Health Services Management Research **15**, 234–244
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Effects of hospitals' structural clinical integration on efficiency and patient outcome

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The objective of this study was to examine the relationships among structural clinical integration, average total charge, and adverse patient outcomes. The conceptual framework of this study is based on Donabedian's triadic model for outcomes research on structure, process, and outcome. Retrospective data were obtained from multiple sources: (1) the American Hospital Association (AHA) annual survey in 1997; (2) the Area Resource File (ARF) data set in 1997; (3) the Dorenfest IHDS+ database (version 2); and (4) the National Inpatient Sample (NIS) data set in 1997. A cross-sectional study design was used. Outcomes indicators were risk-adjusted with logistic regression, and the Medicare case-mix index was used for the risk-adjustment of the efficiency indicator. LISREL (LInear Structural RELationship) was used to test the hypotheses that structural clinical integration is negatively related to average total charge, and that average total charge is positively related to adverse patient outcomes. The risk-adjustment models were successful in discriminating the patients who suffered adverse events. Significant associations were found between structural clinical integration and average total charge per admission, between average total charge per admission and surgical complication, and between surgical complication and in-hospital death. However, the implementation of structural clinical integration did not show the expected reduction in total charge per admission. This study confirms Donabedian's model for outcomes research. However, the study found that hospitals with highly integrated structures showed no immediate financial benefit. Structural clinical integration has only an indirect effect on patient care outcomes.

Introduction

Health services were provided traditionally by separate health organizations in the healthcare market. Then hospitals responded to the problems of fragmentation by transforming their service delivery processes and their relationships with other healthcare organizations into integrated systems. Integration means combining previously separate and independent functions, resources, and organizations into a new, united structure (Lin and Wan, 2001; Shortell and Hull, 1996). Among all healthcare organizations, hospitals have been the central

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players in consolidating service units that traditionally had been fragmented (Lynch and Somerville, 1996). Appropriately organized and integrated hospitals are expected to provide their services at a lower cost and also to provide better care (Fox, 1989; Smith *et al.*, 1999).

Clinical integration is a strategic behaviour used to coordinate services within the internal environment of the hospital and to link it with the external environment. When hospitals adopt this strategy, however, clinical integration may not always be fully developed (Young and Barrett, 1997). The success of a hospital may depend on which medical services it provides in a market and how it organizes patient care. Whether or not hospitals can provide clinically coordinated and integrated health services will determine their survival (Porter *et al.*, 1996).

In the hospital industry, the coordination of hospital services and the integration of health services have not been thoroughly investigated. The strategy of integration is believed to have positive effects on organizational efficiency and on patient outcomes, as well. This assumption must be demonstrated in empirical studies. A few studies have evaluated the relationships among clinical integration, hospital efficiency and quality of care using empirical data (Alexander *et al.*, 1998; Anderson *et al.*, 1993; Conrad, 1993; Gillies *et al.*, 1998; Jacobsen and Hill, 1999; Mason, 1998; Shortell *et al.*, 1993; Smeltzer and Hinshaw, 1988; Young and Barrett, 1997).

The coordination and integration of hospital care is fostered if the organizational structure supports the intended integration strategy. Structural integration facilitates clinical integration, which is a prerequisite for truly integrated services. The purpose of this study was to develop and validate a conceptual framework to examine the relationships among clinical integration, efficiency, and quality of care. Using the Donabedian triadic outcomes model, this study investigated two questions: (1) Is structural clinical integration positively related to the performance of the care process (efficiency)? (2) Is the performance of the care process (efficiency) positively related to patient outcomes? A measurement model was developed to capture the constructs of hospitals' structural clinical integration. The structural equation model examined the effects of structure and process factors on patient care outcomes while controlling the effects of the hospital's internal/external environments.

