710.0	392.5	317.5
1971	732.5	402.5	330.0
1972	755.0	412.5	342.5
1973	777.5	425.0	352.5
1974	800.0	435.0	365.0
1975	822.5	447.5	375.0
Backlog plus Increments	$15,710.0	$10,782.5	$4,927.5

Source: U. S. Congress, Joint Economic Committee, Subcommittee on
Economic Progress, State and Local Public Facility Needs
and Financing, Vol. I, (Washington, D. C.: Government
Printing Office, 1966), p. 425.

Notes: Modernization estimates are based on Hill-Burton State Plans
for 1966 and an annual obsolescence rate of 3 percent. Ex-
pansion estimates assume population growth. Both moderniza-
tion and expansion have been based on costs of $25,000 per
bed extrapolated from previous Hill-Burton experience.

10 year period ending 1975 of $15.7 billion, a figure which we can now say will probably be considerably short of actual expenditures as health facility construction has exceeded $2 billion per year since 1966.

Expansion of Hospital Capacity

Allusion has already been made in Chapter I to the controversy surrounding estimates of the need for expansion of capacity. Arguments are made that given the economic difficulties of our hospital care system, the pattern of expansion followed since World War II has been irrational for the following reasons:

1. There is no real shortage of hospital beds. The occupancy rate of non-federal, short-term, general and special hospitals has been rising quite steadily since 1946 when the rate was 72.1 percent, but in 1967 it was still only 77.6 percent.[7] While there is a common belief that efficiency is not commensurate with an occupancy rate of over 80 percent, about 8 percent of the general hospitals have rates in excess of 90 percent, and many hospitals have some inpatient services which operate near full capacity during certain months of the year.[8] Klarman reports that there is a growing consensus that 85 percent is a highly desirable occupancy rate.[9] Furthermore, by extending the effective service areas of the larger existing hospitals with some coordination of modern transportation facilities, many of the localized shortages could be overcome more economically than by building new beds at an average cost of approximately $25,000.[10]

2. The unused bed capacity resulting from the relatively low occupancy rates constitute a heavy cost burden which must be borne by the sick who are the users of hospital services. A 1957 study in Ohio found that the fixed costs of maintaining a hospital bed were about 75 percent of the average costs, i.e. an unused-bed results in operating costs 75 percent as high as an occupied bed.[11] However, a more recent econometric study presents a conflicting result.

> The present study indicates that once allowance is
> made for differences in services offered, the cost
> of an available bed is the same whether or not it
> is occupied, and it also suggests that a hospital's
> expenditures are largely set according to an ex-
> pected average annual daily census plus a margin for
> peak periods, rather than being tied directly to the
> number of beds. Particularly, if this latter is
> true, then the elimination of unnecessary beds in
> itself would not lead to a material reduction in
> costs, especially as operating costs are high rela-
> tive to construction costs. Furthermore, if the
> unnecessary beds exist but are not in place, staffed,
> and otherwise ready for immediate patient use...
> expenditures for their maintenance may be small.
> Hence the savings resulting from their removal
> might be negligible. Clearly, the real cost of the
> "unnecessary" bed requires more precise definition.[12]

Regardless of the actual impact on operating costs, there is no question that the low occupancy rates result in a considerable amount of idle capital which might have been put to other purposes. Brown estimated that back in 1959 this sum amounted to $3.5 billion for general hospitals alone.[13]

3. The existence of unused facilities constitutes an incentive for the abuse of overutilization of hospital care, the most expensive form of health services. A study by Roemer[14] in 1961 indicated a rise

disproportionate with related regional data in number of admissions, patient days and Blue Cross patient days when a hospital in upstate New York increased its number of beds. Other studies have demonstrated that significant proportions of hospital admissions are unnecessary,[15] and that utilization can be reduced by institution of mechanisms such as the routine review of admissions and lengthy stays by physician staffed Utilization Committees.[16] As Somers and Somers point out, the fact of professional manpower shortages compounds the problem of overutilization by causing it to exert a negative influence on the quality of care.[17]

4. The pattern of post World War II expansion has moved us only very slowly away from a situation in which many of our general hospital beds are in small institutions (See Table 2-3) which are not able to take advantage of the economies of scale which may be possible in larger institutions. At first glance, costs per unit of service seem to be higher in large hospitals (See Table 2-4), but this is apparently because they generally have more complex services to offer. A recent study by Berry has shown that once adjustments are made for the differences in complexity of services available, it can be demonstrated that hospital services are subject to economies of scale and that a large proportion of our hospitals operate at suboptimal size.[18] These questions have been the subject of considerable discussion and a consensus has not yet been reached. Klarman believes that the hospital cost function conforms to a U-shaped curve with lowest costs resulting from operation at some yet

TABLE 2-3

Percent Distribution of Short-term, Non-Federal
Hospitals by Size: 1953 and 1965

No. of Beds Per Hospital	Hospitals		Beds	
	1953	1965	1953	1965
Under 50	44	33	12	8
50 - 199	42	45	43	35
200 - 499	13	20	38	45
500+	1	2	8	12

Source: U. S. Department of Health, Education and Welfare, A Report
to the President on Medical Care Prices (Washington, D.C.:
Government Printing Office, February 1967), p. 28.

TABLE 2-4

Average Total Cost Per Discharge: June 1967

Hospital Size (Number of Beds)	Average Total Cost Per Discharge
0 - 49	$268
50 - 74	286
75 - 99	316
100 - 149	320
150 - 199	339
200 - 299	383
300 - 399	427
400+	455

Source: American Hospital Association, Hospital Administrative
Service, Special Operational Indicators: 1964-1967,
(Chicago, American Hospital Association, 1968).

Note: Data are from samples of hospitals selected from all U. S.
hospitals.

to be determined optimal size range.[19] Ingbar and Taylor, on the

other hand, found the reverse situation in their study of Massachu-

setts hospitals.[20] They found an inverted U- shaped cost curve which

suggested a least efficient range of operation between 150 to 200

beds for the hospitals of between 30 and 330 beds which they studied.

Whatever the case may actually be with regard to economies of

scale and optimal size, it is clear that these notions are of poten-

tial significance. Berry has suggested that savings which would result

if all hospitals operated at optimal size may be as high as 30 percent

of total costs for government hospitals, 24 percent for voluntary

hospitals and 46 percent for proprietory hospitals.[21] However, even

much more modest percentage reductions would yield significant dollar

savings in an industry which incurs yearly expenses in excess of

$16 billion.

5. Estimates of increased capacity needs are generally based on

extrapolation of past and present utilization trends.* Such planning

practices tend to accept these trends as inevitable and, in fact, do

much to perpetuate them. They fail to encourage large scale rethinking

of the problems of medical care, and are favorable to only very

---

*Prior to 1964 Hill-Burton estimates of hospital bed needs were based
on a theoretical need for 4.5 acceptable beds per 1,000 population.
With the Hill-Harris amendments the beds per population ratios were
abandoned in favor of a calculation based on the following: 1. area
population projected 5 years into the future, 2. current area use
rate per 1,000 multiplied by the projected population, and 3. an occu-
pancy factor of .80 for general hospitals and .90 for long term hos-
pitals.

conservative changes, and leave possibilities such as substitution of less costly forms of care largely unexplored.

The issues raised by expansion of hospital capacity have received much attention and are of importance because of both the large initial costs and operating expenses which may be incurred by this activity. But they are only peripheral to this study. The larger emphasis here is on the obsolescence and modernization of facilities; subjects which, as earlier citations indicate, are also of potential importance as influences upon hospital costs.

Obsolescence and Modernization of Hospital Facilities

As mentioned briefly in Chapter I and the above discussion of the Hill-Harris amendments, there is a working conviction that hospital efficiency is related to the quality and relative obsolescence of the physical plant and equipment. This view is not confined to hospital spokesmen who may be thought to be simply seeking the aggrandizement of their institutions, but is found to be a rather prominent theme in the writings of those who have commented on this aspect of the hospital problem. The following quotation by Hayes illustrates what seems to be the consensus view of the general relationship.

> In all departments of the hospital, modern techniques
> may be applied most economically where the facilities
> are designed to meet the needs of the service program.
> Many existing hospital plants were not designed for
> many of the services they are now offering. Cost of

> effective care will be relatively high if the physi-
> cal plant has excessively large nursing units, in-
> sufficiently or poorly arranged space for ancillary
> service departments or for storage, inadequate plumb-
> ing or electrical installations, or lack of function-
> al correlation in the location of the various depart-
> ments and units. Additional capital invested in re-
> modelling will often reduce costs to an extent which
> will more than compensate for the resulting increase
> in fixed charges.[22]

A frame of reference in time for this problem is provided by the Hospi-

tal Review and Planning Council of Southern New York which, after ex-

tensive studies of facility quality, reached the following conclusion.

> Hospitals built early in the twentieth century were
> still able to carry out their programs satisfactorily
> as late as 1940. Since then, however, the dependence
> of medicine -- especially hospital based medicine --
> on sophisticated equipment and highly skilled per-
> sonnel has increased enormously. Our hospitals --
> even many of those built since World War II -- were
> not designed to house the facilities, the scientists,
> the technicians now required.[23]

The same authors warn us that the solution to the problem of

obsolescence is not entirely straightforward. They point out that

hospitals have typically attempted to periodically renew themselves,

and that very few continue to function long in their facilities as

originally built. However, in their opinion, "...these 'modernizations'

are seen to have been piecemeal, shortsighted attempts that solved few

problems, complicated others, and made it virtually impossible to

adapt the plant to subsequent needs."[24] Relatively small, incremental

improvements, it is argued, do not have a major impact on the

problem. Attributing the current state to a general shortage of

capital funds, the Council argued for an expenditure of $705 million

to update the general hospital facilities in New York alone.[25]

A number of economists active on health care problems have also
supported the view that obsolete facilities lead to inefficiency.
Dunlop, citing the relatively high proportion of total costs devoted
to payrolls, the rapid pace of medical technology, and the aging
stock of facilities has argued for a major effort to substitute
capital for labor in the production of hospital services.[26] Ingbar
and Taylor have suggested that facility quality and efficiency are
positively related,[27] and even such cautious observers as Somers
and Somers, who attribute some of the need estimates to perfection-
ism and warn us to "distinguish what is needed from what is
desired,"[28] report that,

> The vanguard hospitals are learning that efficiency
> and productivity in the mursing service, as in any
> other service, is far less a matter of hard work on
> the part of the individual employee than of proper
> engineering of the job, advanced mechanical equip-
> ment for performing the job, size and flexibility
> of the institution, layout of work place, and
> relationship of jobs with one another.[29]

Recent experience, including aid to hospital modernization under
the Hill-Harris amendments, has not altered the consensus on these
issues, except, perhaps, to strengthen it. The following from a
May, 1969 article by Senator Jacob K. Javits will by now sound
redundant but it is worth quoting at length because it is part of
the explanation for his proposed Hospital Modernization and Improve-
ment Act of 1969 (S.-269) which would authorize federally guaranteed
and subsidized loans for modernization of up to $1.2 billion over a
three year period.

And yet another phenomenon of change must be cited
that has made more difficult the task of achieving
better care at lower cost -- the slow and steady
aging process, which today has brought one third
of this nation's hospitals into the obsolete, out-
moded and outdated column.

