Evaluating Uses of Information Technology in Health Care Administration

Jerry Post, (Post@wku.edu), Western Kentucky University
Albert Kagan, (aaajk@asu.edu), Arizona State University

Abstract

An introductory study of health-care providers reveals that larger institutions are earlier adopters of many technologies. For-profit institutions may be earlier adopters of technology in general, but they lag other firms in terms of some patient-care and research technologies. Healthcare institutions in general are adopting administrative transaction processing technologies first, with substantially longer delays in patient care and decision-support technologies.

Introduction

There are two major issues facing health care facilities: (1) increased pressure to reduce costs and (2) a move towards for-profit status and consolidation of facilities into a few large health-care organizations. As in other industries, Information Technology plays an important role in cost control and innovation.

To date, implementation of information technology within the health care sector has largely been limited to basic billing, insurance transactions, patient records and diagnostic applications (Greenes [1993], Minard [1994]). The personal care nature of the industry, high costs of technology, limited health-care specific software, and low-budget operations have all been cited as factors in the limited usage of IT (Blau [1993]).

Despite the limitations, a number of new technologies are being developed for health care administration (Minard). Some are borrowed from other industries, while specific technologies that are relatively unique to health care are also becoming available (Valentino, Mazziotta, and Huang, 1991). The basic technologies are listed in the sample copy of the survey. The list was derived from case studies of industry leaders and from innovative uses of information technology as it pertains to health care delivery.

There appears to be a movement towards more effective software development within the health care industry that will address work flow issues, accessibility of information, groupware applications, cost containment and data security needs. Various studies have indicated the need for a strategic view of medical information systems with respect to declining government reimbursements and enhanced third party/insurance intervention (Gritzalis et al [1991]. Gritzalis et al [1992], Ikeda, Ishigaki, and Yamauchi [1995], Lilienthal [1995]).

Readers with comments or questions are encouraged to contact the authors via e-mail.

Typical developments in the use of information and computer technology within this industry have been directed towards diagnostic and patient health issues (Michael and Nelson [1989]. Valentini, Mazziotta, and Huang [1991]. Manos et al [1993]). Multimedia applications have been used in conjunction with database developments to support advanced diagnostic procedures (Chu, Cardenas, and Taira [1995]).

Issues pertaining to the cost relationships of medical information systems are starting to be explored from a cost-benefit basis (Glandon and Shapira [1988]. Glandon and Buck [1993]). Woodward and Boxerman [1994] studied the impact of IS spending on the returns to hospitals from a perspective that information value goes beyond the basic cost response approach. Given the varied nature of IS usage within the medical industry, this study was designed to classify IS usage by different health care providers.

The objective of this study is to determine the extent to which health care organizations are currently implementing new technologies and to what extent they are planning to expand their usage in the next few years. The goal is to identify technologies that are especially useful. By collecting data on preferences and the current environment, it is also possible to forecast future usage and to identify strengths and weaknesses of the tools (products) within different types of health care organizations.

Methodology

To improve response rates, the survey instrument is kept relatively simple. Additional data can be obtained from health care industry publications. The basic data gathered from the instrument is a usage rating for each specific technology. For each technology application, respondents are asked to indicate the current usage level, from heavy usage, to experimental usage, to no plans to use the technology. A copy of the survey instrument is included within the Appendix.

Initial Hypotheses

1) Do for-profit health care organizations have a different demand/usage of IT? Null hypothesis: the implementation of technology is randomly distributed across types of health care organizations.
2) Is organizational size (health related firms) an issue in implementing new technologies? Null hypothesis: technologies are randomly implemented without regard to organization size.
3) Are some technologies (or categories) more important to health care organizations? Null hypothesis: technologies in the list are of equal importance and implemented randomly.
4) Do health care organizations utilize and implement IT in particular combinations (e.g., financial records, patient relationships, care delivery). Null hypothesis: Health care organizations randomly implement technologies from all categories of technologies.

