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Quality improvement and hospital financial performance

JEFFREY A. ALEXANDER[1]*, BRYAN J. WEINER[2] AND JOHN GRIFFITH[1]

[1]*Health Management and Policy, University of Michigan, School of Public Health, Ann Arbor, Michigan, U.S.A.*
[2]*Health Policy and Administration, University of North Carolina, Chapel Hill, North Carolina, U.S.A.*

Summary The objective of this study was to examine the association between the scope and intensity of Quality improvement (QI) implementation in hospitals and organizational performance. A sample of 1,784 community hospitals was used to assess relationships between QI implementation approach and two hospital-level performance indicators: cash flow and cost per case. Two-stage instrumental variables estimation, in which predicted values (instruments) of eight QI intensity and scope variables plus control (exogenous) variables were used to estimate hospital-level performance indicators. Our results suggest that QI has a measurable impact on global measures of organizational performance and that both control and leaning approaches to QI matter in these settings. Hospitals that implement QI effectively can reasonably expect to improve their financial and cost performance, or at least not place the hospital at risk for investing in quality improvement. These outcomes are specific to QI strategies that emphasize both control and learning. Copyright © 2006 John Wiley & Sons, Ltd.

Introduction

Shortell and his colleagues (1998:594) operationally describe quality improvement (QI) as:

> A philosophy of continuous improvement of the processes associated with providing a good or service that meets or exceeds customer expectations. This is accomplished by involving a broad array of organizational members, who are trained in basic statistical techniques and tools and are empowered to make decisions based on their analysis of the data. QI differs from traditional quality assurance methods primarily in its emphasis on understanding and improving the underlying work processes and systems in order to add value rather than on correction of individuals' mistakes after the fact.

Although QI practices were originally developed in the manufacturing sector, quality experts contend that QI methods can be successfully applied to service delivery (Deming, 1986; Ishikawa,

* Correspondence to: J. A. Alexander, Health Management and Policy, University of Michigan, School of Public Health, 1420 Washington Heights, Ann Arbor, MI U.S.A. E-mail: jalexand@sph.umich.edu

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1985; James, 1989; Walton, 1990). One of the most promising recent developments is the effort made by hospitals to institutionalize quality improvement as a coordinated, organization-wide approach to care. These practices, collectively, are designed to systematically examine and improve processes of care and care support in organizational settings.

This approach differs significantly from traditional hospital level quality assurance (QA), wherein quality is defined as adherence to acceptable standards of patient care, and behavior of individual providers is subject to retrospective peer review, and corrective or disciplinary action is taken when necessary (Weiner & Alexander, 1993).

While few would dispute the importance of providing high quality care in hospitals, there is less certainty about the relationship between engaging in quality improvement programs and overall organizational performance. For example, many hospital managers feel that they cannot afford to invest heavily in quality improvement programs because such investments would erode their bottom line and make them less competitive in markets where cost containment receives primary emphasis. Others have maintained that clinical quality may improve under QI but at the price of reduced operating efficiency. By contrast, proponents of investing in quality improvement efforts maintain that enhancing quality makes the hospital more attractive to patients, physicians and payers, thereby contributing positively to the hospital's financial health. Although this issue has been widely debated in terms of 'the business case for quality,' few empirical studies have examined the relationship between hospital quality improvement efforts and the performance consequences for hospitals (Hendricks & Singhal, 1996, 2001; Ittner & Larcker, 1996; Lederer & Rhree, 1995). Further, those studies that have been conducted are subject to several problems of measurement and design such as endogeneity, period of performance assessment and absence of attention to QI implementation.

Using a conceptual framework that emphasizes the relative importance of learning versus control in hospital settings, this study addresses these gaps by examining the relationship between hospital quality improvement activity and organizational performance. Two research questions are addressed: (1) Are hospital cash flow and operating efficiency over time related to the scope and intensity in quality improvement programs? and (2) What specific elements of quality improvement programs are associated with positive financial performance or negative financial performance, and which are unrelated to financial performance? In exploring these questions we analyze data from over 1,700 hospitals, drawing on an extensive national survey of hospital quality improvement activity as well as independent data on hospital financial performance.

From a theoretical perspective, study findings will provide evidence of the transferability of contemporary management techniques to settings that are highly complex and interdependent, and dominated by professional production workers.

Background

Quality experts contend that QI methods can be successfully applied to service delivery (Deming, 1986; Ishikawa, 1985; James, 1989; Walton, 1990). Juran (1988), for example, argues that services like manufactured goods, are produced through processes, and those processes can be analyzed using universal statistical-based quality control techniques. While Juran acknowledges that service outcomes are difficult to measure due to the intangibility of the product and the interactive nature of service delivery, it remains conceptually feasible to identify customer requirements, to translate these requirements into behavioral routines and standards for personnel, and to monitor these processes. Although QI practices in hospitals offer promise for improving quality of care and reducing preventable problems in the process of delivering care, the effectiveness of these efforts remains to be documented, especially as it pertains to organizational performance (Shortell, Bennett, & Byck, 1998).

Several studies have examined the structures, processes, and relationships common to designing, organizing, and implementing hospital quality improvement efforts (Barsness et al., 1993a,b; Blumenthal & Edwards, 1995; Gilman & Lammers, 1995; Shortell et al., 1995b, 2000; Weiner, Alexander, & Shortell, 1996, Weiner, Shortell, & Alexander, 1997). These studies indicate that hospitals vary widely in terms of: (1) their approach to implementing QI; (2) the extent to which QI has affected core clinical processes; and (3) the degree to which QI practices have been diffused across clinical areas. Few of these studies, however, examined the effectiveness of hospital QI practices, particularly on organizational performance. Those that have typically employ perceptual measures of impact or self-reported estimates of cost or clinical impact rather than objectively derived measures of cost or quality (Gilman & Lammers, 1995; Shortell, 1995; Shortell et al., 1995b). The few studies of the effects of clinical practice guidelines and other QI approaches on costs and financial performance have reported inconsistent findings (Gandjour & Lauterbach, 2001; Grimshaw & Russell, 1993; Larson, 2003; O'Brien, Jacobs, & Pierce, 2000). These inconsistencies may be attributable to three conceptual and methodologic problems. First, short term performance impact may differ from longer-term impact. For example, treatment cost may increase initially following quality improvement adoption because of change in long-standing organizational routines and investment in data systems and other elements of QI infrastructure. However, organizational performance may, over a sufficiently long period of time, result in net savings and improved economic efficiency, as well as greater market share and profitability. To account for such changes in organizational performance over time, studies should employ a sufficiently long assessment period to smooth out such effects (Cabana et al., 1999; March, 1996).