The burden of these deteriorating facilities is
borne by the patient as well as by the health-
care team and stands as a principal barrier to
innovation, to development of alternatives to in-
tensive hospital care, to optimum use of skilled,
scarce and expensive personnel, to lower costs
and to delivery of the best possible health ser-
vice that medical knowledge can devise. This
situation has not crept silently upon us, but has
for the past several years been the subject of a
series of public pronouncements and reports suffi-
cient to stock a library shelf.

If we continue to postpone this needed hospital
modernization, the nation could well face a major
crisis in the delivery of health care, a crisis
measured in economic as well as social dimensions.[30]

Specific Areas for Improvement

A modern hospital is a complex of numerous specialized and

distinct services which vary considerably in their characteristics

and, presumably, in their ability to benefit in efficiency from

an investment in modern facilities and equipment. It is of interest,

therefore, to see which areas of hospital operation receive the most

attention in the literature and which are thought to have the

greatest potential for improvement.

The relatively large share of total hospital costs devoted to

salaries has prompted many to conclude that it is a substitution of

capital for labor which promises to be most effective in holding

back the rising costs. As nursing personnel represent about 50 per-

cent of all payroll costs[31] it is not surprising to find that

considerable attention has been devoted to efficient design of the

nurses' work place, the patient ward. Interest in the subject dates

back at least a century to the concerns of Florence Nightingale who,

in her efforts to separate patients with sufficient space to curtail

airborne contamination, also strove for reasonable compactness of

overall ward design to avoid undue travel by the staff.[32] In so

doing she anticipated much of the work of more recent investigators.

Current estimates are that nursing personnel spend 10-20 percent of

their time travelling within their wards,[33] and studies of nurse

traffic patterns which aim to reduce this figure are still common.

The influential studies conducted by the research staff of the

Nuffield Provincial Hospitals Trust in the early 1950's recognized

many relevant factors in ward design but emphasized internal traffic

as an important factor. They found that traffic patterns and

volumes varied considerably among the six hospitals they studied

and developed a comparative measure of compactness based on the

number of beds per 10 linear feet of corridor.[34] Pelletier and

Thompson, working at Yale in 1960, studied the flow of traffic

on links between work points within the ward and developed a

system which weighted the links by their importance or frequency

of use.[35] When wards of different hospital services were compared,

little significant variation was found in the weighting and the

authors concluded that their model was generalizable. Freeman has
analyzed nursing traffic and found that the number of trips to a
given patient room depended more upon the severity of illness than
on room location.[36] In addition to this encouraging result he found
that in an analysis of six nursing unit designs modest reductions
in operating expenses* could be derived from using the best as
opposed to the worst design. A more ambitious effort using
techniques suggested by modern traffic system analysis was made by
TRW Systems Group for the design of a new 1500 bed hospital in
Alberta.[37] Their analysis assigned different weights or costs to
trips according to the trip purpose and role of the traveller.
Movement of a doctor to an emergency, for instance, was valued
50 times higher than that of a visitor to a patient. The annual
savings per available bed day which TRW claims will result from
their efficient design are roughly of the same magnitude ($0.73)
as those suggested by Freeman; multiplied over the large number of
beds, the savings amount to about $400,000 per year.

Most recently, a team of researchers made comparisons of
nursing unit designs in the Rochester (Minn.) Methodist Hospital
which had been built in 1966 with seven different unit designs in
order to study the differences. Three units, radial, straight

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*For a hospital of about 100 beds, he found a possible saving of
approximately $0.55 per available bed day using Georgia costs.

double corridor and straight single corridor, were studied and the
radial performed significantly better according to the following
measures of nursing activity: distance traveled, travel time,
nursing time with patients, absenteeism, and staff attitudes.[38]

Hospital traffic studies have not been limited only to nurses.
The movements of food, laundry, drugs, and patients themselves
have been examined and there is a growing conviction that the labor
intensive modes used to transport them can be abandoned in favor
of automated systems such as those used by other industries. A
group at Tufts, writing in 1965, felt that there was a potential to
save up to one-third of all staff time by adoption of such methods.[39]
And their adoption at the Holy Cross Hospital in San Fernando,
California is credited in large part with achieving their very low
personnel to patient ratio of 1.7 to 1 at a time when the national
average was 2.5 to 1.[40]

The movement and processing of information has been noted to
absorb up to 60 percent of nurses' time and 30 percent of physicians'
time,[41] and a good deal of attention has been given to applying
modern electronic data processing as a means to save manpower.
Routine accounting functions such as payroll, which are very similar
to analogous operations in industry, have frequently been converted
to automatic processing. Certain information functions of clinical
laboratories as well as other isolated functions have also been
automated. Patient medical data as traditionally recorded on

medical records, however, has so far resisted computerization by virtue of its complexity and volume.

An area in which automatic equipment has made notable progress is that of certain clinical blood tests. Dahlgren reported that at an automated laboratory set up by six hospitals with a total of 1200 beds, a series of 12 standard blood chemistry tests was being performed at a charge of $15 where a $75 charge would be necessary if manual techniques were used.[42]

Other approaches to hospital efficiency relating to facilities are those which concentrate on reduction of extra days of hospitalization necessitated by post-operative infection. Llewelyn-Davies estimates that there are about one million such hospital days after the one and one-half million operations in British hospitals each year.[43] This problem of hospital infection is held to be at least partially subject to physical environmental controls. The handling and routing of soiled laundry, waste and other disposables, techniques of ventilation and air filtration, size and volume of patient rooms, and accessibility of hand-washing facilities are all felt to be relevant factors.

The Study of Obsolescence

The gaps which exist between the normative conception of a hospital as a facility which accommodates the evolving functions of hospital, medical care and allows them to be carried out with

appropriate levels of efficiency, safety, dignity and amenity
constitute obsolescence. It is obviously a relative concept. By
virtue of their variety and complexity, hospital functions are
unlikely to be either matched and supported perfectly, or hindered
completely by any facility. Because of the time lag of some three
to ten years between the initial planning and completion of any
hospital construction project, even the newest facility will be
found wanting in some ways by those involved in performing unantici-
pated functions. On the other hand, the adaptability of most
functions is such that they can be carried out in some form in even
highly unsuitable surroundings.

Measurement of hospital obsolescence is, therefore, a complex
matter involving the weighting and assessment of a large number of
factors. Writing in 1958, one commentator on this problem concluded
that fine distinctions on this matter were beyond our capabilities
and settled for the seemingly conservative assumption that once
a facility was 50 years old it should be replaced.[44] For accounting
purposes, the American Hospital Association has estimated the range
of useful economic lives of hospitals buildings as between 15 and
40 years depending upon use and type construction, fixed equipment
8 to 25 years and major movable equipment 4 to 20 years.[45]

Such rule of thumb estimates are of limited usefulness for the
purposes of making the difficult decisions concerning modernization
or replacement of specific facilities. Since the inception of the
Hill-Burton program and especially since 1964, when large scale

expenditure for these activities became a matter of national concern, several large scale attempts have been made to make realistic assessments on an institution by institution basis of relative obsolescence and need for capital improvements. Hill-Burton regulations provided for the categorization of existing facilities in terms of conforming and nonconforming beds. Criteria for this dichotomization included a federal standard for safety hazards, but were otherwise developed by the individual state Hill-Burton agencies. Each existing facility was surveyed* and the resulting inventories of acceptable beds were compared with the standard of an adequate bed supply, 4.5 beds per 1,000 population, to determine local and national facility needs. There was substantial variation among state criteria,[46] however, and comparability of estimates was a conceptual if not a practical problem. Nevertheless, there were the criteria by which in 1948 41 percent of our existing general hospital beds were classed as unacceptable, and in 1964 $4.6 billion were estimated to be needed for facility modernization.

In 1963, the Hospital Review and Planning Council of Southern New York attempted a more elaborate analysis of hospital obsolescence in its area. Their survey was based on an extensive list of criteria which incorporated measures of the hospital's level of sophistication (medical center, teaching or community hospital),

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*Surveys excluded federal hospitals.

type and volume of services, staffing, adequacy of facilities for

services performed, and type and condition of construction and

equipment. The method involved detailed inspection and evaluation

by members of a team which included two senior Council members

(including one physician), two men experienced in structural and

mechanical evaluation of buildings, two architects, one mechanical

engineer and one electrical engineer. They sought to judge the

adequacy of hospital facilities "...in terms of the extent to which

what is being done can be done with safety to patients and personnel,

with efficiency, and with a decent regard for human dignity.[47]

It should be emphasized that it was not the hospital care which was

being observed and judged, but the facilities themselves in relation

to a set of normative standards. In the words of the study's co-

directors:

> Can work of high quality be done in this facility?
> Note that the question is not whether or not work
> of high quality is being done: such a question is
> outside the purview of an appraisal of physical
> facilities, because to answer it would require
> decisions on the quality of medical care and ad-
> ministration.
>
> Obviously, a department in which there are too few
> diagnostic rooms to accommodate the load is inade-
> quate, because such a facility results in short-
> cuts that may result in poor work.[48]

Results of this study of 58 hospitals were projected to cover

all 130 general hospitals in New York City. The findings were that

modernization needs (including complete replacement of 47 institutions)

amounted to $705 millions.[49]

In 1964, as authorized by the Hill-Harris amendments, the
Public Health Service prepared a complete set of uniform national
criteria for use by the state Hill-Burton agencies. The following
outline lists the factors included.[50]

    A. Fire resistance of construction: if a building does
       not conform to this standard, it is not considered further.

    B. Safety standards:

        Non-fire-resistive portions of structure

        Fire resistance of finish materials

        Adequacy of exits

        Fire resistive enclosures of vertical shafts

        Area subdivision with fire and smoke screens

        Door construction

        Fire alarm system

        Condition of electrical service and equipment

    C. Nursing units:

        Room size

        Nurse call system

        Rooms more than 32" below grade

        Lack of operable exterior window

        Lack of direct access to corridor

        Corridor less than 7' wide

        Distance from nurse's station

        Adequacy of toilet and hand-washing facilities

        Elevator connections between service floors

D. Service departments: seven departments studied

    Location within hospital

    Fire resistance of construction

    Safety

    Presence of special facilities

    If total service departments are judged to be deficient,
then one-half of all remaining* beds are counted as
non-conforming

E. Optional state criteria

The evaluations are conducted on-site by teams to include an
architect or engineer and a hospital administrator or licensing
official. As with the New York appraisal, the facilities are
compared to norms for what a hospital facility should be, and no
attempt is made to observe and assess actual operations. Application
of the standards in 1967 caused 287,557 general hospital beds, or
37 percent of those existing, to be classified as non-conforming.
They are also the basis of current official Public Health Service
estimates of a $10.7 billion backlog of need for hospital moderniza-
tion.[51]

---

*Remaining beds are those which have not been judged unacceptable
under standards A, B and C.

The prominent and rigid standards for fire resistance of hospital construction are a common feature of all the facility appraisal schemes discussed. The following quotation by the Hospital Review and Planning Council of Southern New York typifies the strong consensus on this matter.

> Fire-resistive construction is the sine qua non of fire safety in hospitals. Every department into which patients must go must be considered totally inadequate if it is in a non-fire-resistive building.[52]

The extent to which this attitude affects hospital appraisal is indicated in Table 2-5. Over one-quarter of the non-conforming beds were disqualified by standard A alone, and many of those listed under B and D are also there because of this factor.

