5.
Hospital Costs and Strategies

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INTRODUCTION

One of the major concerns regarding NMR imaging relates to the impact this new technology will have on health care costs. This concern derives in part from the high costs anticipated for the purchase and installation of an NMR imaging system and uncertainties regarding the extent to which NMR imagers will be used in addition to, rather than instead of, other diagnostic modalities already in hospitals. The purpose of this chapter is to present a framework for addressing the cost issue. The chapter is organized into three sections. The first section presents data regarding the likely capital and operating costs of different types of NMR systems. The second section addresses other factors that will influence the effect of NMR imaging on patient care costs, and the final section describes the NMR acquisition strategies and decisions of different segments of the hospital industry.

CAPITAL AND OPERATING COSTS

Initial capital expenses and routine operating expenses for an NMR imaging system are primarily determined by the type of magnet used to produce the static magnetic field. Although insufficient experience has been accumulated to permit accurate predictions of the likely expenses of acquiring and operating an NMR imaging system, tables 15 to 17 attempt to provide the best available estimates of such expenses for four different types of NMR systems. It should be emphasized that the values provided in the following tables are *estimates,* and nothing more. They should therefore be interpreted in that spirit. Our purpose in presenting these estimates is to provide some indication of the factors that will contribute to the cost of operating NMR imaging systems and what total costs are likely to be, given reasonable assumptions.

In determining annualized capital costs, we have made the assumption that the useful life of the NMR imaging system itself is 5 years, while that of the site renovation is 10 years. A 10-percent interest rate has been employed. Physi*cian costs (i. e., professional fees) have not been included.*

supply costs, estimated to be $15 per procedure, vary with the number of procedures performed per day. In the near future, while NMR remains investigational, it is probably reasonable to assume that no more than 10 procedures will be performed per day. By *1985* or 1986, it is reasonable to assume that 20 procedures per day will be performed on a single machine. If paramagnetic contrast agents come into use, supply costs will increase.

Maintenance costs are estimated to be either 5 or 7 percent of the purchase price. The former estimate is more reflective of the cost of maintenance performed by the hospital; the latter of the cost of maintenance provided by a manufacturer as part of a service contract. Given the absence of moving parts in NMR imaging systems, actual maintenance costs may be less than the estimates provided. Finally, overhead, which has been estimated to be *25* percent of operating costs, will vary from institution to institution.

As can be seen in table 15, purchase prices for permanent and superconducting NMR units tend to be higher than those for current generation X-ray CT scanners (estimated to be *$600,000* to $1,200,000) (180,181). Based on the assumptions implicit in this analysis, including the performance of 10 procedures per day, the cost of an NMR imaging study in 1983 *exclusive of professional*

Table 15.–Range of Estimated Costs for NMR Imaging Systems by Type of Magnet, 1983

	Resistive (0.15 T)	Permanent (0.3 T)	Superconductive (0.5 T)	Superconductive (1.5 T)
Capital costs:				
Purchase price	$800,000[2 b] 1,200,000'[c]	$1,500,000'[4]	$1,500,0002[b] 1,700,000'[c]	$2,000,000[4]
Facility modification:				
Renovation		20,000 to 50,000[4]	150,000 to 250,000[4]	
New construction		50,000 to 75,000		
Unspecified modifications	150,000[3 b] 510,000'[c]	75,000'[b] 250,000[2 c]	650,000'	250,000[b] to 1,000,0004[c]
Annual operating costs:				
Electricity (and cryogens[a])	$20,000[1]	$ 3,000'[b]	$ 60,000'[c]	$ 30,000[b] to 50,000[4 c]
	10,000[b] to 30,000[3 c]	8,200'[c]	20,000[b] to 40,000[3]	
Personnel:				
Single shift	70,000[3]	70,000[3]	70,000[3]	70,0003
Double shift	140,000[3]	140,000[3]	140,000[3]	140,0003
Supplies ($15/procedure):				
10 procedures/day (2,500/year)	37,500[3]	37,500[3]	37,500[3]	37,500[3]
20 procedures/day (5,000/year)	75,000[3]	75,000[3]	75,000[3]	75,000[3]
Maintenance:				
5°/0 of purchase price	40,000[2 b] 60,000'	75,000'[4 b]	75,000[2 b] 85,000'	100,000[4 b]
7°/0 of purchase price	56,000[2] 84,000'[c]	105,000'[4 c]	105,000[2] 1 19,000'[c]	140,000[4 c]
Annual overhead:				
25°/0 of operating costs	$39,375[d] to 82,250'	$46,375[d] to 82,050'	$ 50,625[d] to 98,500'	$ 59,375[d] to 103,750[e]