Methods

Research design and data sources

This study employed a cross-sectional design. The sample was selected by nonrandom sampling. The unit of analysis was the hospital. Multiple data sets were used in this study: (1) National Inpatient Sample (NIS) for 1997 from the Hospital Cost and Utilization Project (HCUP); (2) American Hospital Association (AHA) annual survey for 1997; (3) Area Resource File (ARF) for 1999; and (4) Dorenfest IHDS+ database (version 2). Dorenfest is a proprietary data set containing information about the resources for healthcare information technology of 4000 hospitals. This data set was collected by telephone or mail/telephone survey, and Chief Information Officers were interviewed for the information technology section. As a result, this database provides the most accurate and reliable information about hospital information technologies in use. After using a carefully defined merging process, 358 community hospitals in NIS were used as the study sample.

Measurement of variables

Structural clinical integration is a latent variable. Performance of the care process (average total charge per discharge) and two outcome indicators (surgical complication and in-hospital mortality) are the manifest endogenous variables. Control variables are introduced in the structural equation model as exogenous variables.

Structural clinical integration

This latent construct reflects the degree of clinical integration achieved by hospitals from a structural perspective. From the literature review, four dimensions of structural integration were identified: (1) integration across sites of care; (2) integration across divisions of care; (3) integration of physicians and (4) integration of the information technology. Each dimension was measured with multiple indicators.

Integration across sites of care is defined by the number of pre-acute and sub-acute facilities either in a hospital or as a subsidiary of a hospital. Vertical integration strategy was explained by either forward (sub-acute facilities) or backward (pre-acute facilities) integration (Cody, 1996). In this study, pre-acute

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facilities included: (1) freestanding outpatient centres; (2) hospital-based outpatient care centres; (3) outpatient surgery; (4) primary care departments; (5) psychiatric outpatient services; and (6) alcoholism-drug abuse or dependency outpatient services. Sub-acute facilities included: (1) home health services; (2) hospices; (3) physical rehabilitation outpatient services; (4) rehabilitation care; (5) skilled nursing care; and (6) other long-term care.

Integration across divisions of care is measured by two indicators: breadth of services and case management. Breadth of services refers to the availability of care units, facilities, and services within a hospital. This indicator is measured by summing the numbers of hospitals' high-tech services. Hospitals with more services will have more complex structures as compared to those with few services. With a complex structure, the hospital can provide patients with a more broadly clinically integrated service system. Case management has been considered as an important tool for accomplishing clinical integration. It is measured here by whether or not a hospital has implemented case management.

Physician–hospital integration is defined by the kinds of arrangements that a hospital has with physicians. Three dummy variables are used to identify four levels of physician–hospital integration (Dynan *et al.*, 1998): (1) no physician–hospital integration strategy (reference); (2) a contract arrangement: whether the hospital has any combination of management service organizations (MSOs), physician–hospital organizations (PHOs), independent practice associations (IPAs), and group practices without walls (GPWWs); (3) an ownership arrangement: whether the hospital has any combination of medical foundations (MFs), integrated salary models (ISMs), and integrated health organizations (IHOs); and (4) a hybrid arrangement: whether the hospital employs any combination of both contract and ownership organizational forms.

Integration of hospital information systems should be designed to cover all core functional areas in patient care. To attain information integration, a hospital must apply information systems to support all core functions, and the installed application systems should be coordinated/integrated. In this study, the core functions of hospitals are conceptualized in terms of administration, management, and clinical function, as modified and adopted from Zviran (Zviran, 1990a; Zviran, 1990b). In order to measure the degree of information system integration, the number of application systems in each functional area is used as the proxy measure. The generic assumption in measuring information system integration is that the more application systems in each function, the greater the clinical integration of a hospital. It also measures the total capacity of the information integration of a hospital. Hospitals with more application systems in the functional areas are considered to spend more resources on information system applications. It is therefore reasonable to conclude that when hospitals have more application systems, their information systems may be more integrated.

Process performance

The care process is evaluated with an efficiency indicator: average total charge per discharge. Charge per discharge, so-called cost efficiency, is an indicator for measuring hospital efficiency (Flood *et al.*, 1987). This variable represents how well the time and resources were used in the process of patient care, i.e. whether resources are organized and managed in a manner that minimizes the cost of production (Aday *et al.*, 1998). This indicator, however, actually represents the inefficiency of process, in that the higher the total charges per discharge are, the poorer the performance of a hospital. Therefore, higher structural clinical integration is expected to have a negative relationship with the average charge.