Second, potential endogeniety or omitted variables may lead to misinterpretation of study findings. For example, the adoption of quality improvement practices and guidelines may be a function of organizational performance. Financially sound hospitals, for example, may be more likely to adopt because they have innovative management, while less solidly financed hospitals may adopt because they perceive profit. In either case, the adoption of quality improvement structures and practices is endogenous with organizational performance.

Third, little has been done to determine whether or not quality improvement has been implemented in hospital settings in a manner consistent with both the need to produce reliable outcomes and cope with the uncertainties inherent in patient care. Because most previous research has treated quality improvement (e.g. CQI, TQM) as a discrete phenomenon that is universally applicable, such questions have rarely been tested (Dean, Suchyta, Bateman, Aronsky, & Hadlock, 2000; Hackman & Wageman, 1995). Given the systemic nature of quality improvement and the complexity of implementing such programs in hospitals, it is critical to assess the degree to which QI structures and practices have been deployed in order to evaluate the relationship between QI and organizational performance.

Theory and Hypotheses

Our theoretical framework derives from the work of Sitkin, Sutcliffe and Schroeder (1994) who make the case that the boundary conditions for successful QI programs are related to whether the organization and its technology are better suited for a control- or leaning-oriented approach to

QI. Specifically, when the technology, market or clientele of an organization are uncertain, control-based approaches to QI may be inappropriate. Control-oriented approaches to QI emphasize 'a process in which a feedback loop is represented by using standards of performance, measuring system performance, comparing that performance with standards, feeding back information about unwanted variances in the system, and modifying the system'. This approach to QI works best when activities are done repeatedly, when task routineness is relatively high, and when cause-effect relationships are well understood. By contrast, a learning-oriented approach to QI emphasizes exploration of new solutions to problems that are non-recurring. Such an approach emphasizes input from multiple players in the organization, lateral communications channels, and the freedom to experiment and make mistakes (Van de Ven & Polley, 1992). Under conditions of high uncertainty, a learning approach to QI will emphasize the capacity to learn and adapt to changing situations.

Whereas Sitkin et al. note that a universalistic approach to QI is inappropriate, we would note that their contingency-based arguments about QI do not necessarily suggest that an organization must adopt, according to uncertainty, *either* a control-oriented or learning-oriented QI approach to be effective. Rather, their framework suggests that both approaches may operate in organizational settings and that it is the relative emphasis on one or the other, given situational requirements, that determines effectiveness. Hospitals, for example, are subject to a variety of uncertainties in the presenting conditions of patients, the appropriate treatment procedures for particular illness, and unclear means ends connections (Begun, Zimmerman, & Dooley, 2003). Such conditions would seem to lend themselves to a learning-oriented approach to QI. However, because of their mission of saving lives and curing disease, hospitals do not have the luxury that other learning organizations have of 'making errors' and learning from those errors. In fact, much of the current health care literature centers on reducing patient errors and improving reliability of service delivery processes (Institute of Medicine, 1999; Leape, 1994). Under such conditions, both reliability *and* the ability to effectively learn from inherently uncertain conditions are mandatory (Eisenhardt, 1993). This suggests that organizations and researchers need to unbundle prepackaged QI programs so that the most applicable parts of these programs are used to address both the need to cope with uncertainty and the need to increase reliability. For example, the use of QI teams may help produce solutions to problems that are complex and uncertain through the input of professionals from a variety of disciplines, while the use of statistical process tools may allow providers to increase reliability by tracking variability in outcomes and improvements over time as new procedures are introduced.

Specifically, we posit that organizational performance will positively covary with approaches to QI that are consistent with organizational learning and organizational control. These concepts are manifest in two dimensions of QI implementation—scope and intensity.

Scope refers to the extent or range of application of QI philosophy and methods and, as such, indicates the pervasiveness with which QI practices permeate organizational structures and routines. We view this dimension as necessary for the learning component of QI insofar as it emphasizes organization-wide commitment and involvement and because most, if not all, vital work processes span many individuals, disciplines, and departments (Berwick, Godfrey, & Roessner, 1990; James, 1989). Learning generally requires that clinical professionals and hospital staff from different specialties, functions, or units work together in order to document how patient care processes work in its entirety and identify the key process factors that play a causal role in process performance. Implementing systemic learning in an organization also requires collaboration across disciplinary, functional, and unit boundaries. For example, improving cardiac surgery outcomes may entail multiple, simultaneous changes in physician offices, inpatient units, and home-health units (Gustofson, Risburg, & Gering, 1997). Even when implementing 'local' changes (i.e., those within a single unit), cross-unit collaboration is often necessary in order to avoid undesirable, unintended consequences to arise in other units due to task interdependencies.

Second, enhancing performance on an organization-wide basis though a learning approach to QI requires mobilizing large numbers of staff, equipping them with technical expertise in QI methods, and empowering them to diagnose and solve patient care problems in the context of teams. A small number of people working together on a cross-functional team could, with the right support, make systems improvements that address a specific quality problem (e.g., stroke mortality). An organization-wide effort focusing on 5, 10, or even 15 quality problems, however, would require harnessing the knowledge, the energy, and the creativity of many hospital staff members.

Finally, extensive involvement of hospital staff across multiple units may also strengthen the effectiveness of QI efforts by promoting a 'learning' culture. That is, pervasive participation in QI promotes shared values about the importance of continuous improvement, communicating openly, and collaborating to implement solutions. These shared values, in turn, support the value of discovering new solutions to problems and the implementation of systemic changes that cross disciplinary, departmental, and organizational boundaries (by reducing turf battles) and increase the likelihood of 'holding the gain' (O'Brien et al., 1995). Thus, the more pervasive the QI effort, the greater the *organizational* capability to systematically learn from variable and uncertain conditions, leading to better organizational performance.