TABLE 2-5

Non-Conforming General Hospital Beds: January 1, 1967

	Number	Percent
Total number of non-conforming beds	237,557	100.0
Breakdown by Criteria		
A: Fire-resistivity	74,163	25.8
B: Safety	108,867	37.8
C: Nursing Units	57,145	19.9
D: Service Departments	46,080	16.0
E: State Standards	1,302	0.5

Source: U. S. Department of Health, Education and Welfare, Public Health Service, Hill-Burton State Plan Data, Public Health Service Pub. No. 930-F-2 (Washington, D.C.: Government Printing Office, 1968).

Investigation of the literature on fire in hospitals leads

this writer to question the heavy emphasis placed upon this criteria.

The National Fire Protection Association, which is the well estab-

lished authority in these matters, estimates* that in 1967 there were

2.4 million fires in the U. S. which were responsible for approximately

12,200 deaths and $2.1 billion in property damage.[53] They also

report that for a sample of 14,587 fires occurring in the period

1930-1957, 220 fires, or 1.5 percent of the total occurred in

hospitals, nursing homes, prisons and similar institutions. These

institutional fires were responsible for 761 deaths or 2.5 percent

of the total of 30,085.[54] Scaling these figures up to the 1967

frequencies, we should expect an incidence of approximately 3600

fires and 305 fire related deaths in institutions. The NFPA has esti-

mated that there were 4500 hospital** fires in 1967[55] but has not

estimated fatalities. This estimate of 1.9 percent of the total

fires in 1967, while higher than the previously mentioned sample,

would indicate, does help to establish the order of magnitude of the

problem. If the figures are at all indicative of reality, the

annual death toll due to hospital fires is probably in the range

of 250 to 500.

---

*These estimates are based upon the reports of city and state fire
marshalls in areas including 27 percent of the U. S. population.
**Excludes nursing homes, prisons, etc.

Information regarding another sample of reported fires throws

additional light on the subject. The NFPA analyzed the type of

construction involved in 300 hospital fires and found that one-third

of the fires occurred in buildings of fire-resistive construction.[56]

While we do not know the proportion of hospital buildings which are

fire-resistive, and cannot deduce the probability of a fire occurring

in such a structure, we can have significant doubt about the effect-

iveness in preventing fires of a strategy based on fire-resistive

construction. Such doubt may be increased when one reads that, "In

most of the fatal fires in hospitals one person is killed. For the

most part, these single-fatality fires are caused by smoking in bed

or by an accident in an oxygen tent or by an explosion of anesthetic

in an operating room."[57] In such cases spreading of the fire is not

the issue and the type of construction would seem to be relatively

unimportant. Even the NFPA itself downgrades the importance of

fire-resistive construction in favor of emphasizing sprinkler

protection. They state that their records indicate that the number

of deaths occurring in buildings protected by sprinklers is almost

negligible.[58]

The evidence is certainly sketchy, but the problem of potential

loss of life due to inadequate fire-resistivity of hospital construc-

tion would seem to be a relatively modest one. A simple comparison

helps to put it into perspective. In 1966 the Department of Health,

Education and Welfare studied the potential costs and benefits of

14 proposed disease control programs. Their analysis included

estimates of the costs per death averted; these ranged from $87 for
an automobile seat belt use program to over $40,000 for programs
such as head and neck cancer control, and emergency medical services.[59]
Prevention of deaths from fires by replacing non-fire-resistive
hospital buildings would be far more costly per death averted. If
one makes the very generous estimates that of the stated $10.7 billion
need for modernization only $1 billion would be for fire safety (aside
from efficiency and quality), and that this expenditure would reduce
deaths by one-half (say 200 per year), then, if we count our initial
$1 billion investment as equivalent (at 6 percent) to an income
stream of $60 million per year, the cost per death averted would be
$300,000.

III A STUDY OF THE RELATIONSHIP OF EFFICIENCY
TO OBSOLESCENCE - PART I

The Hypotheses

The review of the literature outlined in Chapters I and II has

established that there are commonly held beliefs linking the efficiency

of hospital services with state of the facilities in which they are

housed. Furthermore, these beliefs are the basis or at least the

rationalization for a significant amount of federally aided hospital

construction activity. They may be stated as a hypothesis in the

following form: There is a relationship between hospital services

and the qualities of the physical plant and equipment used in their

production, such that obsolescence of those facilities leads to

inefficiency of production.

This chapter, and those that follow, will attempt to substantiate

this research hypothesis. For methodological reasons it is the null

hypothesis which will actually be tested. It is as follows: There

is no relationship between the efficiency of production of hospital

services and the relative obsolescence of hospital facilities and

equipment.

The Subject Hospitals

This study will test the null hypothesis by means of statistical

correlation analysis of data on the efficiency and obsolescence of

68 voluntary, short-term, general hospitals in Massachusetts for the

year 1967. This sample, drawn from the total of 202 Massachusetts hospitals registered by the American Hospital Association,[1] was selected for its relative homogeneity and excludes hospitals of the following types: medical school affiliates with major[*] teaching programs, government run (federal, state and local), church related or operated, special service (psychiatric, maternity, children's etc.) and long-term care.[**] The basic group from which they are drawn, non-governmental, non-profit, short-term, general and special hospitals, is the most important in terms of its use by the public. Nationally, it represents 80 percent of all hospitals, 47 percent of all beds and 92 percent of all admissions. The figures for Massachusetts are comparable as seen in Table 3-1.

Data Used in this Study

Both the variables, obsolescence and efficiency, have the difficulty that there are no intuitively obvious measures which describe their levels in a completely satisfying way. For obsolescence, several alternative measures were considered.

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[*]Some hospitals with a medical school affiliation, but with only a relatively minor teaching program, have been included in the sample.

[**]At a long-term care hospital, over 50 percent of the patients admitted stay over 30 days.

TABLE 3-1

Characteristics of Non-Governmental, Non-Profit, Short-Term, General and Special Hospitals as a Percent of All Hospitals in the U. S. and Massachusetts: 1967.

Percent of all:	U.S.	Mass.
Hospitals	80	70
Beds	47	39
Admissions	92	93
Total Hospital Expense	74	71

Source: American Hospital Association, "The Nation's Hospitals: A Statistical Profile," Hospitals, Guide Issue, Part II, 42:437-473, August 1, 1968.

1. Measurement of the ages and floor areas of hospital buildings. Hospitals are usually composed of numerous structures of varying age, but a composite age could be computed. Data on age of structure is available from the records of a survey conducted in 1965 for the Massachusetts Department of Public Health as part of its appraisal of existing facilities using the uniform evaluation standards developed by the U. S. Public Health Service. Building floor areas are not available directly, but can be derived from scaled site plans available from the same source.

2. The proportion of non-conforming beds (as determined according to the uniform U. S. P. H. S. standards) to total bed capacity.

3. The present value of capital per available bed invested in buildings and equipment as recorded on Form HCF 400, the mandatory reporting form of the Bureau of Hospital Costs and Finances of the Massachusetts Commission on Administration and Finance. This is the historical cost of the plant and equipment less depreciation. Thus an unrenovated building which is still in use beyond its theoretical economic life would have a present value of zero, while a newly erected building would be valued at its full construction cost.

The first of these measures, composite age, has the difficulty that it fails to consider modernizations and new equipment which could keep a nominally old building up-to-date; it was, therefore, abandoned. The second, proportion of non-conforming beds, was obviously designed to measure obsolescence for purpose of Hill-Burton planning. It offers the advantage of being based upon on-site judgments by trained investigators, but the study of the appraisal criteria and the approximately modal distribution of values obtained (See Figure 3-1a) raise some skepticism about their usefullness. The evaluative rules are somewhat arbitrary in their disqualification of non-fire-resistive construction and 50 percent of otherwise acceptable beds where service facilities are non-conforming.

Present value of capital per (available) bed, the third possible measure, is admittedly blind to the actual physical qualities and modernity of the capital equipment, and it is certainly possible that

a poorly designed new building could be less suitable for modern
functions than a well designed new one, but, by and large, we would
expect that even mediocre designs of the 1960's would be able to
more appropriately house the new and unanticipated services of today
than the best of their counterparts practicing at the beginning of
the century. Value of capital does fully weight renovations and
equipment, and with its financial orientation, closely parallels the
substitution of capital for labor arguments which are a prominent
part of current thinking. Unlike the proportion of non-conforming
beds, its distribution is approximately normal (See Figure 3-1b)
and has a range of values between $2,100 and $31,500. Buildings,
fixed equipment and major movable equipment are included in the values.

Both the proportion of non-conforming beds and the present
value of capital per bed were used in the analysis. Present value
of capital, with its heavy weighting of recently acquired capital
equipment, seems to match the conception of a rapidly progressing
medical technology obsolescing its quarters. It also would seem to be
a gauge of the value placed upon facilities and equipment by
hospital administrators and trustees. The proportion of non-
conformity, on the other hand, de-emphasizes actual age in favor of
a series of quantitative and qualitative standards which are assumed
to be the requisites for efficiently delivered, quality care. It
replaces the automatic depreciation mechanism with guided judgments
of experienced investigators. Because of this complementarity to
the value of capital, and its great importance for federal program

FIGURE 3 – 1a

Frequency Distribution of Present Value of Capital/Bed

$ 0 - 3,999	
4,000- 7,999	
8,000-11,999	
12,000-15,999	
16,000-19,999	
20,000-23,999	
24,000 +	
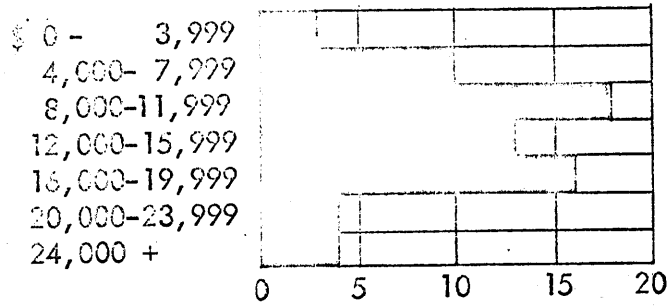
FIGURE 3 – 1b

Frequency Distribution of Nonconforming Beds/ Licensed
Bed Capacity

0.00-0.09	
0.10-0.19	
0.20-0.29	
0.30-0.39	
0.40-0.49	
0.50-0.59	
0.60-0.69	
0.70-0.79	
0.80-0.89	
0.90-1.00	
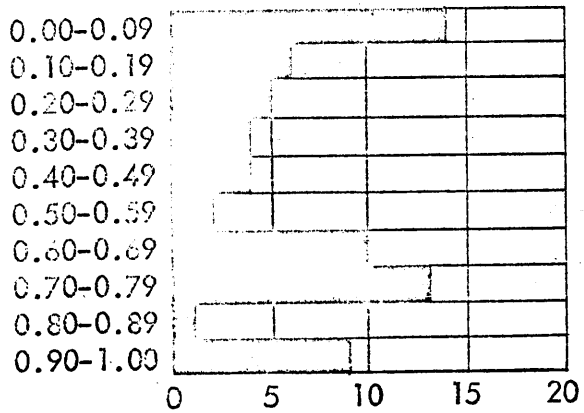
planning, the proportion of non-conformity has been maintained as
an alternate measure of obsolescence.