[a]Cryogens apply only to superconductive systems
[b]Low estimate.
[c]High estimate
[d]The lower estimates of operating costs are derived from the low estimates of electricity (and cryogens[a]) costs and of maintenance costs, as indicated. For personnel costs, a single shift and 10 procedures per day are assumed
[e]The higher estimates of operating costs are derived from the high estimates of electricity (and cryogens[a]) costs and of maintenance costs, as indicated For personnel costs, a double shift and 20 procedures per day are assumed.

SOURCES. 'American Hospital Association, Nuclear *Magnetic* Resonance Guideline *Report*, AHA Hospital Technology Series, vol 2, No 8. (Chicago' AHA, 1983)
'W H Stephens, A E James, A. C. Win field, et al., "Financial Implications of NMR Imaging, " In *Nuclear Magnetic Resonance (NMR) Imaging*, C L. Partain, A. E James, F. D. Rollo, et al. (eds.) (Philadelphia: W. B Saunders, 1983)
'W H Stephens, J A Patton, J. E Lagan, et al., "Certain Economic Considerations in NMR Imaging, " In *Nuclear Magnetic Resonance and Correlative Imaging* Modalities, C.L. Partain (cd.) (New York: The Society of Nuclear Medicine, Inc , 1983).
"Interviews with manufacturers
[5]E F Kuntz, "New Magnet May Lower Cost of NMR, " Modern *Health Care* 106, January 1983
[6]Fonar Corp , "Cost.Effectiveness in NMR Scanning" Making NMR Available to the Public at an Affordable Cost," October 1983

Table 16.—Estimated Annual Costs for NMR Imaging Systems by Type of Magnet, 1983

	Resistive (0.15 T)	Permanent (0.3 T)	Superconductive (0.5 T)	Superconductive (1,5 T)
Annual capital costs: [a]				
Purchase[b]	$203,972 (800,000)	$ 382,447 (1,500,000)	$ 382,447 (1 ,500,000)	***$ 509,929*** (2,000,000)
Facility modification	***23,787*** (150,000)	11,894 (75,000)	103,078 (650,000)	111,007 (700,000)
Total annual capital costs	$227,759	$ 394,341	$ 485,525	$ 620,936
Annual operating costs.[d]				
Shift / maintenance / # procedures **per** day				
Single / 5 % / 10	$177,500	$ 190,700	$ 232,500	$ 267,500
Single / 5 % / 20	215,000	228,200	270,000	305,000
Single / ***7 %*** / 10	193,500	220,700	262,500	307,500
Single / ***7 %*** / 20	231,000	258,200	300,000	345,000
Double / ***5 %*** / 10	247,600	260,700	302,500	337,500
Double / ***5 %*** / 20	285,000	298,200	340,000	375,000
Double / ***7 %*** / 10	263,500	290,700	332,500	377,500
Double / ***7 %*** / 20	301,000	328,200	370,000	415,000
Range of operating costs	177,500 **to** 301,000	190,700 to 328,200	232,500 to 370,000	267,500 **to** 415,000
Annual overhead:				
25%0 of operating costs	44,375 to 75,250	47,675 to 82,050	58,125 **to** ***92,500***	66,875 to 103,750
***Total annual* costs**	***449,634*** to 604,009	632,716 to 804,591	***776,150*** to 948,025	955,311 to 1,139,686

[a] Total costs on which annualized costs are based are in parentheses
[b] Assuming 5-year useful life, 10 percent interest, and 60 equal monthly payments
[c] Assuming 10-year useful life, 10 percent interest, and 120 equal monthly payments
[d] The electricity and cryogens costs assumed (cryogens apply only to superconductive systems) were as follows (S00 table 15)

Resistive (O 15 T)	**$30,000**
Permanent (O 3 T)	**$ 8,200**
Superconductive (O 5 T)	**$50,000**
Superconductive (1 5 T)	$60,000