Patient outcomes

The outcome construct is represented by two separate indicators: risk-adjusted, surgical complication ratio and risk-adjusted, in-hospital mortality ratio. These two indicators are measured from multiple procedure/complication types designed to capture the avoidable events and represent the overall patient outcomes of a hospital. Because of the frequent occurrence of complications, these types are more sensitive to variations in patient care. Complication is considered as the more direct consequence of the process of care (Geraci *et al.*, 1999). In the analysis model, a direct relationship is hypothesized between process performance and the surgical complication ratio. An indirect influence of average total charge on the in-hospital death ratio is hypothesized.

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Study outcome indicators were computed by dividing the aggregated actual numbers of deaths or complications by the expected deaths or complications, that were aggregated probabilities of deaths or complications of patients in a hospital. Deaths following six common and prevalent procedures were aggregated: (1) hysterectomy; (2) laminectomy/spinal fusion; (3) cholecystectomy; (4) transurethral prostatectomy; (5) hip replacement; and (6) knee replacement. Nine surgical complication types after major surgery* were aggregated: (1) pulmonary compromise; (2) acute myocardial infarction; (3) gastrointestinal haemorrhage or ulceration; (4) venous thrombosis or pulmonary embolism; (5) venous thrombosis or pulmonary embolism after invasive vascular procedure; (6) mechanical complications due to device, implant, or graft, (7) urinary tract infection; (8) pneumonia after major surgery; and (9) pneumonia after an invasive vascular procedure. The predicted probability of individual in-hospital death and of one of six complication types is between 0 and 1. As the predicted probability of a patient closes to 1, it indicates worse patient outcomes. The calculated predicted probabilities of patients were aggregated at the hospital level.

As the numerator was the actual number of patients and the denominator was the sum of the predicted probability of patients, if a hospital had a higher ratio than those of other hospitals, it indicates that the hospital had worse patient outcomes. A higher ratio of an outcome indicator means worse patient outcomes.

Risk-adjusted complication ratio:

$$= \frac{\Sigma \text{ Actual number of patient complications following surgery in a hospital}}{\Sigma \text{ Predicted probability of one of the six patient complication types, following major surgery in a hospital}}$$

Risk-adjusted mortality ratio:

$$= \frac{\Sigma \text{ Actual number of patient deaths following one of six procedures in a hospital}}{\Sigma \text{ Predicted probability of a patient death following one of six procedures in a hospital}}$$

*NOTE: HCUP QI measures followed Iezzoni *et al.*'s list of ICD-9-CM codes for complications of major surgery, with the exception of urinary tract infection (Iezzoni *et al.*, 1992).

Control variables

Control variables represented the hospital's internal and external characteristics. This study incorporates four organizational and two environmental control variables. Hospital attributes include ownership type, teaching status, system affiliation, and size. Ownership type is represented by a dummy variable: for-profit (coded 1) versus not-for-profit (coded 0). Teaching status is the ratio of the number of medical residents to total beds. System hospital is represented by a dummy variable: multihospital system (coded 1) versus non-system hospital (coded 0). System hospitals tend to use integration strategies more frequently (Burns *et al.*, 1998; Morrisey *et al.* 1999). Size is measured by the number of hospital beds.

Environmental conditions were assessed by city/county mortality and Health Maintenance Organization (HMO) penetration. The city/county mortality was calculated by dividing the total number deaths by the total population in the city/county where the hospitals are located. HMO penetration refers to the rate found by dividing the total HMO enrolments by the total population in a health service area where the hospitals are located.

Analysis

Risk adjustment

The Medicare case-mix index of 1997 was used to adjust for the differences in the average total charge per discharge indicator. By multiplying the variable with the Medicare case-mix index, the adjusted score was computed.