Survey Methodology

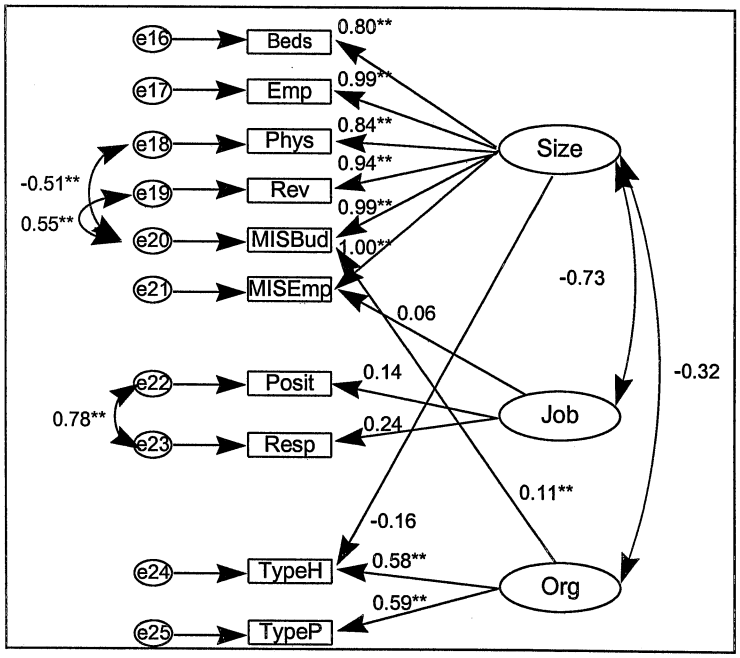
In light of the difficulty of obtaining responses, the survey was conducted via telephone interviews with 50 health care providers, representing various industry segments. A FAX or mailed copy of the survey was provided to participants for ease of response during the phone interviews. Obtaining responses is highly labor intensive and time consuming, but the methodology limits misperceptions and ensures reliable responses.

Responses to the technology questions were first evaluated in terms of internal consistency. The Cronbach alpha is 0.896, which indicates a fairly high level of consistency within the survey instrument (Cronbach [1951]). Typically a Cronbach alpha of 0.80 is considered as an acceptable measure of internal validity of a survey instrument.

Some of the survey data was obtained by placing the instrument on an Internet Web site.

Respondents were asked to answer the questions using their Web browsers instead of traditional pencil and paper responses. These responses were compared to the original set, both in means and as a new independent variable. There was no significant difference in the responses or results from this technique. However, the technique needs additional testing before it can be used for a complete survey. For now, it is best to obtain some traditional responses that can be compared against the Web delivered survey.

Figure 1. Latent Variable Relationships



Results

A model was estimated using a latent variable approach. The complete model is cumbersome to display in one piece. Instead, it is displayed in its three components. The first section examines the latent variables that describe the respondent characteristics. The second section evaluates the information technology factors and classifies the various uses of technology. The final step is to connect these two halves to determine how individual health care attributes affect the use of the various types of technology.

Respondent Characteristics

The first section of the model and results categorizes the respondents into three factors: size of the institution, job characteristics of the respondent, and the organizational structure of the institution. The results indicate that these three latent variables are relatively accurate predictors of the individual characteristics.