We assess scope along four dimensions: number of organizational units involved in QI efforts, percentage of hospital personnel participating on QI teams, percentage of hospital managers participating on QI teams, and percentage of physicians participating on QI teams.

> *H1*: Hospitals that demonstrate greater scope in QI deployment will have better hospital-level performance.

Intensity refers to the strength of application of standardized procedures and QI tools and statistical techniques in the organization. As such, it indicates the degree to which control elements of QI are practiced. The widespread use of standardized approaches to patient care (e.g., clinical guidelines[1]), for example, suggests that the organization emphasizes common (versus tailored) approaches to care and the reduction of variability in both care process and outcomes through controlling how physicians and other clinical providers perform their work. Similarly, an emphasis on data presentation and feedback in QI implies that standards of performance are identifiable and that benchmarking to such standards will shape the approach to patient care and allow the organization to monitor performance and impose appropriate accountability for performance. As with scope of QI implementation, intensity of QI is likely to impact organizational performance when it becomes an integral part of the daily work life of organizational members as opposed to an intermittent or circumscribed activity (Berwick, Godfrey, & Roessner, 1990; Deming, 1986; Ishikawa, 1985). The more intense or developed the QI effort, the greater the organization's capability to systematically improve quality. For example, hospitals that have developed clinical guidelines for multiple conditions and procedures should demonstrate improved organizational performance. We assess intensity along four dimensions: number of clinical guidelines in use, the extent to which data are used in support of clinical guidelines, proportion of hospital physicians using clinical guidelines, extensiveness of QI tool use, and organizational focus on quality improvement versus quality assurance.

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[1]A clinical guideline (also referred to as a practice guideline) is a set of directions or principles to assist the health care practitioner with patient care decisions about appropriate diagnostic, therapeutic, or other clinical procedures for specific clinical circumstances.

H2: Hospitals that demonstrate greater intensity in QI deployment will have better hospital-level performance.

Organizational Context

The Health Care Environment

Over the past two decades, American hospitals have experienced dramatic changes in their economic and institutional environments. Government-mandated cost containment efforts, a shift from cost-based reimbursement to prospective payment, increased influence of managed care plans, and advances in medical technology that reduce in-patient care have created enormous pressures on hospitals and threatened their very survival (Mick & Morlock, 1990; Shortell, Morrison, & Friedman, 1990). For example, many employers have encouraged workers to enroll in managed care plans, and also legitimated the use by health plans of competition among hospitals and physicians for managed care contracts and patient dollars as a means of driving down prices for medical and hospital services. Similarly, employers, health plans, and other interested parties actively promoted the rationalization of medical care as a means of gaining operational efficiencies in patient care, lowering costs and improving quality and organizational performance (Conrad & Shortell, 1996). At the same time, the delivery of health care has been increasingly 'corporatized (Alexander & D'Aunno, 1990).' Voluntarism and professional norms that once constrained the behavior of hospitals are giving way to market competition and corporate management practices that have freed hospitals to pursue a variety of organizational and strategic changes, many of which are borrowed from the corporate sector where market competition and an orientation to process improvement have been long standing features (Fennel & Alexander, 1993; Mick & Morlock, 1990; Topping & Hernandez, 1991).

Hospital Responses to a Changing Environment

Within this context, hospitals, in particular, are being challenged to produce high quality care without raising healthcare costs. Moreover, hospital leaders face the additional challenge of developing policies, procedures, and incentives to improve quality within a domain that has traditionally been the province of highly autonomous professionals. Quality improvement (QI) practices have emerged in recent years partially as an alternative to quality assurance and as a reaction to the shortcomings of outcome-based control strategies (Berwick, 1989; Berwick, 1990; James, 1990; Laffel & Blumenthal, 1989). With mounting pressure to maintain or improve quality in the face of reduced resources, hospitals have been encouraged to look to process improvements as a mechanism to provide high quality care while containing healthcare costs (Casalou, 1990; King, 1990). While the adoption of QI appears to be an internally generated response to changing market conditions, for the most part, accrediting bodies such as the Joint Commission on Accreditation Healthcare Organizations (JCAHO) have also encouraged hospitals to adopt QI (Koska, 1991; Larson, 1990). JCAHO is also simplifying its accreditation standards to make it easier for hospitals to adopt and implement QI practices. Despite its intuitive appeal QI faces many challenges in hospital settings, including the following: (1) clinical processes exhibit much greater variation than manufacturing processes because of the inherent uncertainty of patient-level factors; (2) clinical work processes are not directly under the control of the organization implementing QI; (3) those who directly control clinical work processes view QI as a threat to their professional autonomy and treat it with suspicion as an encroachment of 'business practices.'

Methods

Data sources

Data on hospital QI practices derived from a 1997 national, mailed survey sent to the CEOs of all 6150 US hospitals. The CEO was asked to complete the survey and seek the assistance of the person responsible for the hospital's QI effort in order to ensure the most accurate data or assessment about the hospital's QI activities. The 26-page survey requested information about all hospital efforts to improve quality and did not assume (nor encourage respondents to make assumptions about) the superiority of any specific approach. The survey provided definitions of terms like 'quality improvement,' 'quality assurance,' 'continuous quality improvement,' 'total quality management,' and 'quality improvement project' in order to increase the consistency and comparability of respondents' answers. Of the 6150 hospitals in the sampling frame, 2350 (or 38 per cent) responded to the survey. Logistic regression analysis showed no statistically significant differences between respondents and non-respondents in terms of bed size, ownership, community hospital status, teaching hospital status, metropolitan location, or census region.

In addition to the QI survey, the study used data from the 1997 and 1998 American Hospital Association's (AHA) Annual Survey of Hospitals, the 1998 Bureau of Health Professions' Area Resource File, and two proprietary data sets compiled by Solucient, Inc. The AHA Annual Survey is administered annually in the fourth quarter to all AHA registered and non-registered facilities. The Area Resource File supplies county-specific data on an annual basis for numerous market and demographic factors. Solucient Inc. provided information on county-level insurance coverage for six types of insurance, making possible the construction of managed care penetration measures. Solucient Inc. also supplied financial performance ratios for each hospital derived from the 1997 through 2001 Medicare Cost Reports.