SOURCE Table 15

Table 17.—1983 Estimated Costs per NMR Imaging Study by Type of Magnet

	Resistive (0.15 T)	Permanent (0.3 T)	Superconductive (0.5 T)	Superconductive (1.5 T)
Single shift, 5% maintenance, 10 procedures per day:				
Annual cost	$449,634	$632,716	$776,150	$ 955,311
Cost per procedure	$ 180	$ 253	$ 310	$ 382
Double shift,* 7% *maintenance, 20 procedures per day:				
Annual cost	$604,009	$804,591	$948,025	$1,139,686
Cost per procedure	$ 121	$ 161	$ 190	$ 228

SOURCE Table 16

fees will likely range between $180 and $382, depending on the type of magnet system employed (see tables 16 and 17). However, Joseph P. Whalen, Chief of Radiology at The New York Hospital-Cornell Medical Center, New York City, recently estimated the cost of an NMR study as $700 (111), and recent industry estimates range from *$382-$632 (66) to $500-$700 (159).* This range of estimates derives from differences in underlying assumptions and suggests that it is too early to make cost-per-study estimates with much precision. In particular, lower estimates appear to reflect personnel and maintenance costs more typical of routine operations of a settled and defined technology, not of one still in an uncertain and developmental phase.

PATIENT-CARE COSTS

To consider only capital and operating expenses in a discussion of the fiscal impact of NMR imaging on hospital costs (or health care costs in general) ignores the effect of NMR imaging on patterns of patient management. Although physicians, hospital administrators, and health care researchers have alluded in the past to the importance of technology's effect on patterns of patient management, techniques for estimating the magnitude of a technology's effect on health costs are fairly primitive. With the advent of prospective, per-case systems of hospital payment, however, it has become increasingly important, particularly with regard to decisions to acquire new technology, for hospital managers to be able to explicitly assess the expected marginal cost of new services in relation to projected marginal benefits *(102).*

Regardless of the potential attractiveness of NMR imaging (or spectroscopy) as a diagnostic or research tool and the potential of NMR to be a cost-saving addition to physicians' diagnostic armamentarium, the actual impact of NMR on health care costs will depend not only on its diagnostic efficacy, but also on how it is employed by physicians in actual practice situations. Several factors should be considered in this regard. The first is the extent to which NMR imaging is performed instead of, as opposed to in addition to, other diagnostic modalities in the management of specific patient complaints or disease entities. It is possible, for example, that NMR will be used to assess the existence of lumbar disc protrusion in the evaluation of patients with low back pain, since it can provide excellent images of the vertebral column. To the extent that NMR imaging substitutes for the more invasive and risky technique of myelography (in which a radiopaque substance is injected into the spinal arachnoid space), NMR may decrease the cost of managing and increase the quality of care of such patients. To the extent that NMR is used in addition to myelography, however, NMR might improve patient care, but at additional expense.

A second determinant of NMR's impact on health care costs is the extent to which it will be used in situations in which no diagnostic modality is currently used.[1] Since NMR use does not involve radiation risk, such "newly induced" test usage may occur frequently. Consider, for example, the patient with low back pain alluded to previously. Patients suspected of having low back strain might in the future undergo NMR scans to confirm the clinical assessment of strain, rather than being treated with bed rest, heat, and analgesics without the use of any diagnostic imaging modality. Such use of NMR is likely to increase health care costs.

Two other potential newly induced test uses can be foreseen with the introduction of NMR. The first is "sequential NMR scanning" (see ch. 2) to monitor the natural history of disease in patients with atherosclerosis, multiple sclerosis, cysts, etc., in whom symptoms have either increased, decreased, or even not changed. The second is "sequential NMR scanning" to monitor therapeutic progress in patients being treated for cancer, infections, etc. The extent to which NMR will, in fact, be used in such a fashion should be determined by the sensitivity and specificity of the technique in each clinical application. The impact such

[1]This could be considered a special case of "add-on, " with the patient history and physical examination being construed as diagnostic tests,

usage will have on health care costs will depend on the as yet undemonstrated extent to which such usage decreases or increases total patient management costs in addition to improving diagnostic information or the quality of patient care.

Recent analyses have suggested that over the past decade there have been striking increases in the amount of real inputs employed both per patient-day and per admission in U.S. hospitals *(48).* It is much too early to determine the aggregate effect of NMR imaging on patient care costs. Much will depend on such factors as how much surgery is avoided, whether hospital lengths of stay are shortened, and whether diagnostic workups that were previously performed in the hospital are shifted to the outpatient setting.