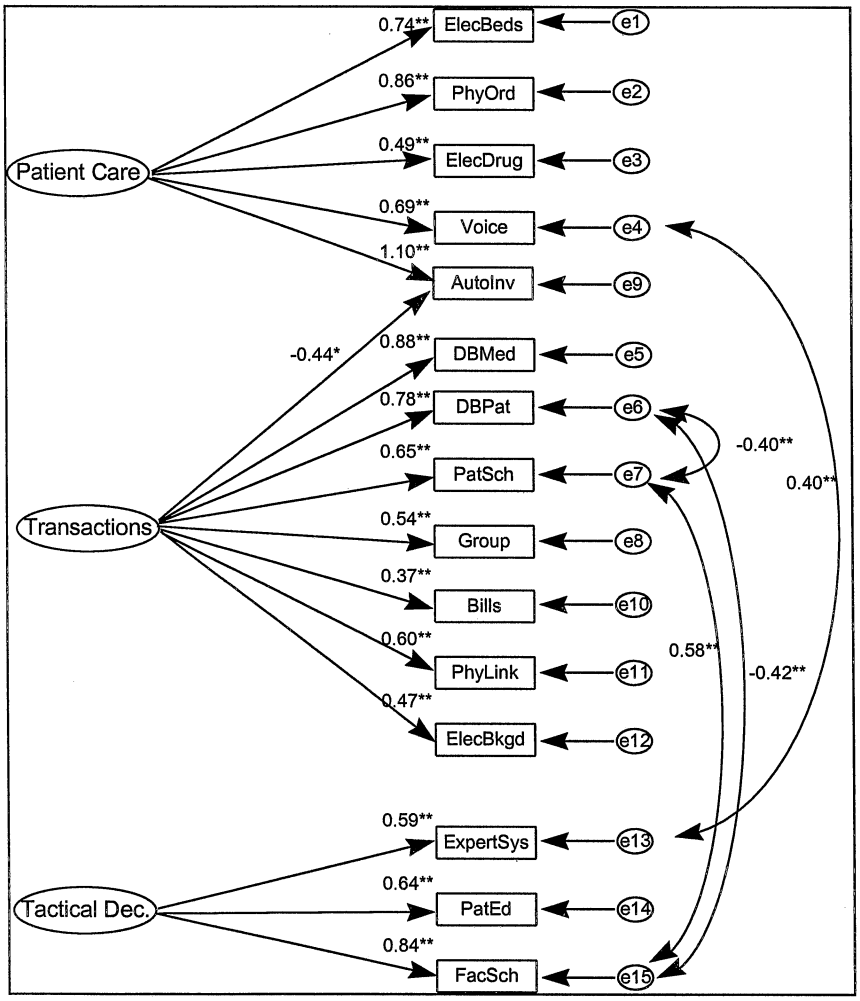
The first portion of the latent variable model is given in Figure 1. This figure identifies the relationships between three basic latent variables: organization size, organizational structure, and the respondent's job. Note that all of the measures of size are highly correlated. However, to avoid cluttering the diagram, not all correlation's are drawn in the figure. From a statistical standpoint, virtually any of the measures of size would be acceptable. The number of beds is commonly used in the industry. Also notice that the cross-factor regression coefficients (e.g., size to type of health care institution) are statistically insignificant. They were included in the base model to test for interrelationships between the variables.

Organizational structure is determined by two characteristics. (1) Type of health care, where lower values represent more general hospitals, higher values are smaller clinics. (2) Profit status of the organization, where 1 is public, 2 is private not-for-profit, and 3 represents private, for-profit. That is, higher numbers represent institutions with a greater financial motive.

Uses of Information Technology in Health Care

A primary component of the survey identifies the various uses of information technology. Factor analysis on preliminary data identified three primary factors or uses of technology, which have been labeled: (1) patient care, (2) transaction processing, and (3) tactical decisions. Note the strong standardized regression coefficients on components within each fac-

Figure 2. Factor Uses of IT



tor. A few additional cross-factor relationships were also tested, (e.g., patient care to medical and patient databases), but the relationships were insignificant (Figure 2). Overall results indicate that these three latent variables accurately classify the information technology studied.

Two common levels of business decisions are reflected in these three categories: operations and tactical management. Note that in the health-care industry, information technology related to patient care also focuses primarily on the transaction decision level.