Logistic regression was used for the adjustment of patients' risk factors, and the probabilities of death and complication for each patient were calculated. Risk factors were included from four dimensions: (1) patients' demographic attributes; (2) hospitalization characteristics; (3) socioeconomic factors; and (4) clinical factors. Patients' demographic attributes are age, gender, and race. Hospitalization characteristics are admission type and admission source. The socioeconomic status of patients is the median income for a patient's zip code. The number of secondary diagnoses and procedures were used to distinguish the main reason for hospitalization (Elixhauser *et al.*, 1998).

Sex is a dummy variable: female (coded 1) versus male (coded 0). Race is represented by two dummy variables, black and other race,

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with white (coded 0). Age is a continuous variable (year). Admission source is represented by two dummy variables, emergency department and another hospital, with routine, birth and other sources (coded 0). Insurance type is represented by three dummy variables, Medicare, Medicaid, and others, with private insurance (coded 9).

The socioeconomic factor is represented by the level of income, with three dummy variables, $25,000 ⩽ income < $30,000, $30,000 ⩽ income < $35,000, and income ⩾ $35,000, with income < $25,000 (coded 0). Clinical factors not related to the primary reason for hospitalization were assessed: multiple secondary diagnosis and multiple secondary procedures. These variables were defined as the sum of all diagnoses/procedures except the principal reason in a patient claim.

A risk-adjustment model that is unique to 15 indicators of death and complications is required for the proper control of patient differences. The four dimensions of risk factors discussed will have different influences on the occurrence of deaths or complications, depending on the types of procedures or complications. That is, risk factors in one procedure will have different influences on outcomes from those in other procedures. All risk factors will not have the same effect on the patient outcomes of all six procedures or nine complication types. Therefore, the selection of risk factors in the risk-adjustment model should depend on the procedures or complication types studied.

Risk factors for each procedure or complication type were selected through two phases. In the first phase, all risk factors were included in 15 logistic regression models for each of the six procedures and nine complication types. In the second phase, the results of logistic regression analysis in phase one were used to select risk factors. The following rules were made: firstly, biologically and clinically important patient characteristics such as sex, race, age, and number of secondary diagnoses/procedures were included in the model regardless of the result of statistical significance. Secondly, the remaining variables were dummy variables for admission source (two variables), insurance type (three variables), and income status (three variables). For example, if the dummy variables for admission source were not significant in a model, then the variables were excluded from a model. But if one of two dummy variables was significant, then the two variables remained in a model. Therefore, each adjustment model could have different combinations of risk factors. After the analysis, the probabilities of each patient death or complication were computed.

LISREL (LInear Structural RELationship) analysis

This study used LISREL analysis with the maximum likelihood method to assess the structural relationships among structural clinical integration, process performance and patient outcome. Correlation analysis and confirmatory factor analysis were used to assess the measurement model of structural clinical integration. A structural equation model specified the relationships among the endogenous variables (Figure 1). The endogenous variables were explained by specifying that they were related to other endogenous variables and/or exogenous variables. The control variables were considered as exogenous variables.

The structural equation model is usually expressed by the equation:

$$\eta = \beta\eta + \Gamma\xi + \zeta$$

where η is a vector of latent endogenous variables; β is a matrix of coefficients relating an endogenous variable to another endogenous variable; Γ is a matrix of coefficients relating the exogenous variables to the endogenous variables; ξ is a vector of latent exogenous variables; and ζ is an error term in the equation that indicates that the endogenous variables are not perfectly predicted by the structural equations.

Results

Comparison of sample hospitals with the hospitals excluded from the HCUP data

The representativeness of the study sample was assessed. Table 1 shows the frequency distributions of the characteristics of the study hospitals. Statistically significant differences were found in attributes between the study hospitals and the HCUP hospitals excluded from the analysis. A higher percentage of the study hospitals (88.3%) than of the excluded HCUP hospitals (80.3%) were not-for-profit. Approximately three-quarters (73%) of the study hospitals were located in an urban area, compared to 48% of the excluded hospitals. The study hospi-