Both measures of obsolescence are ratios with beds in the
denominator. In the case of non-conformity it seemed appropriate to
use the bed capacity as licensed by the Massachusetts Department of
Public Health. For purposes of value of capital, the choice did not
seem so straightforward. Four conflicting estimates of hospital bed
count were available:

1. Bed capacity as licensed by the Massachusetts Department of
   Public Health;

2. Total bed capacity as reported by the on-site survey teams
   hired by the Hospital Facilities Division of the Massachu-
   setts Department of Public Health for Hill-Burton planning
   purposes;

3. Number of beds as reported to the American Hospital Associa-
   tion by the hospitals;

4. Number of beds as reported by the hospitals on form HCF 400.

While all the estimates were for the same period (1 and 2 for
the year ending June 30, 1967; 3 and 4 for the year ending September
30, 1967), there was considerable variation. Estimates 3 and 4 tended
to agree very closely with only occasional differences of one or two
beds, but estimates 1 and 2 differed markedly with one another and
with 3 and 4. The bed count reported on HCF 400 was taken to be the
most reasonable estimate of the number of beds actually available

for service and was used as the deflator for value of capital.

Efficiency is at least as difficult to measure as obsolescence. Because of its complexity, a hospital is producing many different outputs simultaneously. Efficiency in the production of surgical operations may have little relation to efficiency in the dietary or radiology departments, and any aggregate measure is bound to mask what may be significant departmental differences. An additional problem is that of quality differences among institutions. Surgical procedures, x-ray examinations, etc., may be better at some hospitals than others. While in the sample selection homogeneity was a criteria, and major teaching hospitals on the one hand, and those not accredited by the Joint Commission on Hospital Accreditation[*] on the other, have all been screened out, there are certain to be qualitative differences in services. An additional effort to deal with this issue is described in the following section on adjustments,

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[*]The Joint Commission on Accreditation of Hospitals (JCAH) was founded in 1952 by the American Medical Association, American Hospital Association, American College of Physicians and the College of Surgeons. It has a lengthy list of requirements regarding both facilities and services and conducts site inspections every three years. In 1967, 67 percent of all non-federal, short-term hospitals (with 90 percent of the beds in that category) which were registered with the A.H.A. were accredited by the JCAH. Of non-federal, long-term hospitals, only 55 percent of those registered (with 59 percent of the beds) were accredited.[2]

but the problem remains and we must fall back upon a position similar

to that taken by Feldstein in his recent study, Economic Analysis

for Health Service Efficiency:

> Unfortunately, until clinicians develop a useful
> measure of the quality of patient care we cannot
> distinguish between the effects of efficiency
> and quality. It may be best to assume that the
> medical care in large acute hospitals is gener-
> ally of the same standard and that quality differ-
> ences are limited to the hospitals' hotel activi-
> ties.[3]

The measures chosen are total expense (to the hospital) per

patient day and per admission. Here there is the difficulty that

patient days and admissions, whether they be on the surgical service,

the medical service or the pediatric service, are taken together as

approximately equal quantities. Saathoff and Kurtz have attempted

to correct for this by devising a weighting system which attempts

to create comparability among units of output in the various de-

partments.[4] Their method has not been replicated here because

(1) sufficient data on departmental activity was not available and

(2) the method has not been sufficiently convincing to induce

subsequent hospital cost analysts to repeat it.[5]

Costs per patient day and per admission remain the prevailing

measures of efficiency, but there are also disputes as to their

relative usefulness. Macaulay and Llewelyn-Davies[6] and Feldstein[7]

prefer admissions as a basis because it recognizes the possibility

of a trade-off between intensity of therapeutic activity, with its

probable relation to cost per day, and length of stay. A high

cost per patient day, they argue, if associated with a relatively low cost per admission, would mean greater rather than less efficiency. Despite this seemingly persuasive argument, costs per patient day are still used and, in fact, Ingbar and Taylor[8] found that for their study of Massachusetts hospitals it made little difference which was used as the unit of output.

Adjustment I: Weighted Days

Form HCF 400, in its calculation of costs per patient day, incorporates a weighting system which attempts to equalize the effects on per diem cost of the presence of different proportions of private, semi-private and ward accommodations. The studies of the Bureau of Hospital Costs and Finances indicate that patient days on a ward cost 90 percent and those in private accommodations 115 percent of the cost of semi-private accommodations.[9] The number of actual patient days for each accommodation is therefore weighted by an appropriate factor and combined to form a single measure: weighted days.

It may be argued that ward service is a relatively efficient mode of service and that its effects should not be cancelled by such an adjustment. However, the choice among these service types is effectively being removed from the hands of hospitals by the wide-spread and growing public aversion to open wards and the ability of even the poor to command semi-private accommodations with the help

of programs such as Medicare and Medicaid. Abandonment of the open

ward seems to have been a societal decision which a hospital resists

at the cost of having additional unused facilities. It is because

of this societal norm that weighted patient days has been adopted

as a measure to discount the effects of differing service types.

As it turned out, because of the relative uniformity among the sample

hospitals, the differences in proportions of the three service types

were not great and the amount of the correction was always small.

Adjustment II: Complexity of Services

It is a characteristic of general hospitals that they do not all

offer the same types of services. There are a series of 16 special

services and facilities (including pathology laboratory, dental

facilities, physical therapy, diagnostic x-ray, coronary care unit,

etc.) whose presence was reported by the A.H.A. in registered hospi-

tals for 1967. These are services in addition to the basic require-

ments including six beds, safe and sanitary facilities, staffing by

doctors and nurses, staff organization, medical records, surgical

or obstetrical services, diagnostic x-ray and clinical laboratory

services, which are necessary for registration.

Berry,[10] in a study of costs in over 6,000 short-term hospitals

aimed at exploring economies of scale made use of these special

service listings to form subgroups of hospitals which had the

identical array of services. At the time of his study 28 separate

services were enumerated by the A.H.A., and the probability for any one combination of services was exceedingly small. Nevertheless 40 groups of hospitals ranging in size from 10 to 92 hospitals were found. Within these groups, he argued, hospital outputs could be considered relatively homogenous, or at least much more so than within the larger designation of short-term hospitals. This seemed particularly appropriate for a cost analysis as it is the presence of many modern technological advances, the bases for many of the specially enumerated services, which is felt to be an important upward force on costs. By grouping hospitals so that the complexity of their product was comparable, Berry was able to penetrate the first appearance of the data in which large hospitals appear to be more costly than smaller ones, and show that economies of scale did exist.

The explicit claim for the value of this procedure is that it deals with the variations in complexity of hospital service, but it also is an approach to differences in quality. Current conceptions of quality in hospital care are more dependent upon the appropriate use of the highly sophisticated modern medical technologies than on factors such as physical comforts or even the attentiveness of nursing and medical staffs. The presence and skilled use of these technologies are probably linked to the presence of pathologists, therapeutic radiology, physical therapy, coronary care and the other special services. While it cannot be said that such complexity of service groupings combine hospitals of equal

quality, they do at least begin to make useful distinctions in that direction.

More recent work by Berry[11] on the special services found in short-term hospitals provided a basis from which a similar method could be developed for the much smaller sample used in this study. He found patterns in the expansion of hospital services and identified four clusters or types of services which hospitals tend to acquire sequentially.

1. A group of five basic services which seem to be acquired before all others:

    a. Clinical laboratory

    b. Emergency department

    c. Operating room

    d. Diagnostic x-ray

    e. Delivery room

2. A group of five services primarily intended to improve the quality of the basic services rather than to increase the quantity or range of types of cases which could be handled:

    a. Blood bank

    b. Pathology laboratory

    c. Pharmacy

    d. Premature nursery

    e. Post-operative recovery room

3. A group of nine "complexity expanding" services aimed at
    increasing the range of conditions which can be treated:

      a.   Electroencephalography

      b.   Dental facilities

      c.   Physical therapy

      d.   Intensive care unit

      e.   Therapeutic x-ray

      f.   Radioactive isotope

      g.   Psychiatric inpatient

      h.   Cobalt therapy

      i.   Radium therapy

4. Lastly, outpatient services and services whose acquisition
    transforms the institution from a primarily acute care
    hospital to a community medical center:

      a.   Occupational therapy

      b.   Outpatient department

      c.   Home care

      d.   Social work department

      e.   Rehabilitation unit

      f.   Family planning unit

      g.   Hospital auxiliary

      h.   Chaplaincy

      i.   Chapel

      j.   Routine x-ray

      k.   Routine blood sugar

Each of the 68 hospitals in this study were assigned to a
service group, characterized by one of these four stages of service
development. Table 3-2 lists tne 16 services enumerated for 1967
subdivided into four groups comparable to those found by Berry as
well as the assignment rules which were used to distribute the
hospitals.

Table 3-2

Groupings for 1967 Services and Assignment Rules

Service Group	Assignment Rule
1. Basic Services a. Emergency ward	Since all registered hospitals must have clinical laboratory, surgery, or obstetrics and diagnostic x-ray, even a hospital without an emergency ward would qualify for Group 1

2. Quality Enhancing Services
   a. Pathology lab with pathologist
   b. Pharmacy with registered pharmacist
   c. Premature nursery
   d. Post-operative recovery room
	A hospital with any three of these services qualifies for Group 2.

3. Complexity Expanding Services
   a. Dental facilities
   b. Physical therapy
   c. Psychiatric inpatient unit
   d. Supervoltage x-ray therapy
   e. Coronary care unit
	Hospital must qualify for Group 2 and have any three of these services, or have two of these services and at least three from Group 4.

4. Community Services
   a. Occupational therapy
   b. Outpatient department
   c. Inpatient rehabilitation unit
   d. Social work department
   e. Home care program
   f. Hospital auxiliary
	Hospital must qualify for Group 3 and have any four of these services.

Application of this assignment process to the 68 sample hospitals showed a pattern of service occurrence which was consistent with that found by Berry. With the exception of the hospital auxiliary, which is almost universal among the sample hospitals, the frequency distribution of the services as shown in Table 3-3 corresponds quite well with the assumption about sequences of their acquisition.

The relation of service group to hospital size is also roughly consistent with Berry's finding that the services are acquired as the hospital grows in size. As Table 3-4 indicates, Group 4 hospitals seem to be an exception to this pattern, but the large standard deviation of the mean number of beds and the small size of Group 4 make this finding less certain.

Table 3-4 also reinforces the value of analyzing costs in terms of costs per admission. The cost per patient day in the basic service hospitals (Group 1) is less than that incurred in hospitals with more services. However, their cost per admission, i.e. per total hospital stay, does not seem to be less and it would be unwarranted to conclude that they are more efficient as producers of hospital care.

TABLE 3-3

Frequency Distribution of Special Services
for the 68 Sample Hospitals

Service Group Association	Service	Rank Order	Number of Occurrences
4	Hospital auxiliary	1	66
1	Emergency ward	2	65
2	Post-operative recovery	3	60
2	Pharmacy	4	60
2	Pathology laboratory	5	59
3	Physical therapy	6	47
2	Premature nursery	7	41
4	Outpatient department	8	39
3	Dental facility	9	34
4	Social work department	10	30
3	Coronary care unit	11	23
3	Supervoltage x-ray therapy	12	10
4	Occupational therapy	13	9
4	Home care	14	9
4	Rehabilitation inpatient unit	15	4
3	Psychiatric inpatient unit	16	2

Source: American Hospital Association, "Registered Hospitals,"
Hospitals Guide Issue, Part II, 42:   103-110, August 1,
1968.

Note: Three hospitals did not report their services for this year
and data from the previous Guide Issue of Hospitals was used
in these cases. This seemed a reliable procedure as none of
the three reported an increase in number of beds, a change
which would have signalled a construction project and possi-
ble service expansion.