Primary Relationships

Goodness of Fit

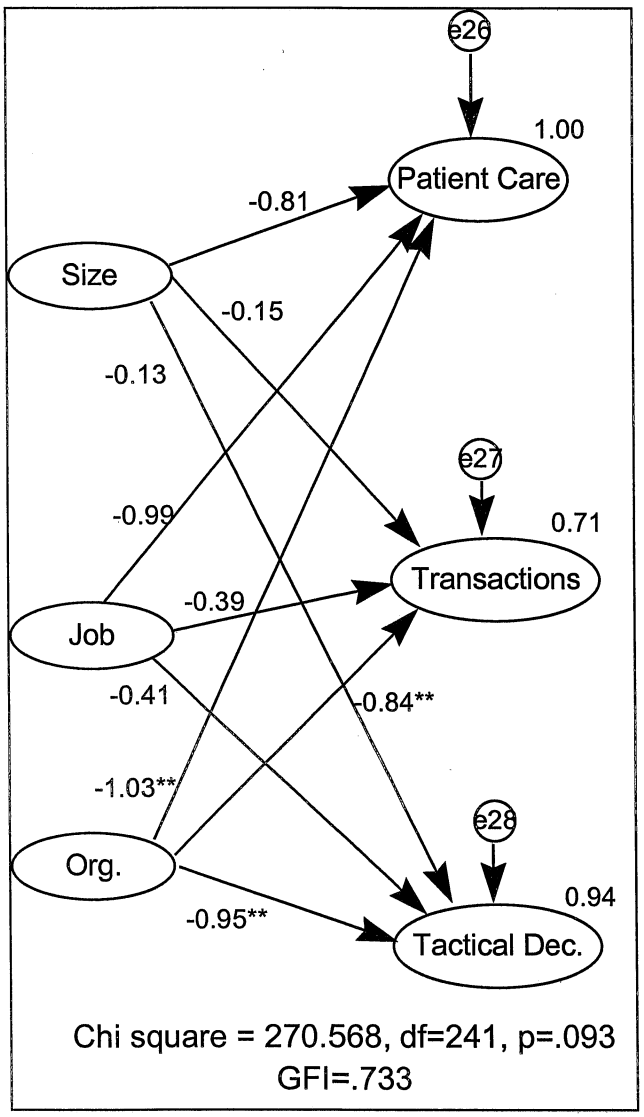
Figure 3 represents the main effects in the model. It incorporates portions of Figures 1 and 2 to highlight the relationships between the important variables. The goodness-of-fit measures are also given. Note that the overall model is reasonable with a goodness-of-fit over 70 percent. Also, the values of the individual squared - multiple correlations are relatively high — particularly for a cross-sectional study. Overall, the results indicate an accurate model.

Organizational Structure

The regression coefficients related to organizational structure are particularly important. All three coefficients are significant at a 1% level. More importantly, the relationships with the technology variables are negative. Increasing technology was coded so that higher values represent a heavier use of technology. In evaluating the organizational structure, higher organizational structure values reflect an increased for-profit organization. Hence, the negative relationship indicates that for-profit health care organizations tend to use lower levels of information technology. In particular, they delay adoption of all three types of technology.

As further analysis indicated, the model was tested without the latent organizational structure variable, which enables testing the two components separately. The results did not change, except that the relationship between Type H and Transactions is not significant. Similarly, the relationship between Type P and Patient Care is not significant. The interpretation is that not-for-profit and for-profit institutions are not significantly different in their adoption of technology for patient care—when size or type of

Figure 3. Model Main Effects



institution is not examined. After factoring in the type of institution (general hospital versus smaller clinic), the smaller, for-profit clinics are later at adopting technology for patient care.

Institution Size

In general, the relationships between institution size and the use of information technology are not significantly different from zero. However, the relationship between size and patient care is relatively high (and negative). The implication is that larger institutions make more use of information technology in patient care. The lack of significance in the relationship is due primarily to the high variance of the responses.

Respondent Characteristics

Overall, the evaluation of the information technology is unaffected by the job situation of the respondent. This result is important because it means that both IS staff and administrative managers are generally consistent in their evaluations. While the respondents are from different institutions, it is useful to know that the IS staff and management have essentially the same views on IS applications.

Financial Structure

Is IS technology use affected by the financial structure of the organization—particularly with respect to for-profit and not-for-profit? The basic results say "Yes." A more detailed comparison is presented in Table 1. Each of the three organizational structures is examined against the others by computing T-Test differences between the means.