With the advent of prospective, per-case systems of hospital payment and increasing competition in health care, it is likely that those vested with the responsibility for making decisions regarding the acquisition of new technology such as NMR for hospitals will increasingly feel the force of two conflicting incentives. On the one hand, there will be the already mentioned fiscal pressure to be increasingly discerning of the patient care benefits compared to costs associated with acquisition of new technology. On the other hand, there will be pressure to offer the "best" and most recently available services in order to protect (or increase) an individual hospital's share of patients in the increasingly competitive market for patients. Whether and how hospital directors will obtain the type of information necessary to make such decisions may determine not only which hospitals survive in the current economic climate, but also the rate at which they acquire promising new technology such as NMR imagers.

HOSPITAL STRATEGIES

Introduction

Different segments of the hospital industry have employed different strategies for determining whether, when, and what type of NMR imaging equipment to buy. Each strategy and subsequent acquisition decision reflects the priorities of the hospital-industry segment or of particular hospitals within a segment and provides insights not only into technology assessment as practiced by hospitals, but also into hospitals' perceptions of the state of development of NMR imaging technology. An attempt has been made in this section to describe the acquisition strategies and decisions of three different segments of the hospital industry: university teaching hospitals and major medical centers; the Veterans Administration; and investor-owned hospital chains.

University Teaching Hospitals and Major Medical Centers

The Acquisition Decision

Most of the early NMR units acquired by hospitals have been installed in university teaching hospitals or major medical centers. This is not surprising given the interest such hospitals have in performing research and being at the "cutting edge" of medical developments, the manufacturers' need to have research performed in order to obtain FDA premarket approval, and the tendency of such hospitals to have large numbers of beds and a complicated mix of patients.

In addition to these forces driving university hospitals to acquire NMR imaging technology early on, several benefits that have accrued to those university hospitals that were among the earliest to acquire NMR imaging systems may help explain their acquisition decisions.

First, university centers have been able to use their special strengths to obtain NMR imaging systems from manufacturers at decreased or even no cost, Among the assets that university hospitals offer to manufacturers are: 1) their ability to provide a "laboratory setting" in which clinical data, needed by manufacturers for preparation of an FDA premarket approval application (PMAA), can be collected; 2) their special research talents in basic science, engineering, and clinical trial design, from which manufacturers have derived benefits in the form of improved system design, help with PMAAs, and publicity from publications in

professional journals or presentations at professional meetings; and 3) the prestige associated with their institutions, which manufacturers' marketing divisions can convert into an effective form of advertising.

Second, because many of the university hospitals that were first to obtain NMR systems did so at little or no charge, they have ironically protected themselves from much of the cost associated with technological obsolescence.[2]

Third, the "price" and operating costs of these experimental systems are often partly subsidized by research grants provided to the hospital by the manufacturers.

Fourth, because many university hospitals have shared their NMR imaging systems with nonhospital university researchers, some of the acquisition expenses were often shared with the university. Finally, those hospitals and universities that obtained NMR imaging systems early are now in a position to capitalize on any research funds that will be awarded in early 1984 by the National Cancer Institute as part of its "Comparative NMR Imaging Studies" program (see ch. 6).

These observations suggest that many of the university hospitals that have obtained NMR imaging systems to date may have done so partly because they did not have to be so concerned with acquisition and early operating costs as other hospitals have to be.

Interestingly, in the case of NMR, a second opportunity to capitalize on university teaching hospital assets is now emerging for those hospitals that did not benefit the first time around. This second opportunity derives from the fact that increasing numbers of manufacturers are beginning to offer high field strength (1.5 T) NMR systems on which spectroscopic applications (an area in which many universities are replete with talent) need to be explored. These second-round hospitals can be expected to be fewer in number than those in the first round and are likely to obtain their benefits in the form of "two-for-one" bargains in which a 1.5 T system and a lower field strength system are obtained for close to the price of the lower field strength systems. Second-round buyers will benefit from the experience in site-planning gained by first-round hospitals.