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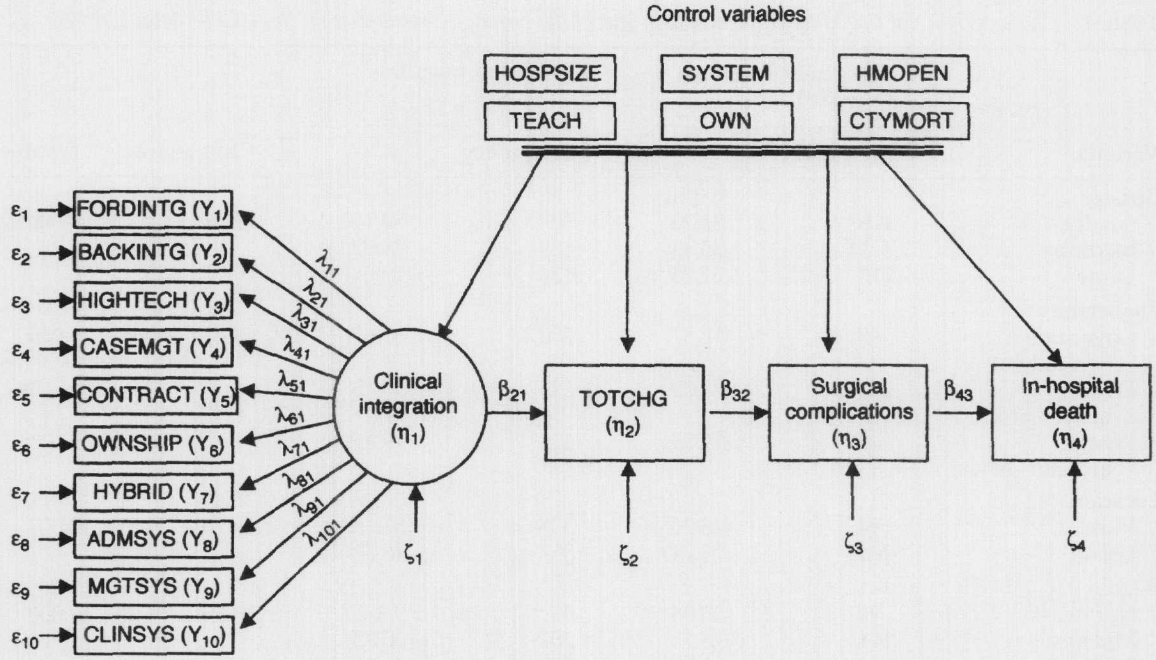

Fig. 1 *Structural equation model of the study*
BACKINTG = backward integration; FORDINTG = forward integration; HIGHTECH = high-tech facilities/services within hospital; CASEMGT = case management; CONTRACT = contract physician–hospital relationship; OWNSHIP = owned or employed physician-hospital arrangement; HYBRID = hybrid arrangements of hospitals with physicians; ADMSYS = automated application systems in clinical administration function; MGTSYS = automated application systems in clinical management function; CLISYS = automated application systems in clinical function; TOTCHG = Average total charge per admission; COMPRATE = Risk-adjusted surgical complication ratio; MORTRATE = Risk-adjusted in-hospital mortality ratio

tals had a larger average number of discharges per hospital (9 625) than did the excluded hospitals (5 661). The study hospitals tended to be larger (have more beds) than the excluded hospitals. In summary, the study hospitals were more likely to be urban, private, non-profit, and large hospitals.

Risk-adjustment of outcome indicators

It was found that patient characteristics such as age, gender and number of secondary diagnoses/procedures were statistically significant in all 15 models. Among the non-clinical risk factors, two dummy variables of admission sources (ER and admissions from other hospitals) were statistically significant in all models for explaining the variation in patient complications, except for acute myocardial infarction after major surgery. For explaining patient risks, income variables were significant in more models than were insurance types. Income status variables were significant in the three models of in-hospital deaths (hysterectomy, cholecystectomy, and knee replacement), and in seven models of surgical complications (pulmonary compromise after major surgery, acute myocardial infarction after major surgery, gastrointestinal haemorrhage or ulceration after major surgery, venous thrombosis or pulmonary embolism after invasive vascular procedure, urinary tract infection after major surgery, pneumonia after major surgery, and pneumonia after invasive vascular procedure). Surgical complications were better explained by income variables than by insurance types.