In general, the public institutions reported a greater use of information technology than both the for-profit and not-for-profit institutions. The not-for-profit institutions were substantially below the others in adopting new technologies. The numbers in Table 1 are coded so that higher means represent a greater use of the technology (9 is effectively the highest score). Note that the strength of the private for-profit institutions comes largely because of the weakness of the not-for-profit sector. The not-for-profit institutions reported significantly less use of technology in nine specific categories. They reported substantially lower uses of virtually all types of information technology; including patient care, transaction processing, and tactical decisions.

Public institutions were significantly higher in the use of information technology for patient and facility scheduling, tracking physician orders, and in introducing groupware tools. Clearly, the public institutions, which are generally research-based, are driving the introduction

Table 1. Firm Structure by IT Usage

Structure	Technology	T-Probability	Mean	Mean of Others
Private/For Profit	Database—Medical	.035	7.53	6.53
	Overall	.000	6.90	5.98
Public	Physician Orders	.014	7.64	6.08
	Patient Schedule	.050	8.64	7.12
	Facility Schedule	.007	8.73	6.27
	Groupware	.015	6.91	4.73
	Overall	.000	7.18	6.05
Private/Not Profit	Physician Orders	.002	5.05	7.05
	Electronic Drug Disp.	.031	4.14	5.85
	Auto Inventory	.015	5.24	6.70
	Patient Schedule	.004	6.48	8.10
	Facility Schedule	.000	5.19	7.85
	Patient Education	.005	4.90	7.25
	Database—Medical	.003	5.43	7.70
	Database—Patient	.048	5.52	7.25
	Physician Links	.006	5.38	7.15
	Overall	.000	5.47	6.89

of information technology in the health care field.

Institution Size

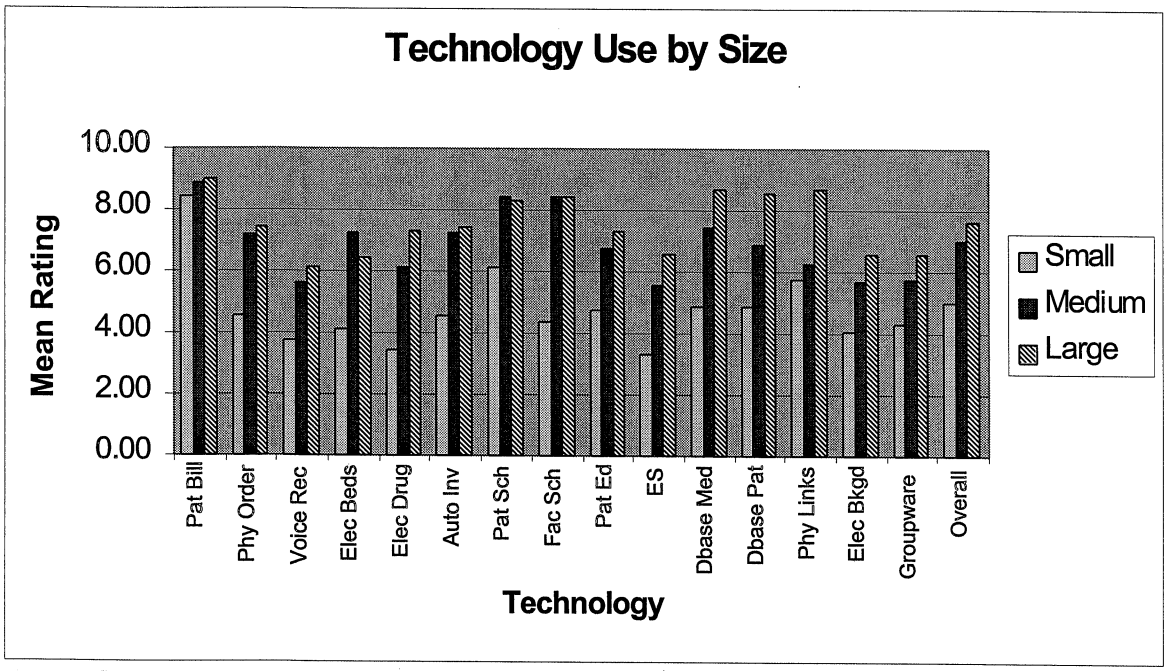
A second research question is whether or not firm size plays a role in the implementation of technology. There are several measures of size within the health care industry (number of beds, number of physicians, revenue, MIS budget, and MIS employees). All of these measures exhibited a high degree of correlation. Consequently, the number of beds is probably the most commonly used measure of size. In this study, the average number of beds was 280, therefore; the definition of "large" is any institution greater than average.