TABLE 3-4

Selected Characteristics of Hospital Service Groups

Service Group	Number of Hospitals	Mean No. of Beds	Mean Value of Capital/ Bed	Mean Nonconforming Beds/Licensed Bed Capacity	Mean Adjusted Cost/ Patient Day	Mean Adjusted Cost/ Admission
1. Basic Services	9	66 (15)	$8,366 (3,783)	0.46 (0.37)	$41.29 (4.16)	$379.88 (66.23)
2. Quality Enhancing Services	37	139 (60)	14,886 (6,390)	0.48 (0.35)	47.04 (6.05)	379.02 (61.04)
3. Complexity Expanding Services	16	245 (64)	13,350 (4,674)	0.51 (0.28)	47.74 (7.23)	440.00 (120.72)
4. Community Services	6	236 (137)	10,966 (3,441)	0.59 (0.38)	44.28 (1.97)	369.16 (52.34)

Note: Figures in parentheses ( ) are standard deviations.

Adjustment III: Area Wage Differentials

The 68 hospitals in this study are located in all parts of the
state. Differences among the local economies of the state result
in variations in the costs of living and the prevailing wage levels.
In order to be able to make more valid comparisons of the costs of
hospitals in different geographic areas, an adjustment was made to
all cost figures in an attempt to neutralize the wage differential
effect.

Two approaches to this adjustment were considered. The first
utilized data on total payroll costs and total number of employees[12]
(in terms of full time equivalents) in order to compute an average
annual wage and, then, a correction factor. The second approach
was based on information contained in a detailed wage survey
conducted by the Massachusetts Hospital Association. This survey
provided the minimum (starting) wage and maximum wage actually being
paid by each hospital in a large sample drawn from all parts of
the state for each of some 60 job categories. The starting wage
for the one most important job category, general staff nurse, was
selected as the basis of comparison as it was felt that because
of the variations in mix of staff positions in different hospitals
it would be very difficult to derive a composite index from the
data for many job categories. Maximum wages were not used because
they would in fact be paid to only a very small number of nurses
due to the very short average tenure in that profession. The
reporting hospitals (48 from the sample of 68) were arranged in

groups according to their membership in one of the five Massachusetts area hospital councils (as was also done for the first approach) for purposes of computing averages and comparative indices. Table 3-5 summarizes the results of the two approaches.

Nurses' starting wages were selected as the basis for cost adjustments because of their uniformly smaller standard deviations and their avoidance of the complications due to variations in the treatment of the category of part-time personnel and in personnel mix. Manipulation of this latter factor would be important in the ultimate efficiency of a hospital and basing corrections on the average wage would, in effect, be penalizing institutions in an area which had used relatively large numbers of lower skilled, low-wage employees in the interests of economy. Reassurance that this choice has not led this study astray is taken from the similarities between the variations of the two set of indices. The differences in the range of average annual wages is not much greater than that of nurses' starting salaries, and the rank order relationship of the geographic areas is almost identical.

For purposes of the actual cost corrections, the index numbers for nurses' wages as shown in Table 3-5 were converted to adjustment factors by use of the following formula:

$$A = 1 - (1 - 1/W) \, P$$

where: A = adjustment factor
W = wage index
P = percent of total costs devoted to payroll*

*Data from American Hospital Association, "Registered Hospitals," pp. 103-110. For five hospitals where this data was not reported, the average percentage for the appropriate area council was made.

TABLE 3-5

General Staff Nurses' Starting Wages and
Average Annual Wages for Massachusetts Hospitals
by Area Council as of October 1, 1967

Nurses' Starting Wages

Area Council	Mean Wage	Standard Deviation	Index (W)	Rank Order	Number of Hospitals Reporting
Greater Boston	$6,502	156	1.07	1	16
Northeastern Mass.	$6,437	187	1.06	2	8
Worcester	$6,131	292	1.01	4	8
Western Mass.	$6,149	159	1.01	3	9
South Shore	$6,079	173	1.00	5	7

Average Annual Wages

Area Council	Mean Wage	Standard Deviation	Index (W)	Rank Order	Number of Hospitals Reporting
Greater Boston	$5,122	457	1.11	1	19
Northeastern Mass.	$4,997	794	1.08	2	9
Worcester	$4,842	825	1.05	3	10
Western Mass.	$4,631	373	1.01	4	12
South Shore	$4,591	759	1.00	5	13

Sources: Nurses' Wages - Massachusetts Hospital Association, Fringe Benefit and Wage Survey: 1968, Part II, (Boston, M.H.A., 1968) and Greater Boston Area Hospital Council, Fringe Benefit and Wage Survey: 1968 (Boston, G.B.A.H.C., 1968). Average Annual Wages - American Hospital Association, "Registered Hospitals," pp. 103-110.

Note: Data was used only for hospitals in the sample of 68 used for this study.

This adjustment factor, which ranged from .95 to 1.00, when multiplied by total costs yields the adjusted costs per weighted patient day and per admission which were used for this study. The procedure actually adjusts only the salary component of total costs. Most of the other costs represent supply costs and it was assumed that these would be relatively constant across an area the size of Massachusetts.

Analysis of the Data

The data, accumulated and adjusted as described above, were subjected to two types of analysis:

1. Least-squares linear regression: a technique which yields an equation of the form $Y = mX + b$ for the unique straight line which best "fits" the data on two variables X and Y as mapped on a two-dimensional graph. The nature of the relationship between X and Y is indicated by the slope of the line, with a flat line whose slope is zero generally revealing an absence of relationship. The data may cluster tightly about the regression line, indicating a strong relationship, or scatter loosely about it with the opposite implication.

2. Pearson product-moment correlation analysis: a technique producing a correlation coefficient (r) which is a measure of the goodness of fit of the data to the least-squares line, and, hence, of the strength of the relationship. The coefficient (r) is an arbitrary mathematical measure with no obvious interpretation

except as it is compared with similar coefficients for other data.
It ranges from +1 to -1, extreme values which indicate either a
perfect positive or perfect negative relationship. A value of
zero is consistent with no relationship. The statistical signi-
ficance of the actual values (as measured by the "F" test) is
highly dependent upon the number of observations or sample size so
that two coefficients of the same value need not be equally signi-
ficant. As the number of observations decrease, the absolute
value of the coefficient required for significance increases.

The results of the analysis of the relationship between
present value of capital per bed and adjusted costs per weighted
patient day are summarized in Table 3-6 and Figure 3-2. It will
be noted that total costs have been subdivided into their
routine and special service cost components. This provides a
look at possible differentials in efficiency-obsolescence
patterns which may exist in these two areas of hospital activity.
The subdivision, which was made possible by the detail and format
of the HCF 400 forms, is based upon the following designation of
hospital activities:

1. Routine Services
   a. Administration and General
   b. Repairs and Maintenance of Buildings, Equipment
      and Grounds
   c. Operation of Plant
   d. Motor Service
   e. Laundry Department
   f. Linen Service
   g. Housekeeping Department
   h. Dietary Department
   i. Maintenance of Personnel

TABLE 3-6

Correlation Coefficients (r) for Present Value of Capital per Bed and Adjusted Costs per Weighted Patient Day

| | | Correlation Coefficients (r) | | |
Service Group	Group Size	Total Cost	Routine Cost	Special Cost
1. Basic Services	9	-0.29	-0.25	-0.30
2. Quality Enhancing Services	37	0.03	0.01	0.15
3. Complexity Expanding Services	16	0.55*	0.68*	0.31
4. Community Services	6	0.28	0.41	-0.61
Total	68	0.24	0.23	0.27*

Notes: A negative coefficient would be consistent with the research hypothesis. Coefficients marked with an asterisk (*) are significant at the .05 level according to the "F" test.

TABLE 3-7

Correlation Coefficients (r) for Present Value of Capital per Bed and Adjusted Costs per Admission

| | | Correlation Coefficients (r) | | |
Service Group	Group Size	Total Cost	Routine Cost	Special Cost
1. Basic Services	9	-0.49	-0.45	-0.51
2. Quality Enhancing Services	37	-0.30	-0.40*	-0.11
3. Complexity Expanding Services	16	0.36	0.41	0.27
4. Community Services	6	0.05	0.18	-0.27
Total	68	-0.06	-0.13	0.05

Notes: A negative coefficient would be consistent with the research hypothesis. Coefficients marked with an asterisk (*) are significant at the .05 level according to the "F" test.
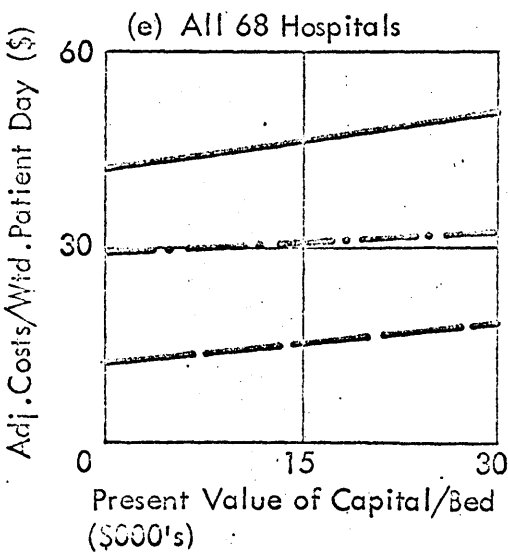
(a) Service Group 1

(b) Service Group 2

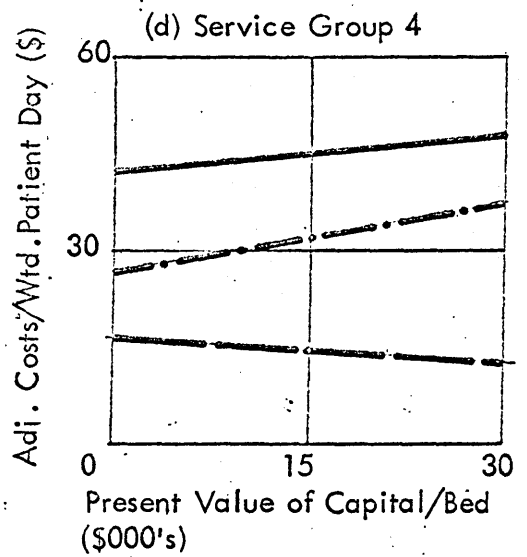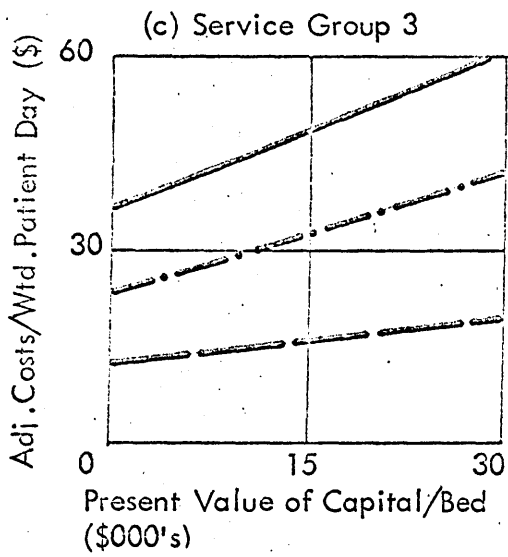(c) Service Group 3
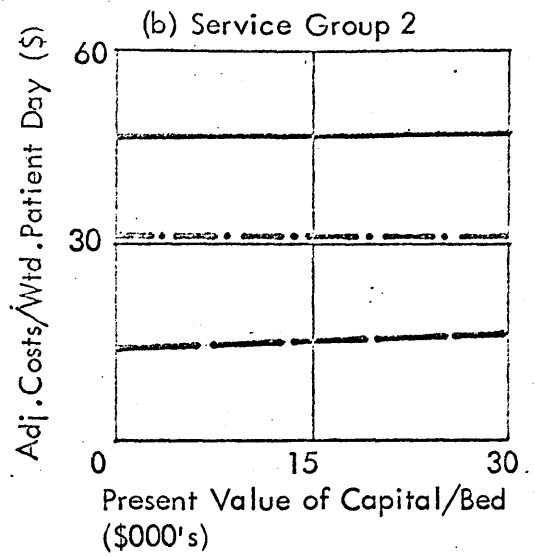
(d) Service Group 4

(e) All 68 Hospitals

FIGURE 3 - 2

Linear Regression Lines for
Present Value of Capital/Bed
and Adjusted Costs Per Weighted
Patient Day.