Choosing a Manufacturer (or University)

Manufacturers have tended initially to install equipment in prestigious university centers. There is little information available on whether these first-round hospitals sought out the manufacturers or whether the manufacturers courted the hospitals, In some instances (such as Siemens and Washington University in St. Louis), installations have been a natural consequence of longstanding business relationships and research collaborations.

Several factors can be expected to influence university teaching hospitals' choices of manufacturers in future rounds of buying. Potentially most important are the hospitals' perceptions of a manufacturer's survivability in the NMR industry, the NMR system's features and capabilities, image quality, system reliability (up-time), manufacturers' interest in collaborative research, and the effect of a hospital's choice on its existing relationships with radiology equipment manufacturers. Potentially of lesser importance to university hospitals interested in performing research are price, protection against early obsolescence, and delivery time. To the extent that a research collaboration evolves, good service and technology upgrades (software and hardware) can be expected.

The Veterans Administration[3]

The Veterans Administration operates 172 medical centers nationwide in 6 regions and 28 districts

[2] 'Although NMR imaging systems will undoubtedly change over time, some experts believe that the changes in the hardware will be much less dramatic than those that have occurred with X-ray CT scanners. Aside from the ***possibility*** that low field strength resistive systems will become obsolete compared to higher field strength superconducting systems (which could be a concern for those "early bird" hospitals that acquired resistive systems), NMR systems may simply evolve through a continuing series of upgrades in software and minor changes in electronics (90). With X-ray CT scanners, in contrast, the entire set of electronics as well as the reconstruction algorithm, and other parts of the system are specific to the particular gantry being used. Thus, improvements have come in generations rather than through a process of simple upgrades (90). One other issue to be considered in this regard is that "early bird" hospitals might also have to redesign their facilities in the future to accommodate changes in magnet design or field strengths.

[3] The information in this section was drawn from a personal communication with S. Smith (171).

on an annual medical service budget of $7 billion to $8 billion. Of these 172 medical centers 130 have onsite nuclear medicine services, and 80 to 90 have X-ray CT scanners.

The VA central office must approve acquisition of technology costing more than $100,000 (a sort of "certification-of-need" (CON) analog). These high-cost items are apparently not considered part of the budgets allocated to individual hospitals, districts, or regions by the VA central office.

The NMR Decision

The VA's interest in acquiring an NMR imager originated in the VA central office rather than in one of its hospitals. In December 1981, after a presentation by an NMR manufacturer, VA elected to defer acquisition of an NMR system.

In early 1983, the VA decided to initiate what could become a program of staged acquisition with a single NMR demonstration and evaluation project. This decision derived from an interest in "helping the VA march into the future" (171). No estimates of the fiscal impact of NMR on the cost of patient care were made. The decision to restrict the initial purchase to a single unit emanated from a concern about the rapid rate at which NMR technology was changing and the desire to avoid installing a large number of systems that might soon become obsolete.

Choosing a Manufacturer

In early 1983, the VA solicited bids from manufacturers for a single system. No specifications were given regarding the type of magnet desired. Two bids, both for 0.15 T resistive magnet systems, were received.

Three factors guided the VA in its final choice of a system and manufacturer. First was a concern about manufacturer "corporate durability. " (The VA regrets having bought six to eight X-ray CT scanners from Pfizer, which subsequently stopped manufacturing X-ray CT systems.) Second was evidence of a manufacturer's proven *rec*ord of reliability in its already existing installations. Third was price.

Choosing a Site

The 0.15 T system obtained by the VA was to have been installed in the Cochran VA Hospital in St. Louis in October *1983.* This decision was again made centrally with interest expressed by the Cochran VA. Three factors were considered in the choice of an installation site: the site had to have all other major diagnostic imaging *mo*dalities, a proven ability in high technology, and a good working relationship with the university with which it was affiliated. NMR expertise was desirable, but not necessary. CON controls were not a consideration because they do not apply to VA installations.

Site Operations

The NMR imaging system will be under the control of the hospital Chief of Staff, rather than being placed in either Radiology or Nuclear Medicine, This administrative decision was made to help foster the multidisciplinary team effort that the VA would like in its NMR program. Research protocols *will* be developed with input from the St. Louis staff, the VA central office, and outside consultants. The VA has not yet allocated monies specifically for NMR research. It should be recalled that the VA does not charge its patients. The VA will be getting a small research grant (approximately **$75,000** per year for **2** years) from Technicare, the manufacturer of the VA's unit.