Sample

Our study focuses on community hospitals located in the US. Therefore, from the 2350 hospitals that responded to the 1997 quality improvement survey, we eliminated federal hospitals, specialty hospitals, and hospitals located in US territories. We also eliminated hospitals that responded to the quality improvement survey but lacked an AHA identification number (50), a Medicare Health Care Financing Administration (HCFA) identification number (96), or any Medicare-reimbursed discharges (43). These screening procedures generated a useable sample of 1784 hospitals. Comparisons with the population of US community hospitals in 1997 indicate that this sample is proportionately comparable on regional location, size, system membership and rurality. However, investor-owned hospitals were slightly under-represented in the sample.

Measures

Independent variables

Measures of quality improvement scope and intensity were derived from the AHA Quality improvement survey and based on multi-item indices. To assess reliability we employed principal component factor analyses using SAS 9.1. All indices reported achieved eigenvalues greater than 1. We captured the **scope** of a hospital's QI effort with four variables. First, we measured the diffusion of hospital QI efforts as the average level of involvement of seven hospital units in the hospital's QI efforts, measured on a five-point scale that ranged from 'not at all' (1) to 'very great extent' (5). The units included acute inpatient care, outpatient clinics, major physician offices or group practices, home health agencies, owned or affiliated nursing homes, owned or affiliated ambulatory surgery centers, and owned or affiliated hospices. Principal factor analysis supported the construction of a single scale, which showed reasonably good reliability ($\alpha = 0.73$). In addition, we measured the extent of mobilization for QI in terms of the percentage of senior management participating in QI teams, the percentage of total full time equivalents (FTEs) on QI teams, and the percentage of physicians on QI teams.

QI intensity was measured by five variables. The first indicated the number of conditions or procedures for which a clinical guideline, pathway, or protocol existed at the hospital. Nine possible conditions or procedures were considered: asthma, diabetes, hypertension, coronary artery bypass graft surgery, total hip replacement, depression, pregnancy, pneumonia, and stroke. The second variable indicated the percentage of conditions or procedures for which quality data are collected and used. Ten conditions and procedures were examined: acute myocardial infarction, congestive heart failure, pneumonia, hip replacement, transurethral resection of the prostate, coronary bypass, Cesarean section, hysterectomy, asthma, and diabetes. The third variable indicated the average extent to which QI tools were used by none (0) a few (1), many (2), or all groups or teams (3) in the hospital. Twelve tools were examined: cause and effect, fishbone diagrams, control charts, run charts, histograms scatter diagrams, process flow charts, affinity diagrams, nominal group methods, brainstorming, systems thinking, rapid cycle process improvement, and Pareto diagrams. Principal factor analysis supported the construction of a single scale, which showed good reliability ($\alpha = 0.88$). The fourth variable indicated the extent to which the hospital's activities focused on quality improvement as opposed to quality assurance. Five program aspects were rated by the respondent on an ordinal scale ranging from 'not at all' (1) to 'a very great extent' (5). The program aspects included: use of structured problem solving processes incorporating statistical methods and measurement to diagnose and monitor progress; philosophy of continuous improvement of quality through improvement of organizational processes; empowering employees to identify quality problems and improvement opportunities and to take action on these problems and opportunities; explicit focus on 'customers' both internal and external; and use of quality improvement teams including employees from multiple departments and from different organizational levels as the major mechanism for introducing improvements in organizational processes. Principal factor analysis supported the construction of a single scale, which showed good reliability ($\alpha = 0.84$). The fifth measure of QI intensity was the proportion of physicians on the active medical staff of the hospitals who routinely use clinical practice guidelines.

Dependent variables

Analysis focused on two indicators of hospital performance-cash flow, and cost per case. These indicators are respectively indicative of the 'bottom line' ability of the hospital to successfully operate in a competitive environment and to control cost in an era of increasing health care cost containment. Both financial indicators were measured as the mean over a 5-year period (1997–2001) to avoid potential short-term bias, and as the standard deviation over the same period to capture volatility. Both measures are inflation adjusted. We measured cash flow as the net available for debt service (i.e., net patient income, depreciation, amortization, and interest expense) divided by the sum of net patient revenue and total other income (1997–2001). Cash flow margin indicates the percentage of operating revenue available to cover debt service and build equity. It is a measure of the ability of the organization to generate sufficient cash flow from operations to assure financial viability. In recent years, credit rating agencies (e.g., Moody) have placed increased emphasis on cash flow adequacy (as compared to balance sheet quality) for purposes of determining the credit worthiness of hospitals. Cost per case was measures as operating expense per discharge, adjusted for outpatient and non-acute care, HCFA case mix, and HCFA labor market index.

Control variables

We included three categories of covariates expected to relate to QI implementation, hospital financial performance, or both: market characteristics, hospital characteristics, and length of QI experience. These controls include many standard variables found in the health services research literature.

Market competition and managed care penetration have been shown to have negative associations with QI implementation scope (Hoff, Jameson, & Hannan, 2004; Weiner, Alexander, Shortell, Baker, Becker, & Geppert, 2006) and negative associations with hospital financial performance (Weil, 1996). Three competition variables are incorporated in the model: a Herfindal Index of market concentration, defined as the sum of the squared market shares of the hospitals in the county in 1997; the self-reported number of other hospitals with which the hospital directly competes for patients on either an inpatient or outpatient basis; and the self-reported intensity of competition for patients among hospitals in the market, measured on a seven-point scale that ranged from 'not at all intense' (1) to 'highly intense' (7). We also included two managed care variables: managed care penetration, defined as the percentage of the total insured population in a county enrolled in a private risk, Medicare risk, or Medicaid risk insurance product in 1997; and self-reported percentage of patients for which hospital is paid on a capitated, negotiated per case rate, or discounted basis (excluding Medicare and Medicaid).