C-statistic was calculated as the performance measure of the risk-adjustment models. C-statistic is commonly reported for risk-adjustment models involving a dichotomous outcome variable (Iezzoni, 1997). Close to 1.00 represents good performance of risk-adjustment models. The c-statistics of all 15 models were quite satisfactory, ranging from 0.737 to 0.958. Most scores were greater than 0.8, except for the

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Table 1 *Characteristics of the 358 sample hospitals and of the hospitals excluded from the HCUP data*

	The study hospitals ($N=358$)		Excluded hospitals ($N=654$)			
Variable	**Frequency**	**%**	**Frequency**	**%**	**Chi-square**	***P*-value**
Bedsize						
Small	119	33.24	327	50.15	28.31	0.000
Medium	127	35.47	189	28.99		
Large	112	31.28	136	20.86		
Ownership						
Government/ non-federal	45	12.57	200	30.67	64.44	0.000
Private not-for-profit	271	75.70	327	50.15		
Private investor-owned	42	11.73	125	19.17		
Location						
Rural	94	26.26	335	51.38	59.70	0.000
Urban	264	73.74	317	48.62		
Region						
Northeast	93	25.98	61	9.33	58.55	0.000
Midwest	101	28.21	201	30.73		
South	93	25.98	272	41.59		
West	71	19.83	120	18.35		
	Mean	Std. Dev.	Mean	Std. Dev.	F-value	*P*-value
Total discharges	9625.07	8726.11	5661.54	7568.40	56.83	0.000

Bedsize Categories (Bedsize: Small, Medium, and Large)
Rural hospital: 1–49, 50–99, 100+
Urban, non-teaching hospital: 1–99, 100–199, 200+
Urban, teaching hospital: 1–299, 300–499, 500+
'Rural hospitals were not split according to teaching status because rural teaching hospitals were rare. The cut-off points for the bedsize categories are consistent with those used in Hospital Statistics, published annually by the AHA.' (AHRQ, 1997).

model for the complication of venous thrombosis/pulmonary embolism after an invasive vascular procedure ($c=0.737$). The performance measures exhibit the substantial discriminant ability of the risk-adjustment models.

Test of the measurement model of structural clinical integration

Before testing the hypothesized relationships, a measurement model of the latent construct (structural clinical integration) was evaluated. Pearson correlation coefficients and *P*-values of the study variables were computed. In the correlation analysis, it was found that two physician arrangements (hybrid and ownership) had negative and statistically significant links with the contract physician–hospital arrangement variable (r for hybrid, contract $=-0.343$, $P<0.05$, r for ownership, contract $=-0.241$, $P<0.05$). These three hospital-physician arrangements were used to measure the common dimension of physician-hospital integration. This suggested that the establishment of hybrid and ownership, physician-hospital integration did not further the concept of structural clinical integration. Thus, two variables were deleted from the measurement model of structural clinical integration.

Eight variables were used in the confirmatory factor analysis of the measurement model. After the analysis, the overall model fit indices showed a good fit of the measurement model for the sample data. The Chi-square value ($\chi^2=40.80$) and the likelihood ratio (2.5) were less than 5, and the adjusted goodness of fit index was 0.973. RMSEA (0.066) and HOELTER's critical N (231) were also acceptable.

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Table 2 *Standardized parameter estimates of the structural equation model (standardized regression weights)*

Construct variables	Clinical integration (η1)	Average total charge (η2)	Surgical complication (η3)	In-hospital death (η4)
Clinical integration (η1)		0.621***	N/A	N/A
Average total charge (η2)			0.197***	N/A
Surgical complication (η3)				0.168**
Control variables				
HOSPSIZE	0.613***	0.022***	−0.081	0.233***
OWN	0.059	0.197	0.146***	0.063
SYSTEM	0.089	0.061	−0.078	−0.030
TEACH	0.066	0.089*	0.059	−0.022
HMOPEN	0.063	0.235***	−0.067	−0.011
CTYMORT	−0.231***	0.050	0.040	0.123**
R^2	0.493	0.603	0.066	0.105
Goodness of fit measures				
Chi-square		273.540		
Degrees of freedom (DF)		90		
Probability (P)		0.000		
Likelihood ratio (chi-square/DF)		3.039		
Goodness of fit (GOF)		0.924		
Adjusted goodness of fit (AGOF)		0.871		