Future NMR Acquisitions

In June 1983, Dr. Donald Custis, the Chief Medical Director of the VA, formed a High Technology Assessment Group to determine what course the VA should follow with respect to acquisition of major new technology such as NMR imagers (e. g., what type, how many, over what time period).

Investor-Owned Hospitals

Humana[4]

Background.—Humana, based in Louisville, KY, owns or operates 92 hospitals. Humana has

[4]The information in this section was drawn from a personal communication with F. D. Rollo (153).

invested considerable effort in an assessment of NMR technology over the past 2 years. It has actively monitored NMR developments and discussed the technology frequently with manufacturers to help it decide what and when to buy. In addition, Humana has undertaken an interesting joint venture with Vanderbilt University, Through this arrangement, Humana obtains detailed information from Vanderbilt regarding NMR installation and operating costs, advice from Vanderbilt personnel regarding important questions to pose to manufacturers, and data from clinical studies. In return, Humana helps Vanderbilt obtain special consideration regarding price, software, and access to scientific and engineering expertise from the manufacturer(s) hoping to obtain a high-volume purchase agreement from Humana. (Humana conducted a similar joint venture with Vanderbilt before purchasing digital radiography equipment for Humana hospitals.) Humana is also providing a grant to Vanderbilt to assess the value of NMR in community hospitals.

The NMR Decision.—Although Humana has not made final decisions regarding what type(s) of and how many NMR systems to buy, it will probably buy in a phased approach, beginning with a purchase of three systems in the near future. Humana feels that such an approach will enable it to conduct an in-house evaluation of NMR, yet take advantage of future progress in the development of NMR imagers, particularly the possibility that permanent magnet systems will become more practical for smaller hospitals.

Humana's decision to acquire an NMR system(s) in the near future is based more on strategic considerations than on a belief that NMR's clinical role has been proven. These considerations are that Humana should not depend on either manufacturers or university hospitals to determine the optimal type of NMR system and NMR clinical applications in community hospitals.

Choosing a Manufacturer.—Humana identified seven criteria that it would employ in choosing a manufacturer: corporate durability, system quality, system reliability, how NMR information is related to the user, manufacturer agreements related to upgrading of a purchased system, quality of a service program, manufacturer's interest in collaborating with Humana's research interests, and price. Of these, price was considered to be the least important and corporate durability the most important.

Site Selection.--Humana considered three main criteria in determining which of its hospitals were appropriate for installation of NMR imaging systems. Appropriate hospitals were considered to be those with: 1) multispecialty practices with heavy emphasis on the neuroscience, oncology, and cardiovascular diseases; 2) high-volume outpatient services; and 3) adequate land for creation of an outpatient diagnostic center that would include, but not be limited to, NMR imaging equipment. In addition to these primary criteria, consideration was also given to the existence of NMR expertise among hospital staff and to whether NMR facilities would enhance the Preferred Provider Organization (PPO) and Health Maintenance Organization (HMO) programs Humana is developing. Finally, since Humana intends its NMR facilities to serve as community resources, it has sought to place them in areas with large patient populations.

Using these criteria in conjunction with in-depth financial analyses, Humana has identified three of its hospitals as appropriate for NMR installations: one each in St. Petersburg, FL *(300* beds), Louisville, KY *(484* beds), and Dallas, TX **(600** beds). CON applications have been filed for two of these installations (the Louisville application was approved in September 1983), and a letter of intent has been filed for the third.

Site Operations.—Humana plans to undertake an educational program for the administrators and medical staff of the hospitals in which the NMR systems will be installed. These programs will deal with NMR in general and with physicians' use of NMR in diagnostic strategies, Access to an NMR system within a hospital will be governed by that hospital. Hospital administrators may undertake studies to evaluate the impact of NMR on the cost of managing various types of patients.

Future.—Humana could purchase as many as 12 NMR imaging systems over the next 3 to 5 years,

AMI Diagnostic Services, Inc.[6]

Background.—AMI owns **90 hospitals** and plans to build **50** to 100 freestanding diagnostic centers that will be affiliated with physician groups or hospitals. When considering the acquisition of new technology, AMI generally tries to assess whether the new technology will replace existing technology, whether it will do so at less cost, and whether it will shorten the length of inpatient stays. AMI requires an expectation of 20 percent return (pre-tax) on any of its investments.