Utilizing number of beds as the measure of size, T-Tests were performed to examine differences between above- and below-average size institutions. The results are presented in Figure 4. The institutions were classified into one of three groups (Small with less than 100 beds, Medium with between 100 and 450 beds, and Large with over 450 beds). Notice that the smaller institutions significantly lag in their use of information technology—particularly in the use of technology for tactical decisions. The larger and medium-sized institutions were similar, except for the strength of the larger institutions in the use of technology for medical and patient databases, and links to physician offices. They are particularly strong in using technology for research and collaboration.

Comparison of Technology Factors

Another interesting question to examine is whether there is a pattern to choosing technologies. As a first step, consider the means displayed in Table 2. Notice there is a substantial difference between the technologies in heavy use (patient billing) and those that are merely under investigation (expert systems). Clearly some technologies are favored with earlier implementation. Glancing at the list, it appears that most of the items at the top of the list involve transaction processing data—patient billing, scheduling, and basic research data. More decision-oriented tasks involving group support and expert systems fall toward the bottom of the implementation list. A

Figure 4. Technology Usage by Size Category



conclusion that is supported by the latent variable analysis.

Since the prior section revealed a difference in technologies based on institutional size, an examination of the individual technologies relative to size is undertaken. Splitting respondents into two categories (above average and below average size), Table 3 evaluates the percentage of respondents reporting at least some current usage of a technology (responses 5 through 9 on the re-coded scale) versus those who are not yet working on adopting the technology. Table 3 illustrates that the larger institutions are adopting technology earlier in almost all categories.

Table 2

Technology	Mean	Interpretation
Patient Billing	8.75	Heavy use
Patient Schedule	7.55	Some use
Facility Schedule	6.86	Experimental
DB Medical	6.63	
Links to Physician	6.45	
DB Patients	6.39	
Physician Orders	6.25	
Auto Inventory	6.25	
Patient Education	6.04	In development
Electronic bedside	5.94	
Groupware	5.41	
Electronic background	5.29	
Electronic drug dispenser	5.25	
Voice recognition	5.08	Plan to develop
Expert Systems	4.84	

One technology stands out from the others: the development and use of Expert Systems. Virtually none of the smaller institutions are even considering adopting this technology—compared to over 50% and 75% of the medium and large institutions.

Summary

This study provides some insight into the use of information systems technology at medical institutions. More observations would be necessary to utilize the results for policy decisions, but the study indicates directions for future research. In particular, the differences be-

Table 3. Technology Adoption by Firm Size.

Table 3	Small		Medium		Large	
Description	Use	Not Use	Use	Not Use	Use	Not Use
General use of technology	0.95	0.05	1.00	0.00	1.00	0.00
Patient data for billing	0.95	0.05	1.00	0.00	1.00	0.00
Physician orders in database	0.43	0.57	0.91	0.09	1.00	0.00
Voice recognition for transcription and	0.19	0.81	0.68	0.32	0.71	0.29
Electronic bedside patient monitoring	0.33	0.67	1.00	0.00	0.86	0.14
Electronic drug dispensers	0.14	0.86	0.68	0.32	0.86	0.14
Automated inventory and replacement	0.38	0.62	0.91	0.09	0.86	0.14
Patient scheduling	0.67	0.33	1.00	0.00	1.00	0.00
Facility scheduling (e.g., OR and exam	0.33	0.67	1.00	0.00	1.00	0.00
Patient education	0.33	0.67	0.86	0.14	0.86	0.14
Expert System for diagnoses	0.05	0.95	0.59	0.41	0.86	0.14
Research databases—medical reference	0.43	0.57	0.91	0.09	1.00	0.00
Research databases—patient data	0.38	0.62	0.86	0.14	1.00	0.00
Links to external physician offices	0.57	0.43	0.82	0.18	1.00	0.00
Electronic background checks on new	0.24	0.76	0.64	0.36	0.71	0.29
Groupware tools for physician consulting	0.24	0.76	0.64	0.36	0.71	0.29