OWN = ownership type of hospital; SYSTEM = system hospital; TEACH = teaching status; CTYMORT = county mortality; HIGHTEGH = high-tech hospital services; HMOPEN = Health Maintenance Organization penetration; HOSPSIZE = hospital size
N/A = Not applicable
**P < 0.05, **P < 0.01, ***P < 0.001*

Structural equation modelling

Table 2 presents the standardized regression weights of variables from the analysis based on Figure 1. A positive relationship was found between structural clinical integration and average total charge ($\beta = 0.621$, $P < 0.000$). Increase in average total charge, a negative measure of efficiency, showed an influence on the surgical complication ratio ($\beta = 0.197$, $P < 0.001$). The surgical complication ratio showed the expected positive effect on the in-hospital death ratio ($\beta = 0.168$, $P < 0.05$). This finding confirms the expected positive relationship between surgical complications and in-hospital death. Hospitals that have more surgical complications were more likely to have in-hospital deaths.

The squared multiple correlation (SMC) index, (R^2), reveals that the analysis model explains well the variance of clinical integration (49.3%) and average total charge (60.3%). However, the two outcome constructs are partially explained by the model: 6.6% of surgical complications and 10.5% of in-hospital deaths.

Hospital size has a positive effect on clinical integration ($\beta = 0.613$, $P < 0.000$), but city/county mortality shows a negative relationship with clinical integration ($\beta = -0.231$, $P < 0.000$). HMO penetration had a positive influence on average total charge ($\beta = 0.235$, $P = 0.000$). A positive association exists between ownership type of hospital and surgical complication ($\beta = 0.146$, $P = 0.008$). In-hospital death has positive associations with hospital size ($\beta = 0.233$, $P < 0.000$) and with the city/county mortality ($\beta = 0.123$, $P = 0.014$).

Discussion

This study examines the relationships among the extent of structural clinical integration of a hospital, average total charge per discharge, and patient outcomes (surgical complication ratio and in-hospital death ratio).

Relationship of clinical integration to process performance

With the negative efficiency indicator used in the analysis, hospitals with lower average total charges for treating patients were considered more efficient as compared to others. Clinical

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integration was regarded as the strategic behaviour of hospitals to reduce the charges on the patient bill. Our data analysis does not support this assumption. The extent of structural clinical integration is significantly associated with the average total charge per discharge, but the sign is opposite to the expectation. Hospitals with highly clinically integrated structures showed higher average total charges than others with less clinically integrated structures. This implies that strategic changes of hospitals' structure toward more integration do not immediately improve the financial performance.

There may be several explanations for that finding. Firstly, although the growth of structural clinical integration can have positive effects on clinical integration, they may not be strong enough to attain the maximum goal of restructuring core functions and the care process. Secondly, defining the measurement model of clinical integration from the structural aspect of hospitals is another possible explanation. The close relationships among the structural components of clinical integration can provide appropriate structural support for care integration. However, this measurement model may not adequately capture the effects of the care process integration, and so may underestimate the effects of clinical integration. Although hospitals pursue integration of patient care by investing in information systems, implementing case management, and increasing the types of services, the effects from the measurement model of structural clinical integration may not be enough to show changes in patient outcomes, as compared to those from integration of the care process. Thirdly, there may be a time-lag until the hospitals' structural changes influence the performance changes. One-year data do not allow testing the time effects of structural changes. In order to establish causal relationships and test time-lag effects a panel model will be required that can investigate the changes over time in the relationship between clinical integration and hospital performance.

Relationship between performance and outcomes measures

Supporting previous research, this study found that a higher average total charge had a positive influence on surgical complications, and a higher complication ratio was positively associated with the in-hospital mortality ratio. If we consider the care process and the time order of adverse patient events, two indicators represent patient outcomes at different stages in the patient care process. Surgical complication happens ahead of death in the patient care process. As the intermediary outcomes of patients, surgical complications are affected first by the patient care process.