Hospital complexity has been shown to be both a driver of costs and an impediment to organization wide implementation of QI programs (Alexander, 2005; Carey, 2003; Deitrick, 1986; Griffith & White, 2002). We included six variables indicating the hospital's structural complexity. These included a binary variable indicating whether the hospital belonged to the Council of Teaching Hospitals (COTH); a binary variable indicating whether the hospital had its own governing board; three binary variables indicating whether a hospital had developed—on its own or through a health system, health network, or joint venture with an insurer—a health maintenance organization (HMO), preferred provider organization (PPO), or indemnity product (FFS); and a variable indicating the number of physician arrangements in which the hospital participates, either on its own or through a health system or health network. Eight physician arrangements were examined (e.g., independent practice association, integrated salary model).

Other hospital characteristics included a binary variable to indicate whether the hospital operated under private ownership and two measures of hospital service mix variables: total outpatient visits, including emergency room visits and outpatient surgeries, adjusted by hospital bed size; and ratio of the number of outpatient services offered by the hospital to the number of inpatient services offered by hospital. For the latter, 25 services listed in AHA Annual Survey were designated outpatient services; 47 were designated inpatient services. We measured hospital investment in QI as the total expenses associated with hospital QI activities across five expense categories (e.g., full-time personnel whose job description is associated with QI departments or program functions).

Finally, we controlled for number of years since hospital first became involved in QI and hospital investment in QI. The former measure is a proxy for the potential temporal impact on QI implementation (e.g., period of time it may take QI to be institutionalized in the organization) Previous studies, for example, indicate that innovations may actually be detrimental to organizational performance initially, but over time will improve such performance (cites). We defined 'involved' as the first training of organizational in QI principles and methods or the substantive investment of top management's time in organizing QI. A square-root transformation was applied to correct for positive skew. The latter is a measure of the relative degree of financial commitment made to QI programs. Prior research has shown that resource support to new practices are critical to their successful implementation (cites).

Table 1 summarizes descriptive statistics and the Appendix contains a correlation matrix for all study variables.

Table 1. Descriptive statistics for study variables

Category	Variable	N	Mean	STD
QI scope variables	Diffusion of QI across hospital units	1751	3.80	1.72
	Proportion of FTEs on QI teams	1749	0.23	0.22
	Proportion of managers on QI teams	1749	0.72	0.33
	Proportion of physicians on QI teams	1749	0.23	0.27
QI intensity variables	Proportion of QI teams using quality data	1749	0.72	0.43
	Number of guidelines developed	1784	2.66	2.30
	Intensity of process improvement tool use	1749	1.32	0.55
	Emphasis on quality improvement	1751	3.83	0.74
	Proportion of physicians using guidelines	1784	0.18	0.19
Financial performance variables	Cash flow (5-year average)	1761	9.79	7.10
	Cash flow (Standard Deviation)	1759	5.11	4.21
	Cost per case (5-year average)	1760	4595.90	1356.18
	Cost per case (Standard Deviation)	1754	587.89	615.37
Control variables	Market concentration	1784	0.57	0.36
	Perceived hospital competition intensity	1749	5.00	1.52
	Perceived # of hospital competitors	1749	4.55	4.43
	managed care penetration	1783	0.22	0.20
	Pct of patients private managed care	1749	0.32	0.30
	Teaching hospital status (binary)	1780	0.25	0.43
	Public, non-federal ownership	1784	0.27	0.44
	For-profit ownership	1784	0.09	0.29
	HMO ownership	1784	0.27	0.44
	PPO ownership	1784	0.36	0.48
	Indemnity ownership	1784	0.12	0.32
	Number of physician arrangements	1784	1.22	1.29
	System or network affiliated	1784	0.61	0.49
	Number of inpatient surgeries	1784	2251.31	3536.99
	Outpatient/inpatient ratio	1784	0.49	0.22
	Outpatient visits (adjusted by beds)	1784	605.24	514.22
	Years of formal involvement in QI	1568	4.15	2.36
	No governing board	1784	0.03	0.16
	MSA	1780	2.29	2.38
	Total expenses on QI	1749	246637.82	392170.41
Instrumental variables	CEO participation in QI activities	1749	3.66	1.17
	Board monitoring of QI	1784	10.45	3.17
	Board activity in QI	1784	1.95	1.61
	Perceived barriers to QI	1751	3.23	0.96
	Clinical integration (binary)	1749	0.47	0.50
	Integrated data base	1733	0.21	0.41
	Hospital size (beds)	1784	185.60	185.26
	Hospital size (beds-squared)	1784	68746.16	161588.04
	Clinical IS capabilities	1751	2.37	0.88

Statistical analysis

Our study seeks to model hospital-level financial performance as a function of QI scope and intensity, hospital organizational and financial characteristics, and hospital market attributes. We estimate regression models in which the dependent variables are our measures of financial performance and our independent variables include the measures of QI scope and intensity, and other control variables described above. In these models, the coefficients of the QI scope and intensity variables will provide evidence about the hypothesized relationships between QI scope, QI intensity and outcome measures. Incremental contributions of the QI scope and intensity variable sets to the explained variance will be determined by computing F value differences between the R squares for models containing the control variables only and the control variables plus the QI scope and intensity variables.

Instrumental variables analysis

While results from our regression models may be informative, a concern that can arise in this type of modeling stems from the potential for an endogenous relationship between hospital financial performance and quality improvement. For example, poor performing hospitals may be motivated to correct performance problems by adopting more focused initiatives aimed at improving quality of care. Or, some hospitals may have unobserved attributes that predispose them to better financial performance, and which also increase the likelihood that they will invest in QI strategies. If this happens, results from a general linear regression modeling approach would not reflect the true causal effect of QI implementation on hospital financial performance.

Estimation using instrumental variables (IV) provides a means of determining the extent to which any such bias exists, and, if necessary, correcting for it. To implement the IV technique, we first identified a set of 'instruments,' that is, variables that are hypothesized to influence the level of a hospital's QI activity, but not directly influence financial performance.