Total Cost
Routine Service Cost
Special Service Cost

65

(a) Service Group 1

(b) Service Group 2

(c) Service Group 3

(d) Service Group 4

(e) All 68 Hospitals

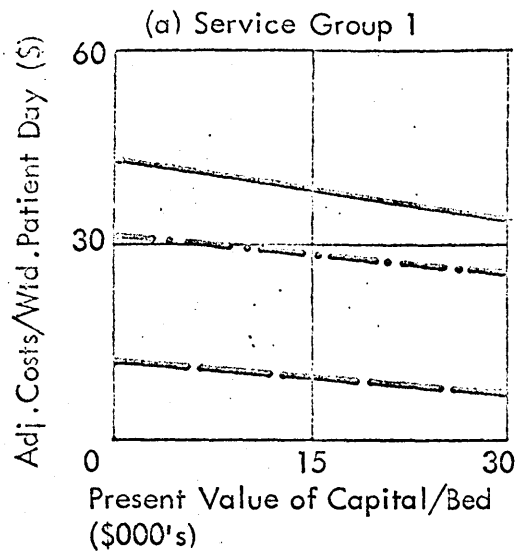FIGURE 3 - 3

Linear Regression Lines for
Present Value of Capital/Bed
and Adjusted Costs Per Admission.
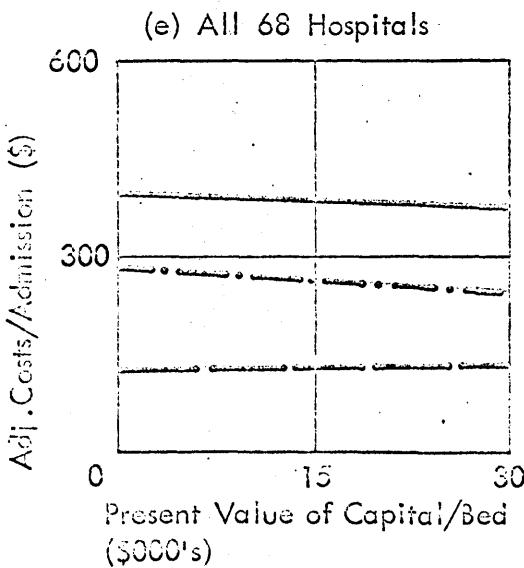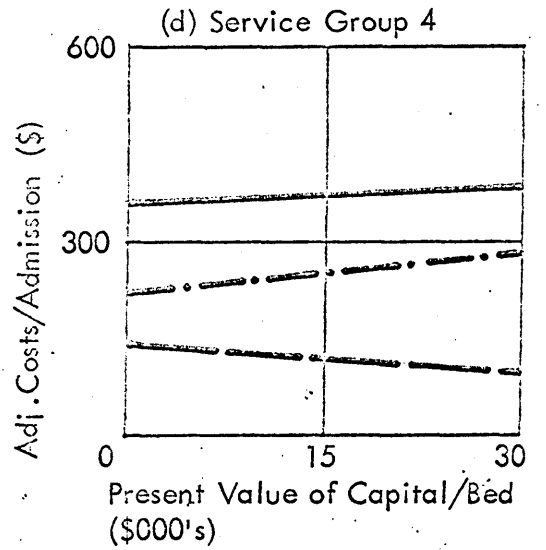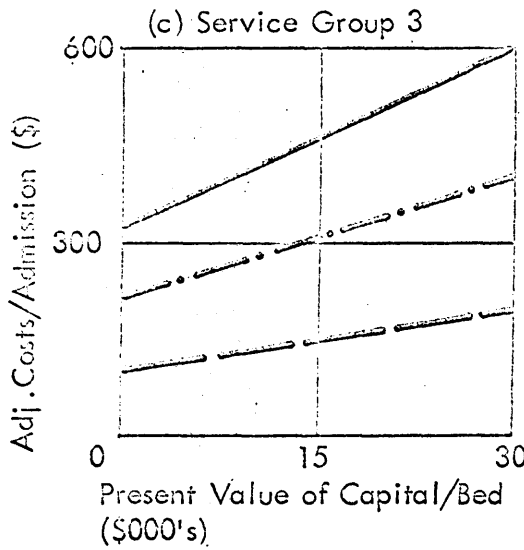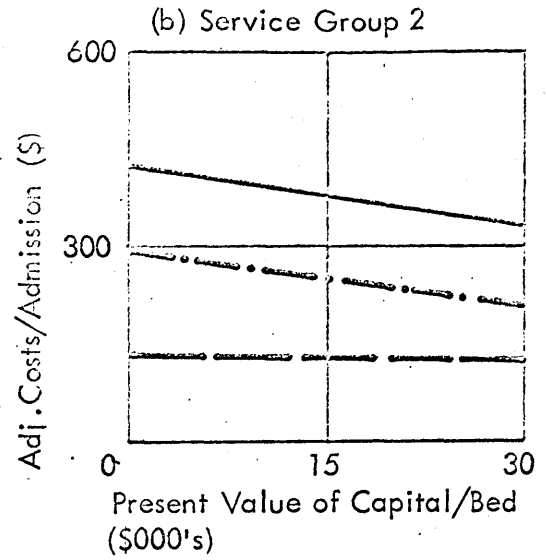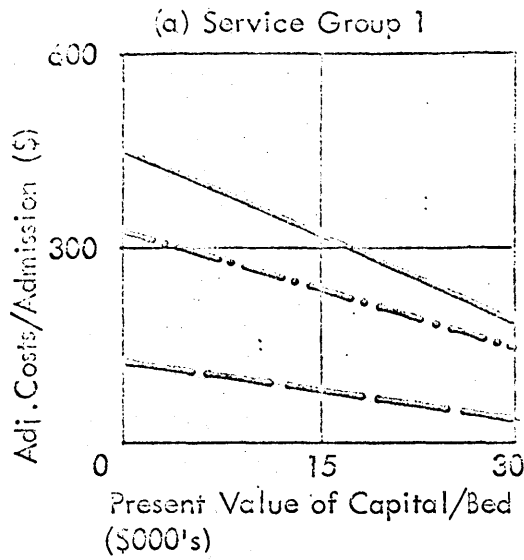
Total Cost
Routine Service Cost
Special Service Cost

1. Routine Services (continued)
    j. Medical and Surgical Service
        (1) Physicians' Salaries
        (2) Supplies and General Expenses
    k. Nursing Service
    l. Nursing Education
    m. Pharmacy
    n. Medical Records and Library
    o. Social Service
    p. Others

2. Special Services
    a. Operating Rooms
    b. Delivery Rooms
    c. Anesthesiology
    d. Radiology
        (1) Diagnosis
        (2) Therapy
    e. Laboratory
    f. Basal Metabolism
    g. Electrocardiography
    h. Physical Therapy
    i. Ambulance
    j. Special Medical and Surgical Services
    k. Special Pharmacy
    l. Emergency Ward
    m. Others

As can be seen from the correlation coefficients in Table 3-6, the associations between the variables is very slight. Indeed, when the correlations are subjected to the "F" test, only three of the fifteen are statistically significant at the .05 level* -- and these show a relationship which is positive. This, of course,

---

*The level of significance of a statistical procedure is the probability of the test causing us to reject a tested hypothesis when it is actually true. In this case, if a coefficient is significant at the .05 level, there is no more than a 5% chance that it would have this high an absolute value if there were actually no relationship between the variables. The .05 level which has been adopted for this study is commonly used as the standard for significance in social science research.

indicates that (for Group 3) as the value of capital per bed increases, costs per patient day tend to rise also, i.e. just the opposite of what is predicted by the research hypothesis. Only four of the fifteen regression lines slope downward and none of these cases have correlations which are significant at the .05 level. The evidence with regard to adjusted costs per patient day provides no basis for rejection of the null hypothesis. Furthermore, it shows no pattern which should encourage belief that investments in facilities and equipment would lead to lower per diem costs for either the routine or special services.

Switching the deflator for costs from weighted patient days to admissions yields a picture which, while different, offers little more support for rejecting the null hypothesis. Just over one half the regression lines (See Figure 3-3.) slope downward and only one of the correlation coefficients is significant at the .05 level.

Should one be willing to stretch a point quite far, and relax the stringency of the statistical test, it might be said that capital investments are conducive to lower costs in small, basic service hospitals, but that this tendency is reduced as the hospitals grow in size and complexity of services. This might follow from the changes in slopes of the regression lines; markedly negative for Group 1, but increasingly positive through Group 3, after which they tend to flatten out. However, it must be reasserted that the relationships are very weak and lack the

statistical significance needed to convince us that this pattern is not merely a chance happening.

The association of the two measures of obsolescence, present value of capital per bed and nonconforming beds/licensed bed capacity (nonconformity ratio), was studied and found to be very weak, correlation coefficients for all the service groups (See Table 3-8.) lacking significance at the .05 level. However, the fact that for each of the groups the coefficients are negative, and that if there were really no association at all the chance of this occurring would be one in sixteen, leads one to believe that there may be some weak relationship between the two. Of course, it is just such a negative relationship which would result if capital investment programs do, in fact, produce facilities which are more in accord with contemporary (Public Health Service) standards.

TABLE 3-8

Correlation Coefficients (r) for Present Value of Capital Per Bed and Nonconforming Beds/Licensed Bed Capacity

Service Group	Group Size	Correlation Coefficient (r)
1. Basic Services	9	-0.62
2. Quality Enhancing Services	37	-0.17
3. Complexity Expanding Services	16	-0.29
4. Community Services	6	-0.21
Total	68	-0.21

Note: None of the coefficients are significant at the .05 level.

TABLE 3-9

Correlation Coefficients (r) for Nonconforming Beds/ Licensed
Bed Capacity and Adjusted Costs per Weighted Patient Day

Service Group	Group Size	Correlation Coefficients (r)		
		Total Cost	Routine Cost	Special Cost
1. Basic Services	9	0.52	0.55	0.37
2. Quality Enhancing Services	37	0.15	0.28	-0.01
3. Complexity Expanding Services	16	0.06	-0.03	0.17
4. Community Services	6	0.15	0.14	-0.07
Total	68	0.15	0.20	0.07

Notes: A positive coefficient would be consistent with the research hypothesis. None of the coefficients are significant at the .05 level according to the "F" test.

TABLE 3-10

Correlation Coefficients (r) for Nonconforming Beds/Licensed
Bed Capacity and Adjusted Costs per Admission

Service Group	Group Size	Correlation Coefficients (r)		
		Total Cost	Routine Cost	Special Cost
1. Basic Services	9	0.66	0.64	0.62
2. Quality Enhancing Services	37	0.21	0.28	0.07
3. Complexity Expanding Services	16	0.24	0.20	0.27
4. Community Services	6	0.68	0.61	0.62
Total	68	0.41*	0.29*	0.20

Notes: A positive coefficient would be consistent with the research hypothesis. Those coefficients marked with an asterisk (*) are significant at the .05 level.