It seems reasonable that some part of the final patient outcomes will be due to the performance of care process. How hospitals provide care services to patients will influence patient deaths. Notwithstanding the possible effects from the care process, its influence may not be strong, nor a direct determinant of the final outcomes. Patients with complications are more likely than patients without complications to require intense use of services and resources, and they will have a higher chance of dying. The intermediary outcomes will be a major determinant of the final patient conditions rather than an indicator of the performance of the care process itself. This suggests that the care process determines the final patient outcomes indirectly, depending on the conditions of intermediary outcomes.

These study findings confirm Donabedian's triadic model for outcomes study: structure, process, and outcomes. As he proposed in the model, direct relationships were found here between structure (structural clinical integration) and process (average total charge), and between process (average total charge) and patient outcomes (surgical outcomes). Structure indirectly relates to the end result of care, death, through an intermediate outcome of the care process (surgical complication). This result seems understandable, since clinical integration is actually designed to change the patient care process. The integrated hospital structure will change the behaviours of providers in the care process, and then the restructured care process will directly influence patient outcomes. In other words, structural clinical integration itself may influence outcomes indirectly through the care process.

Conclusion

Several limitations should be mentioned. Firstly, the sample hospitals were not selected by random sampling, but rather according to the availability in the multiple data merging process. Study hospitals were identified as

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more likely to be selected from urban, private, non-profit, and large hospitals, as compared to other, excluded HCUP hospitals. The different characteristics of the study hospitals make it difficult to generalize the study results to all community hospitals. Secondly, a limitation exists in the measurement model of clinical integration. The study variables reflect only the structural aspects of hospitals. However, the success of clinical integration will depend more on the coordination and integration of the patient care process than on structural integration. The measurement of clinical integration in structural aspects may have difficulty detecting the dynamic integration activities of hospitals. Thirdly, the manifest indicator, average total charge per discharge, was used as a measure of efficiency. Since only one indicator of the efficiency construct was used in the analysis, this variable may not reflect the total configuration of efficiency. Inclusion of another indicator will properly capture the efficiency construct: for example, the technical efficiency score from DEA (Data Envelopment Analysis). Fourth, the risk adjustment model has limitations as well. Although the statistics for the risk adjustment model show high performance in differentiating patients, the effects of detailed clinical information about patients were not available to be included in the risk adjustment models. For example, information such as principal diagnosis/procedure, comorbidities and complications will significantly influence patient outcomes. There are difficulties in distinguishing all diagnoses for the specific clinical information from the administrative data set.

In outcomes research, many studies have confirmed the effects of patient volume on outcome indicators such as mortality and complication rate (Buanes *et al.*, 1998; Cebul *et al.*, 1998; Khartz *et al.*, 1997; Pearce *et al.*, 1999; Phibbs *et al.*, 1996). It has been shown that hospitals with larger patient volumes for a specific procedure or diagnosis tend to have better outcomes than do hospitals with smaller patient volumes. However, this study did not use disease-specific outcomes indicators, but used aggregated indicators from multiple procedures/diagnoses. Those variables are expected to minimize the confounding effects from the service volume for a specific disease or indicator.

The study findings help to conceptualize the complex relationship between hospitals, strategic behaviours and their performances. It is generally believed and acted on by people in the healthcare industry that hospitals with clinically integrated structures can use scarce resources efficiently and increase patient care outcomes at the same time. This study found that hospitals with greater clinical integration had only indirect significant effects on patient outcomes controlling for factors such as size, technology, and market environments. But a positive relationship was found between structural clinical integration and the cost efficiency of the care process. Such partial confirmation of the study hypotheses does not fully support the notion that structural clinical integration of a hospital is a successful strategy to mediate the uncertainty from external environments and to improve the organizational performance.

In conclusion, the results provide theoretical support for understanding the dynamic nature of health care organizations. This study confirms Donabedian's model for outcomes research. However, hospitals with highly integrated structures do not show an immediate financial benefit. Structural clinical integration has only an indirect effect on patient care outcomes.

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