To identify potential instruments, we drew on previous research on QI adoption and implementation in health care organizations (Carman et al., 1996; Kishnan, Shani, Grant, & Baer, 1993; Shortell et al., 1995b; Weiner et al., 1996, 1997). This literature largely supports Klein, Conn, and Sorra's (2001) conceptual model of innovation implementation, which posits that effective implementation (i.e., innovation use by targeted organizational members) depends upon two factors: management support for implementation, and implementation policies and practices (Klein & Sorra, 1996; Klein et al., 2001). Management support signals the organization's priorities and facilitates implementation by influencing employees' recognition and acceptance of the importance of putting the innovation into use. Implementation policies and practices (IPPs) refer to an array of organizational policies, practices, and characteristics that influence innovation use (e.g., training, user support, incentives, recognition, end-user participation, and work load changes). IPPs facilitate implementation by increasing employees' capabilities, motivations, and opportunities to put the innovation into use.

Guided by this conceptual model, we identified two sets of organizational factors in the QI literature that support QI implementation: factors that reflect 'leadership from the top' for QI (e.g., management support) and factors that reflect a supportive infrastructure for QI (e.g., implementation policies and practices). These 'macro-level' factors are not expected to impact quality directly, but rather to support the QI efforts of the clinical micro teams that engage in direct patient care. In other words, leadership from the top and supportive infrastructure will result in a greater likelihood of QI implementation, and successfully implemented QI programs, in turn, are likely to lead to improved quality. Empirically, therefore, we expect that our selected instruments will be associated with successful QI implementation, but have weak or no association with quality of care or patient errors.

Because we include multiple measures of QI implementation scope in our models, we had to identify a number of instruments at least equivalent to the number of QI implementation scope measures in the model. These instruments are discussed below.

Leadership from the top

Research shows that top management and board support for QI is critical to QI implementation in hospitals (Weiner et al., 1996, 1997). We therefore expect that active involvement of the hospital CEO and the hospital board will be associated with more extensive QI implementation. Specifically, we examined three leadership measures. First, we included a variable indicating the number of QI activities in which the CEO personally participated out of 5 activities (e.g., participating in a QI council or steering committee and teaching QI principles/techniques to others). Second, we measured the number of types of quality data the board routinely reviewed, out of 15 types of data (e.g., medication error rates). Third, we measured the number of actions taken by the board on quality-related matters in the past 12 months, out of 6 possible actions (e.g., requested that specific quality of care data be collected). Leadership from the top is not expected to directly improve quality of care, since neither the CEO nor the board is directly involved in the provision of patient care or the cross-functional teams applying QI principles and practices to clinical care processes. However, leadership from the top signals that QI is an organizational priority; this, in turn, provides a supportive context for clinical and non-clinical staff to apply QI principles and practices and improve clinical processes.

Supportive infrastructure

Information systems are a key component of the infrastructure needed for QI implementation. Successful QI efforts depend on the availability, accuracy, and timeliness of information from which to identify problems and benchmark changes in care processes. The extent to which hospitals have developed their information systems and integrated both clinical and financial data will provide the foundation upon which successful QI practices can be built (Alexander, Weiner, Shortell, Baker, & Becker, 2006; Mitchell & Shortell, 1997; Shortell et al., 1998). Conversely, hospitals without well-developed information systems will lack the critical capability to provide accurate and timely information on clinical processes and outcomes. We measured information systems capabilities with a binary measure indicating whether the hospital has a single, integrated database that contains all of the hospital's QA/QI data elements; and also with a four-item perceptual measure of clinical IS capabilities (sample item: provide data that can be analyzed over time for purposes of research, patient monitoring, and detection of trends). These items were measured on a five-point ordinal scale that ranged from 'no extent' (1) to 'very great extent' (5). Factor analysis supported the construction of a single scale, which showed good reliability ($\alpha = 0.81$). Integrated, enhanced clinical information systems capabilities do not ensure high-quality care. Instead, they offer 'macro-level' support for clinical micro teams to systematically study and improve patient care processes. As supportive infrastructure, clinical information systems should facilitate QI implementation which, in turn, should lead to improved quality.

Supportive infrastructure for QI is also indicated by implementation policies and practices that remove or mitigate barriers that thwart organizational members' efforts to put QI principles and practices into use. Such barriers include lack of time, inadequate training in QI methods, misaligned reward systems, and reluctance to change familiar routines and practices (Gustofson et al., 1997; Lurie, Merrens, Lee, & Splaine, 2002; Shortell, 1995). To the extent that such barriers are perceived to exist by hospital leaders, QI implementation will be less extensive. We measured perceived barriers on a seven-point scale that ranged from 'no barrier' (1) to 'great barrier' (7). We examined fourteen barriers (sample item: inadequate employee training in QI principles and methods). Exploratory factor analysis supported the construction of a single scale ($\alpha = 0.87$).

Finally, the organizational characteristics of the hospital itself may create a more or less supportive infrastructure for QI implementation. For example, organization size is associated with both the availability of internal resources and the complexity of internal decision-making and communication structures, two characteristics that may affect QI implementation (Gustofson et al., 1997). We propose that, relative to very small or very large hospitals, mid-size hospitals will experience greater QI implementation because they have the resources to support QI implementation (e.g., staffing resources for QI), and because they have sufficiently complex administrative and clinical operations to justify pursuing QI as a means of rationalizing clinical care processes. By contrast, small hospitals may lack the resources to introduce QI on any extensive scale and large hospitals may be *too* complex and specialized to achieve sufficient buy-in and cultural support for organization-wide QI efforts (Blumenthal & Kilo, 1998). We measured hospital size as the natural logarithm of the number of beds set up and staffed for use. We included a squared term for hospital size to represent nonlinear effects.

We tested the predictive power of the instruments in first-stage regressions of the QI scope and intensity measures on the instruments and other controls (Greene, 2000; see Table 2). We used these results to evaluate the instrumental variable set on three criteria: contribution to variance explained, consistency of statistical significance across models, and consistency of direction of effects. We found in every case that adding the instrumental variable set resulted in statistically significant increases in the variance explained, with marginal increases in R-square ranging from a low of 0.05 for percentage of conditions or procedures for which quality data are collected and used by formally organized quality improvement project teams to a high of 0.24 for extent to which the hospital's activities focused on improving processes and systems of care as opposed to correcting individuals' mistakes after the fact. The F-statistics for the joint statistical significance tests ranged from 12.95 for percentage of conditions or procedures for which quality data are collected and used by formally organized quality improvement project teams ($p < 0.001$) to 72.22 for extent to which the hospital's activities focused on improving processes and systems of care as opposed to correcting individuals' mistakes after the fact ($p < 0.001$). Finally, both the direction and the statistical significance of the effects were consistent across QI variables and consistent with theory.