(a) Service Group 1

(b) Service Group 2

(c) Service Group 3

(d) Service Group 4

(e) All 68 Hospitals
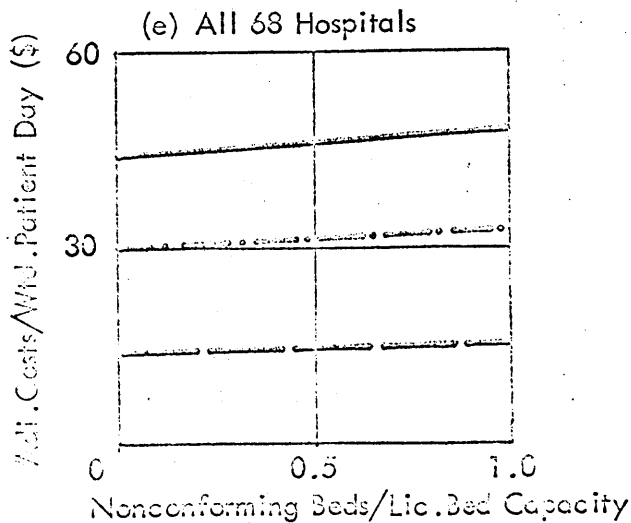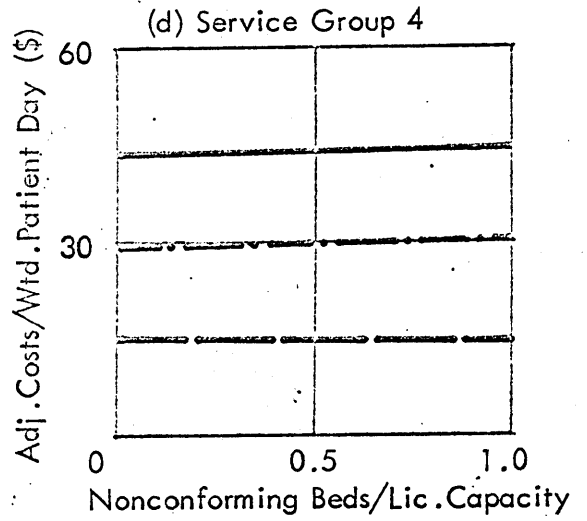
FIGURE 3 – 4

Linear Regression Lines for
Nonconforming Beds/Licensed
Bed Capacity and Adjusted
Costs Per Weighted Patient Day.

Total Cost
Routine Service Cost
Special Service Cost

(a) Service Group 1

(b) Service Group 2

(c) Service Group 3

(d) Service Group 4

(e) All 68 Hospitals
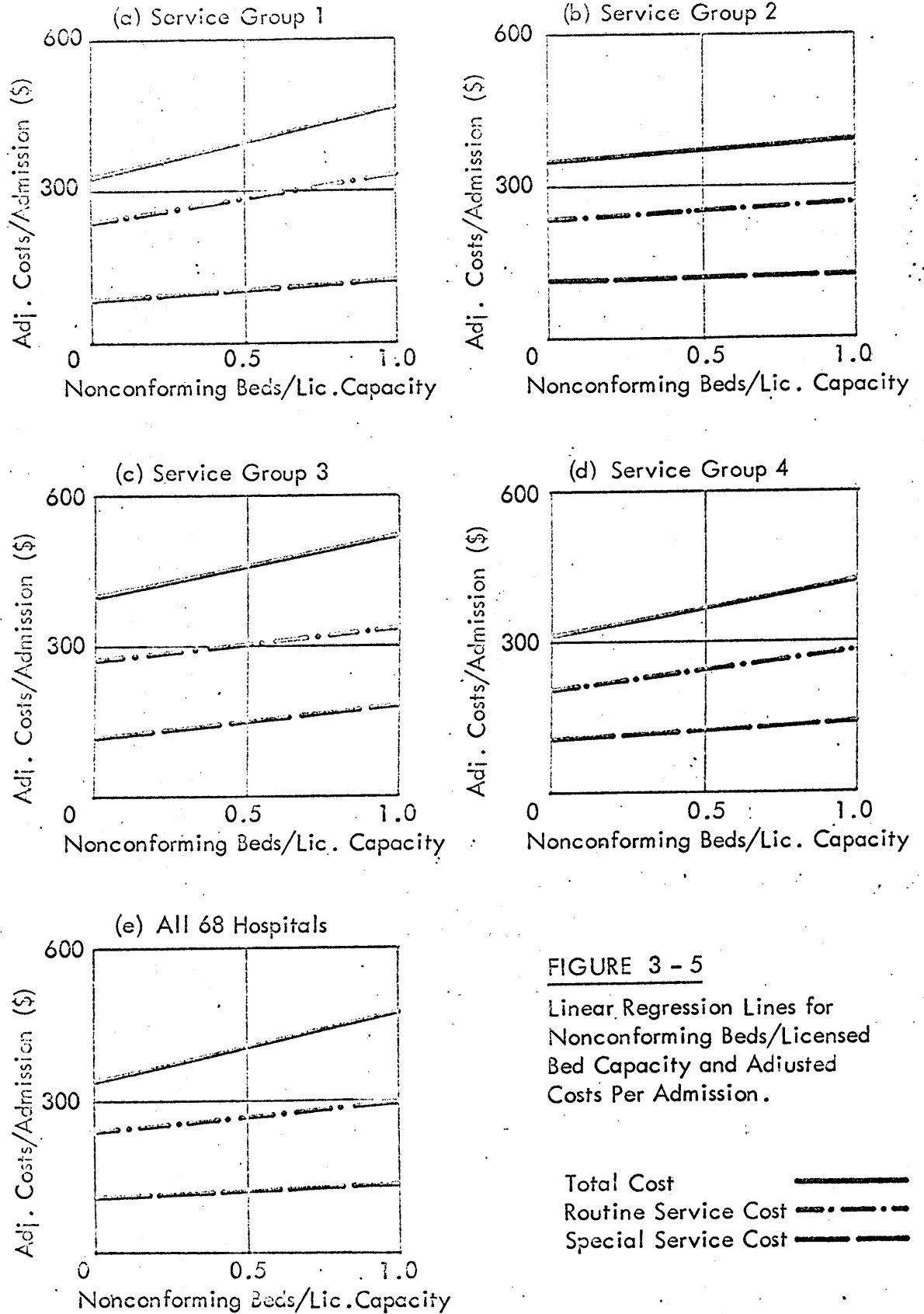
FIGURE 3 - 5

Linear Regression Lines for
Nonconforming Beds/Licensed
Bed Capacity and Adjusted
Costs Per Admission.

Total Cost
Routine Service Cost
Special Service Cost

The absence of a strong association between the two measures of obsolescence opens the possibility that while an analysis using present value of capital failed to permit rejection of the null hypothesis, use of the nonconformity ratio may yield success. This was not to be the case. The results of the comparisons of non-conformity with per diem costs (See Table 3-9.) lend no support to the research hypothesis; the slopes of the regression lines (See Figure 3-4.) are quite flat, none of the correlations are signifi-cant and three are of the "wrong" sign.
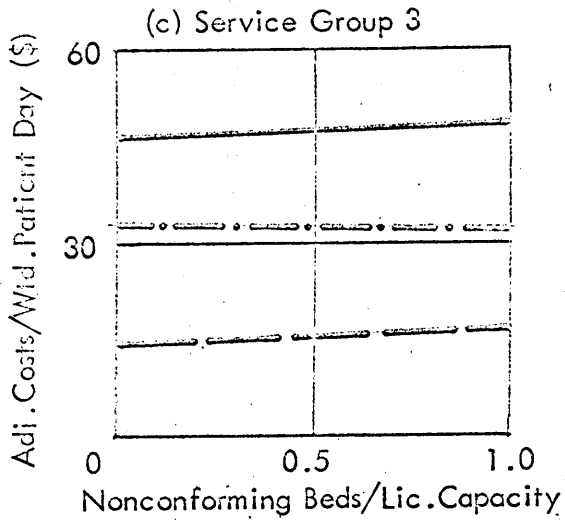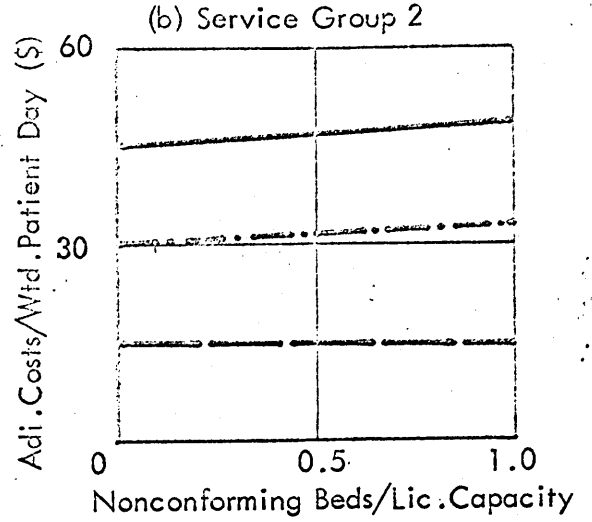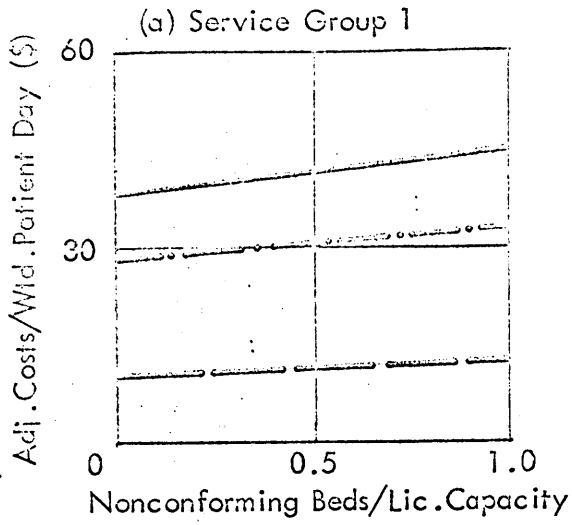
The results of having used costs per admission are somewhat different. All the correlations (See Table 3-10) are positive and, therefore, consistent with the research hypothesis, but in none of the intragroup comparisons was there statistical significance at the .05 level. A distinctly different picture is obtained when the service groups are combined and the comparisons made among all 68 hospitals at once. The three correlations are positive and two are significant at the .05 level. For total costs, the most important measure, the correlation $(r = 0.41)$ is actually signi-ficant at the .001 level.

The importance of this finding, however, is seriously under-mined by its inconsistency with the results obtained for the individual service groups. It is difficult to find an explanation for why if an association between the two variables exists for the larger group of hospitals it cannot be demonstrated among sub-groups of hospitals which are more similar with respect to size and

complexity of services. It may be that the association does not really exist and that the finding is spurious. This conclusion is supported by the systematic differences between the service groups with respect to nonconformity (See Table 3-4.). The larger hospitals with more complex services available are more obsolete than smaller hospitals with fewer services. Hence, the association being noted by the relatively high correlation coefficients found by comparing costs with nonconformity among the 68 hospitals rather than being between costs and nonconformity may really be between costs and service complexity. At least we can strongly suspect that an otherwise insignificant correlation is being inflated by this factor. Verification that costs and service complexity are positively related can also be seen from Table 3-4. The costs per admission for groups 3 and 4 taken together are higher than those for groups 1 and 2.