tween for-profit and not-for-profit or public institutions generates some concern. Given the growing trend of private firms acquiring not-for-profit institutions, policy makers need to carefully watch for differences between the two types of institutions. While for-profit institutions might have a claim to early adoption of technology in general, they appear to be concentrating on transaction-processing applications—presumably as cost-cutting measures. Technology that more directly affects patient care such as recording physician orders and medical database research, is generally implemented earlier in public and not-for-profit institutions. One source of the difference is likely due to the missions of the public teaching and research institutions compared to the mission of for-profit firms. Nonetheless, if these differences exist in the broader market, policy makers (and patients) should be concerned about the long-term level of care. If technology can provide better patient tracking, improved accuracy in physician orders, and medical research, the risk of reducing these applications as for-profit firms focus on cost containment may impact on service delivery.

Similarly, there is a substantial difference in the use of IS technology at larger institutions compared to smaller ones. As long as technology is focused on transaction processing, there are few problems with this variance. However, as technologies are introduced that directly affect patient care (e.g., voice recognition, automated drug dispensers, physician order tracking, and expert systems, enterprise information applications), patient care could be affected by the size (hence budget) of the institution.

Interestingly, few of the institutions were heavily involved in strategic applications such as links to physician offices and groupware projects to support teamwork. It would be worthwhile to track these statistics as consolidation increases within the industry. That is, will increasing consolidation make individual firms more competitive and more willing to utilize technology in a strategic fashion? These issues are consistent with the work of Minard who has discussed the use if IT with health care providers from the aspect of identifying the necessary critical success factors (CSFs) for a successful approach in addressing vendor support. Greenes has called for

the use of IT in the health industry for strategic purposes and has discussed the further use of ES, EIS, and KBS based systems.

Suggestions For Further Research

As medical information systems continue the transformation from transactional based applications to strategic based systems it would be desirable to understand the evolution of these systems in particular the impact upon the decision making process. The movement towards "for profit" hospitals brings the IS into the context of a strategic tool for better profit attainment. Further research into the usage of IT and IS within the "for profit" health care sector is needed. In a general view how are medical information systems being integrated into the overall patient health delivery process from the perspective of record maintenance, diagnosis, third party insurance interactions and medical decision support.

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Appendix
Medical Care Facility Usage of Information Technology

Size of facility: Number of Beds _____ Employees _____
Number of associated physicians _____
Approximate Annual Revenue _____
Size of MIS: Number of MIS employees _____
Your position: What is your position_____
Major responsibility_____

Name of Facility_____
Address _____
Not for profit (yes/no) _____
Approximate MIS Budget _____
How long in this position _____

Indicate the usage of information technology at this institution. Simply mark the column that indicates the current use of the technology.

A: In heavy use.
B: Used for some tasks or in some areas.
C: Experimental usage.
D: Systems are now in development.
E: Planning to develop within a year.
F: Evaluating for possible implementation.
G: No plans to use.
H: Cannot use this technology because of legal limitations.
I: Have decided not to use this technology.

Technology application: Computer system use for these applications.	A	B	C	D	E	F	G	H	I
Patient treatment data.									
Physician orders in database.									
Voice recognition for transcriptions and orders.									
Electronic bedside patient monitoring.									
Electronic drug dispensers.									
Automated inventory / replacement.									
Patient scheduling.									
Scheduling facilities, e.g., OR.									
Patient education.									
Expert System for diagnoses.									
Research databases—medical reference.									
Research databases—patient data.									
Links to external physician offices.									
Electronic background checks on new employees.									
Groupware tools for physician consulting (e.g., Lotus Notes)									
Other (describe)									