The NMR Decision.—AMI started its strategic planning related to NMR technology in October 1982. It views NMR as safe and effective, especially in necrologic applications. It has questions, however, regarding the potential applicability of NMR to body imaging. AMI estimates that initial patient throughput is likely to be 10 to 15 patients per day per machine. Because of continued uncertainty regarding when reimbursement for NMR imaging will be approved, whether reimbursement for NMR will be sufficient to cover its costs, the safety regulations regarding siting requirements that State and Federal agencies will impose, and the impact a decision not to acquire NMR imaging technology will have on AMI's professional staff, AMI has not yet decided whether or when to acquire an NMR imaging system.

Choosing a Manufacturer.—The three most important criteria identified by AMI for choosing a manufacturer were perceived corporate longevity, service quality, and reliability (up-time) based on experience in existing installations. As was the case with other hospital chains, price was a less important consideration. Once the field is narrowed to manufacturers satisfying these concerns, AMI will leave the final decision to individual hospitals and physicians. AMI does establish national contracts for maintenance of its equipment, however.

Site Selection.—AMI identified four characteristics for determining which of its hospitals would be appropriate sites for installation of NMR imaging equipment: bed-size (greater than *250* beds), patient mix (heavy emphasis on necrologic and cardiac disease), large outpatient volume, and a dominant position in the community. Using these criteria, AMI currently considers 12 of its *90* hospitals to be appropriate for NMR installations and is applying for a CON in each of these cases.

Site Operations .—AMI does not intend to impose control over physician decisionmaking regarding use of NMR. It does intend, however, to implement a physician-education program pertaining to NMR and diagnostic-test-ordering strategy in general.

Future.—If AMI decides to purchase NMR equipment, it could purchase *50* to 100 units for its planned diagnostic centers and 12 units for hospitals, over a **24-** to 36-month period.

National Medical Enterprises, Inc. (NME)[7]

NME owns, operates, or manages **339** acute, psychiatric, and long-term hospitals.

NMR.—NME began its strategic planning for NMR in October 1982. At the present time, NME does not plan to budget for NMR equipment until fiscal year 1986. It is maintaining close communication with manufacturers and with institutions that have already acquired NMR devices, however, to be aware of developments that might lead to a change in plans.

NME decided to defer acquisition of NMR technology because of its uncertainty regarding which magnet types and field strengths would prove to be most effective and whether separate systems would be required to perform proton imaging and spectroscopic analysis.

Site Selection.—NME has not decided which of its facilities would be appropriate sites for placement of NMR technology. It did believe that it would tend to put NMR imagers in its larger facilities, however.

Site Operations.–NME believes that NMR technology in the near future will be complementary to, rather than competitive with, X-ray CT.

[6]An American Medical International, Inc , health care subsidiary. "The information in this section was drawn from a personal communication with 1. Atkins (10).

[7]The information in this sesction was drawn from a personal communication with D. Reynolds (152).

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Lifemark[8]

NMR.—Lifemark owns or operates 30 hospital facilities. Since it began assessing NMR imaging technology in early 1983, Lifemark has attempted to keep abreast of NMR developments and to assess the instruments manufactured by various companies. It has made no decision regarding whether or when to acquire NMR imaging equipment, because it would like to be fairly certain that third-party payment is forthcoming before deciding to acquire NMR technology. It has as yet made no assessment of the likely impact of NMR on total patient-management costs.

Choosing a Manufacturer.—The major factors considered by Lifemark in any major equipment purchase are corporate durability, service commitment, and protection against technological obsolescence (as evidenced by manufacturers' ongoing R&D programs and willingness to supply software or hardware updates).

Site Selection. --Lifemark believes that the three hospitals it owns that have more than *300* beds and the one 300-bed hospital it has under construction will be the most likely early candidates for NMR imaging technology. Smaller hospitals that have a strong neurological or neurosurgical orientation would also be potential candidates, Lifemark's Columbia Regional Hospital in Missouri, a 300-bed general medical-surgical, multispecialty referral hospital, expressed an interest in obtaining an NMR unit over a year ago. Although the hospital received CON approval in March 1983, no definite purchase decision has been made.