We then estimated the models using a two-stage instrumental variables approach. The first stage instrumented QI scope and intensity variables as a function of leadership for quality improvement, hospital infrastructure and resources for quality improvement. The second stage model included both the predicted values (instruments) of the QI scope and intensity variables and the control (exogenous) variables in predicting each of four financial performance indicators.

We observed that the two-stage approach and the naïve 'one-stage' approach (without instruments) produced comparable results for both QI scope and intensity variables. Specifically, we observed consistency in the directionality, standard errors and statistical significance of the QI scope and intensity variables across the two modeling approaches. However, adding both the instrumented scope and intensity variables to the model increased the standard errors in the two-stage approach, resulting in a loss of statistical significance for many of the QI variables. We concluded that instrumenting both the scope and intensity variables in the same model introduced too much strain on the second-stage models. We therefore modeled the scope and intensity variables in two separate 2-stage models. However, given the comparability of the main-effects results across the two-stage and naÿve regression approaches we elected to present the results from the simpler 'one-stage' models below (Results of the two stage models are available from the authors).

Results

Results of the naïve regression models are presented in Tables 3–6. In each table, the first model incorporates both QI scope and intensity variables, as well as control variables. The results of these

Table 2. First-Stage regression of quality improvement scope variables on controls and instruments

	Diffusion across hospital units		Proportion hospital staff on QI teams		Proportion managers on QI teams		Proportion physicians on QI teams	
	Beta	SE	Beta	SE	Beta	SE	Beta	SE
Intercept	2.207	0.369***	0.157	0.048**	0.468	0.074***	0.270	0.057***
Market concentration	0.257	0.163	−0.017	0.021	0.000	0.033	0.028	0.025
Number of hospital competitors	−0.002	0.009	0.001	0.001	−0.003	0.002	0.002	0.001
Hospital competition intensity	0.002	0.028	−0.001	0.004	0.000	0.006	−0.009	0.004*
Managed care penetration	0.022	0.281	0.021	0.036	−0.059	0.056	0.013	0.043
Pct patients in managed care	0.141	0.132	0.001	0.017	0.004	0.027	0.008	0.020
Teaching hospital	0.169	0.118	−0.001	0.015	−0.031	0.024	−0.003	0.018
Private ownership	0.000	0.097	−0.013	0.013	−0.038	0.020 M	−0.027	0.015 M
HMO ownership	0.138	0.106	−0.008	0.014	0.002	0.021	−0.008	0.016
PPO ownership	−0.288	0.100**	0.000	0.013	0.002	0.020	0.024	0.015
Indemnity ownership	0.038	0.135	−0.030	0.017 M	−0.011	0.027	−0.026	0.021
No. of physician arrangements	−0.005	0.035	−0.001	0.005	0.001	0.007	−0.003	0.005
Outpatient/inpatient ratio	0.319	0.190 M	0.032	0.025	−0.052	0.038	0.064	0.029*
Outpt visits/bed (in 1000s)	0.069	0.078	−0.020	0.010*	0.005	0.016	−0.039	0.012**
Years of QI	0.072	0.061	0.029	0.008***	0.033	0.012**	0.019	0.009*
No governing board	1.134	0.496*	0.038	0.064	0.092	0.099	0.108	0.076
Metropolitan statistical area	−0.119	0.027***	−0.009	0.004*	0.005	0.006	−0.020	0.004***
Total expenses on QI/Bed	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CEO participation in QI	0.087	0.035*	0.011	0.005*	0.042	0.007***	0.020	0.005***
Board monitoring of QI	0.099	0.016***	0.006	0.002**	0.008	0.003*	0.001	0.002
Board activity in QI	0.062	0.026*	−0.004	0.003	0.008	0.005	0.002	0.004
Perceived barriers to QI	−0.149	0.044***	−0.025	0.006***	−0.005	0.009	−0.028	0.007***
Clinical IS capabilities	0.087	0.048 M	0.013	0.006*	0.004	0.010	−0.004	0.007
Clinical integration	0.388	0.085***	0.009	0.011	0.038	0.017*	−0.004	0.013
Integrated data base	0.176	0.097 M	−0.031	0.013*	0.023	0.019	0.014	0.015
Hospital size	1.9E-03	4.8E-04***	−2.8E-04	6.3E-05***	−1.9E-04	9.7E-05 M	−3.4E-04	7.4E-05***
Hospital size squared	−1.3E-06	6.3E-07*	1.6E-07	8.1E-08 M	−1.1E-07	1.3E-07	3.8E-07	9.6E-08***
N	1743		1743		1743		1743	
Adjusted R-square	0.23		0.18		0.17		0.24	

(*Continues*)

Table 2. (Continued)