In order to compare the value of grouping hospitals by similarities in availability of special services with the more commonly used distinctions, a number of correlations were computed with the 68 hospitals arranged in size groups. The results, summarized in Tables 3-11 and 3-12, are inconclusive in that they are not markedly different from those obtained for service groupings. The same pattern emerges; positive correlations between costs and both capital investment and nonconformity, with significance at the .05 level for the latter within only one group of smaller hospitals. Results for capital investment contradict the research hypothesis while those for nonconformity provide only a hint of support.

TABLE 3-11

Correlation Coefficients (r) for Nonconforming Beds/Licensed

Bed Capacity and Adjusted Total Costs per

Admission by Hospital Size

Hospital Size (Number of Beds)	Number of Hospitals	Correlation Coefficient (r)
0-99	21	0.47*
100-199	25	0.17
200-299	16	0.15
300-497	6	0.60
Total	68	0.41*

Notes: A positive coefficient would be consistent with the research
hypothesis. Coefficients marked with an asterisk (*) are significant
at the .05 level according to the "F" test.

TABLE 3-12

Correlation Coefficients (r) for Present Value of Capital

per Bed and Adjusted Total Costs per Weighted Patient

Day by Hospital Size

Hospital Size (Number of Beds)	Number of Hospitals	Correlation Coefficient (r)
0-99	21	0.22
100-199	25	0.21
200-299	16	0.24
300-497	6	0.26
Total	68	0.24

Notes: A negative coefficient would be consistent with the research
hypothesis. None of the coefficients are significant at the .05
level.

The practical results of having used service groupings, then, have not been to bring us any closer to rejection of the null hypothesis, but rather, by producing sub-samples of improved and more convincing homogeneity, to increase the persuasiveness of the negative findings.

IV   A STUDY OF THE RELATIONSHIP OF EFFICIENCY
TO OBSOLESCENCE - PART II

The data on costs per patient day and costs per admission as discussed in the foregoing chapter proved to be inconclusive and did not allow rejection of the null hypothesis which states that there is no relationship between obsolescence and efficiency. It is recognized, however, that because of the complex, multi-functional nature of general hospitals it might not be appropriate to look for (or possible to find) efficiency at the scale of total costs per unit of outputs. Efficiency may be less the product of broad decisions and policies affecting the whole institution with its multiplicity of departments operating at varying levels of technology, than of a larger number of small scale actions aimed at reducing the costs of specific departments and procedures. Measures which yield effective economies in one area of activity may be ineffective in others and even be counter productive elsewhere. A scale of operation which may be efficient for the nursing service may be just the opposite for the linen or dietary departments. If such is the case, it may be more fruitful to look for efficiencies on the scale of individual departments and services with the hope of being able to discover the optimum conditions for each.

Departmental efficiency is probably not uniformly sensitive to facility and equipment obsolescence. The nursing service, for

instance, with its heavy dependence upon personal services would
probably benefit less from capital investment than would more
production-like departments. Accordingly, two departments,
diagnostic radiology and clinical laboratory, whose operations
include a large proportion of routine, mechanical work of the type
to which modern industrial techniques would seem to be most appro-
priate, have been selected for further study. Each of the 68
hospitals in this study provide these services and their unit
costs,* cost per weighted** x-ray film and cost per laboratory test,
were derived from figures in the "Hospital Statement for Reim-
bursement," form HCF 400 for the year ending September 30, 1967.
As in the analysis described in Chapter 3, these costs were
adjusted to account for wage differentials across the state. The
same method was used and it was assumed, in the absence of any
better information, that the proportion of departmental costs
devoted to payroll was the same as that for the whole institution.

Information concerning facility obsolescence could not be
obtained in the same formats used previously as neither Hill-
Burton facility assessments nor capital valuations are made on a
departmental basis. From the records of the Hospital Facilities
Division of the Massachusetts Department of Public Health, however,

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*Costs include direct and indirect components.

**Twenty dental films are counted as equivalent to one regular,
large size film.

it was possible to determine which of the study hospitals had built

new radiology and laboratory departments with Hill-Burton assistance.

The unit costs of these hospitals were compared with the remaining

hospitals whose facilities were assumed to be less modern. Only

hospitals which had built completely new departments were desig-

nated as new. Those which had expanded existing departments or

which may have built totally new departments without having applied

for Hill-Burton aid* were grouped together with those using older

facilities.

Ten hospitals were found with new radiology departments and

five with new laboratories. All the departments were built and

completed between 1961 and June 1966. The comparisons of the mean

adjusted costs for new and old departments as summarized in Table 4-1

yield a mixed picture. The mean cost for new laboratories is lower

than that of their older counterparts, but in new radiology depart-

ments the situation is reversed; their mean cost is higher. In

the case of laboratory costs, the difference between the mean costs

is not great enough to be significant at the .05 level, i.e. we

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*The size of this latter group is unknown, but in the opinion of
Mr. Timulty of the Hospital Facilities Division it must be very
small. Virtually all hospitals undertaking major building im-
provements apply for Hill-Burton aid and the record in Massachu-
setts has been that the great majority of them have been assisted
to some extent.

TABLE 4-1

Adjusted Costs per Laboratory Test and per Weighted
Diagnostic X-ray Film for 68 Massachusetts Hospitals
for the Year Ending September 30, 1967

Clinical Laboratories:

	Mean Adjusted Cost/Lab Test	Standard Deviation	Number of Hospitals
Old Departments	$2.27	0.49	58
New Departments	2.06	0.43	5

Diagnostic X-ray
 Departments:

	Mean Adjusted Cost/Weighted X-ray Film	Standard Deviation	Number of Hospitals
Old Departments	$3.91	0.76	58
New Departments	4.48	0.78	10

Note: Laboratory costs are computed for only 63 of the 68 hospitals
as in five cases an incompatible method of counting laboratory tests
was used.

cannot conclude that the unit costs of departments operating in new facilities are any lower than those in older facilities and the null hypothesis has once again withstood rejection.

It should be noted that in this study of departmental costs no attempt has been made to subdivide the basic sample of 68 general hospitals to account for variations in departmental size, quality or complexity. Variations are certain to exist; the proportion of accurate diagnostic procedures will not be a constant across hospitals and there will also be differences in the mixes of types of procedures; however, such differences are very probably of much smaller relative importance than are those which exist between the total outputs of entire hospitals. For this reason it was felt to be reasonable to treat the 68 hospitals as being homogenous with respect to the departmental functions.

V CONCLUSIONS

The empirical analyses of the preceding two chapters failed to produce results which would warrant rejection of the null hypothesis that there is no relationship between obsolescence of capital equipment and efficiency in the production of hospital services. Furthermore, there was no evidence in favor of any easy assumptions about the differential sensitivity of routine and special service costs to obsolescence. The search of the literature, while it revealed descriptions of small scale improvements in the efficiency of narrow areas of activity and detailed effects such as reduced walking distances which are consistent with efficiency, also failed to produce any convincing evidence that the basic goal, hospital services at lowered costs, is really achieved by a strategy based upon modernization and capital investment. One possible interpretation for this apparent contradiction is that savings which are achieved may be diverted from the reduction of total costs to goals such as improvement of service quality and patient comfort. Another would be that the economies which have been derived from modernization are of such a small magnitude that they fail to noticeably deflect the movement of total expenditures. The level of facility and equipment technology may not be up to the problem and require major improvements before its effects are felt.

The lesson of this study is not to deny that modern capital

equipment, which has been credited with major economic gains in other industries, may have a similar role to play in hospitals. It is rather that despite the investments of recent years such gains have not been made, or at least, that they cannot at present be demonstrated with current methods as applied to the available data; the data produced by the industry and commonly accepted as valid measures of its performance. These data cannot be said to have a level of precision comparable to that of the statistical methods used in this study. The figures on costs, on value of capital and on nonconformity, it should be remembered, are not the measurements of scientists; they are the reports of hospital administrators and public officials faced with the responsibility to provide information to outside agencies. The degree to which the data conform to reality is open to question. Their production is subject to numerous pressures and the necessity to deliver a certain quantity of information probably exceeds the need for it to be accurate. Supposed uniformity of accounting and reporting methods are undoubtedly often the victim of institutional exped-iency and simple human error. Nevertheless, it is not without justice that these data are used for evaluation of the hospital industry as it is on the basis of these same measures that we are asked to pay for hospital service and to support capital investment programs.

A question to be asked is that if the data which is commonly

accepted as relevant to hospital evaluation cannot be shown to
demonstrate the value of modernization in a convincing way, what
are the foundations of the current conviction that capital
investment strategies will achieve efficiency? They are undoubtedly
based upon analogies between hospitals and other industries;
analogies which have a strong appeal to intuition. It sounds only
reasonable that automatic elevators, pneumatic tubes, movable
partitions, and low maintenance modern finishes would have a
downward influence on costs. However, because of the size of the
problem and the amount of scarce resources potentially required for
this type solution it behooves us to be cautious in acting on
suppositions. A close look at the results in Chapter II could
lead to fears that these suppositions are actually false. The
study of costs in relation to the value of capital per bed may
indicate a tendency for costs to rise as hospitals invest in
modern facilities and equipment, at least for our larger and more
complex hospitals. If such is the case, our present national
policy of making aid for funds available to hospitals for projects
of their own choosing and design may really be counter productive.
This is borne out by the lack of association of high capitaliza-
tion with either high facility ratings according to Public Health
Service standards or low costs.

This finding must certainly temper any hopes raised by the
analysis using nonconformity with national facility standards as the
measure of obsolescence. One could hope that the suggestions of

positive findings might be converted into truly significant results by use of more accurate data, refined facility evaluation criteria and perfected study methods, but it must still be recognized that hospitals, with their investments of over $2 billion per year, do not seem to be moving in the direction of efficiency. While we may move toward an understanding of what types of obsolescence do raise costs, there is little to encourage us to believe that, under present conditions, constructive action would be taken.

Modernization of plant and equipment is too general a prescription for the achievement of hospital efficiency; newness and efficiency are not synonymous. We must discover what types of new facilities are conducive to efficiency and under what conditions. Measures which may prove successful in hospitals of one type cannot be presumed to be universally applicable and even among similar institutions differences in management practices or consumer preferences may cause a given strategy to have very different effects.

Finally, we must be prepared to accept the possibility that, except for extreme cases, hospital costs are not sensitive to facility and equipment obsolescence and that efficiency must be approached via different avenues. Methods of reimbursement, administrative practices, and standards for assignment to inpatient and ambulatory care may be areas where study and reconstruction are far more fruitful. Only research and experimentation at a scale far greater than has been known can provide the information needed to guide the hospital industry and its supporters.

These issues represent serious problems for health care policy makers. Even were we to discover what sorts of combinations of facility design and management practices were productive of efficiency, present forms of construction aid and third party re-imbursement would not encourage their adoption. Federal aid may be used in ways which increase the problem of rising costs rather than help to solve it. This is not an argument for stopping such aid, but it is one for redesigning aid programs to improve their effectiveness with respect to controlling costs. Or if it is really some other goal such as improved quality of service to which the programs are directed, it would be far better to have the public debate conducted about those goals; their place among national priorities, their costs and the benefits of achieving them.

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