Site Operations.—No definite decisions have been made regarding how NMR units would be utilized in hospitals. Any restrictions on NMR use would depend on the type of payment that is approved by third-parties,

Future.—Lifemark anticipates the possibility of purchasing four NMR imaging systems over the next *3* to **4 years.**

Hospital Corp. of America'

Background. -Hospital Corp. of America (HCA) owns 150 hospitals and manages 150 others. It has an internal diagnostic-imaging technology advisory board that has traditionally taken a cautious approach to acquiring new technology. This approach has often resulted in HCA's getting new equipment up to 18 months after other hospitals. Recently, HCA decided that it would like to begin evaluating new technology such as NMR at an earlier point in the technology's evolution. This decision is based on the need to generate information regarding the likely role, operating costs, and patient throughput for new imaging technology in community hospital settings. (HCA has concluded that data emanating from university hospitals are not always applicable to their community hospitals.) In addition to recognizing the need for this type of information, HCA believes that it has sufficient numbers of 300- to 400-bed hospitals to be able to generate this information internally and that such information could help manufacturers obtain FDA and third-party payment approval.

The NMR Decision.—With this strategy in mind, HCA has decided to purchase five NMR systems—one 0.15 T resistive system, three 0.5 T superconductive systems, and one permanent-magnet system—from four manufacturers (Technicare, Picker, Philips, and Fonar), enabling HCA to evaluate several different magnets and manufacturers simultaneously. Each of the five hospitals earmarked to receive an NMR unit has analyzed the likely financial impact of introducing NMR on its patient care costs.

Choosing a Manufacturer.—HCA considered several factors in choosing the manufacturers: perceived corporate durability; maintenance capabilities; expected delivery time; and interest in HCA's research programs, as manifested by a willingness to supply onsite product specialists to help HCA evaluate instruments in community hospitals and to ensure that HCA obtains software updates. In

[8]The information in this section was drawn from a personal communication with K. Harville (82).

'The information in this section was drawn from a personal communication with R. Bird (16).

general, HCA likes to obtain equipment from at least two, but not more than three, preferred manufacturers. HCA believes that such a strategy helps ensure against a manufacturer's "getting lax" in service and being unable to accommodate all of HCA's needs. Within this limited range of potential manufacturers, HCA permits each of its hospitals to make its own acquisition decision.

Site Selection. --HCA considered four primary criteria in choosing the five sites for initial installations: bed size *(250* to *400* beds); type of hospital (acute-care hospital with a large nearby clinical referral base and a sophisticated emergency room capable of handling trauma patients); type of patient-mix (with neurology, oncology, cardiology, and orthopedics emphasized); and degree of sophistication of the hospital's imaging department. On the basis of these criteria, HCA decided to install three units in 400-bed hospitals and two units in 250-bed hospitals. *10* Each of these hospitals have either applied for or are in the process of applying for CON.

Site Operation.—Each NMR facility will be operated as a separate cost center to improve the quality of financial information pertaining to the use of NMR. NMR units will be installed within imaging departments, which include both Radiology and Nuclear Medicine. Physician education programs will be prepared. The various NMR facilities may have different clinical emphases, depending on manufacturer needs.

Future.—The first stage of HCA's evaluation will involve five or six installations. Over the next **5** years, HCA could obtain as many as **25** to *50* NMR imaging systems.

Conclusions

Organizations that own or operate multiple hospitals seem to be employing two different strategies regarding acquisition of NMR imaging equipment. The first strategy is to obtain one or more NMR imaging systems as part of an in-house evaluation project to guide future decisions regarding acquisition of the technology. The alternative strategy is to defer any acquisition until additional information about NMR is available. What is clear is that no one considers it advisable to make large-scale purchases of NMR imaging equipment at this time. Although all hospitals are concerned about the impact of NMR on total patient management costs, only Humana and HCA appear to have conducted a formal, patient-management, cost-impact assessment. Finally, while many university teaching hospitals are able to use their prestige to obtain "favored status" from manufacturers, companies that operate chains of hospitals are able to elicit special consideration from 'manufacturers because of their buying power. The VA could capitalize on its potential to make high-volume purchases by following HCA's approach of designating a small number of preferred manufacturers.

[10]The five hospitals are Chippenham Hospital in Richmond, VA; Medical Center Hospital in Large, FL; West Florida Hospital in Pensacola, FL; Coliseum Park Hospital in Macon, GA; and Parkview Hospital in Nashville, TN.