	Number guidelines developed		Use of quality data by QI teams		Use of statistical tools		Focus on s improvement		Physician use of guidelines	
	Beta	SE	Beta	SE	Beta	SE	Beta	SE	Beta	SE
Intercept	−0.777	0.423 M	0.262	0.096**	0.402	0.105***	3.283	0.140***	−0.070	0.038 M
Market concentration	0.091	0.187	0.039	0.042	−0.006	0.047	0.135	0.062*	0.014	0.017
Number of hospital competitors	−0.001	0.011	0.000	0.002	0.000	0.003	0.001	0.003	0.000	0.001
Hospital competition intensity	−0.031	0.033	0.005	0.007	0.005	0.008	0.023	0.011*	−0.003	0.003
Managed care penetration	−0.857	0.322**	−0.068	0.073	0.103	0.080	0.081	0.106	−0.077	0.029**
Pct patients in managed care	0.460	0.151**	−0.015	0.034	0.057	0.038	0.030	0.050	0.024	0.014 M
Teaching hospital	0.300	0.135*	−0.021	0.031	0.001	0.034	0.064	0.045	0.017	0.012
Private ownership	0.540	0.111***	−0.006	0.025	0.065	0.028*	0.022	0.037	0.034	0.010***
HMO ownership	0.172	0.121	0.042	0.028	0.071	0.030*	0.060	0.040	0.011	0.011
PPO ownership	−0.157	0.114	0.002	0.026	−0.019	0.028	−0.002	0.038	−0.023	0.010*
Indemnity s	0.000	0.154	−0.026	0.035	−0.021	0.038	0.017	0.051	0.019	0.014
No. of physician arrangements	0.053	0.040	−0.011	0.009	0.028	0.010**	−0.019	0.013	0.004	0.004
Outpatient/inpatient ratio	0.279	0.217	0.139	0.049**	−0.053	0.054	−0.081	0.072	0.021	0.020
Outpt visits / bed (in 1000s)	0.315	0.089***	−0.009	0.020	38.237	22.144 M	13.801	29.404	21.477	8.014**
Years of QI	0.275	0.070***	0.054	0.016***	0.057	0.017**	0.073	0.023**	0.022	0.006***
No governing board	0.580	0.567	0.164	0.129	0.500	0.141***	0.687	0.187***	0.002	0.051
Metropolitan statistical area	0.086	0.031**	0.001	0.007	0.006	0.008	0.010	0.010	0.005	0.003 M
Total expenses on QI/Bed	0.000	0.000	0.000	0.000	0.000	0.000**	0.000	0.000	0.000	0.000
CEO participation in QI	0.096	0.040*	0.017	0.009 M	0.056	0.010***	0.056	0.013***	0.010	0.004**
Board monitoring of QI	0.089	0.018**	0.015	0.004***	0.038	0.005***	0.054	0.006***	0.008	0.002***
Board activity in QI	0.005	0.029	0.018	0.007**	0.013	0.007 M	0.014	0.010	−0.004	0.003
Perceived barriers to QI	−0.007	0.050	−0.023	0.011*	−0.044	0.012***	−0.260	0.017***	−0.003	0.005
Clinical IS capabilities	0.163	0.055**	0.025	0.013*	0.063	0.014***	0.054	0.018**	0.013	0.005**
Clinical integration	0.642	0.097***	0.039	0.022 M	0.087	0.024***	0.150	0.032***	0.057	0.009***
Integrated data base	0.249	0.111*	0.068	0.025**	−0.008	0.028	0.087	0.037*	0.029	0.010**
Hospital size	6.1E-03	5.5E-04***	2.1E-04	1.3E-04 M	7.7E-04	1.4E-04***	2.3E-04	1.8E-04	4.4E-04	5.0E-05***
Hospital size squared	−3.6E-06	7.2E-07***	−5.6E-08	1.6E-07	−6.4E-07	1.8E-07***	−3.3E-07	2.4E-07	−2.7E-07	6.5E-08***
N	1743		1743		1743		1743		1743	
Adjusted R-square	0.37		0.26		0.31		0.33		0.26	

M $p < 0.10$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

Table 3. GLM regression of average cash flow on hospital QI practices

	Full model		Scope		Intensity	
	Beta	SE	Beta	SE	Beta	SE
Intercept	5.09	1.37***	6.58	1.22***	5.07	1.35***
Market concentration	1.50	0.70*	1.43	0.70*	1.44	0.70*
Perceived number of hospital competitors	0.52	0.57	0.74	0.57	0.53	0.57
Perceived hospital competition intensity	−0.52	0.12***	−0.50	0.12***	−0.50	0.12***
Managed care penetration	−3.33	1.21**	−3.25	1.22**	−3.40	1.21**
Pct of patients private managed care	0.07	0.04 M	0.07	0.04 M	0.06	0.04
Teaching hospital status (binary)	−0.14	0.45	0.24	0.44	−0.10	0.45
Private ownership	1.65	0.42***	1.97	0.42***	1.68	0.42***
HMO ownership	−0.20	0.45	−0.08	0.46	−0.17	0.46
PPO ownership	−0.11	0.43	−0.05	0.43	−0.17	0.43
Indemnity ownership	0.20	0.58	0.17	0.58	0.22	0.58
Number of physician arrangements	0.29	0.15 M	0.38	0.15*	0.30	0.15*
Outpatient/inpatient ratio	−0.98	0.81	−1.47	0.81 M	−1.10	0.80
Outpatient visits (adjusted by beds)	0.80	0.32*	0.85	0.33**	0.85	0.32**
Years of formal involvement in QI	0.84	0.26**	1.00	0.26***	0.85	0.26**
No governing board	−2.34	2.00	−2.16	2.01	−2.52	2.00
Metropolitan statistical area	0.08	0.12	0.16	0.12	0.11	0.12
Total expenses for QI (adjusted by beds)	0.00	0.00	0.00	0.00	0.00	0.00
Diffusion of QI across hospital units	0.08	0.03*	0.21	0.10*		
Percentage of FTEs on QI teams	0.52	0.85	1.09	0.84		
Percentage of managers on QI teams	0.58	0.53	0.80	0.53		
Percentage of physicians on QI teams	−1.92	0.72**	−2.18	0.72**		
Number of guidelines developed	0.34	0.16*			0.34	0.16*
Use of QI tools	1.26	0.37***			1.37	0.37***
CQI approach to improvement	0.43	0.27			0.48	0.26 M
Physician use of guidelines	−1.90	1.75			−1.92	1.75
Use of QI data by conditions/procedures	−1.12	0.40**			−1.14	0.40**
N	1722		1722		1722	
Adjusted R-squared	0.25		0.17		0.20	

M $p < 0.10$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

integrated models will be discussed below. The second and third models contain respectively the scope and intensity variables plus the control variables. The latter two models correspond to the 2-stage IV models and are presented for information only. The per cent of variance explained is relatively small in all cases, suggesting that cash flow and cost per case are subject to other, unmeasured influences.

Hospital cash flow

Hypothesis 1 and 2 predicted respectively that greater scope and intensity of QI deployment would be positively associated with better hospital performance. Our results provide partial support for these hypotheses. As predicted for QI scope, greater diffusion of QI across hospitals units was associated with higher average hospital cash flow over the 5-year study period. Unexpectedly, however, the greater the percentage of physicians participating in QI teams, the lower the average cash flow over the study period. With respect to QI intensity, both number of guidelines employed by the hospital and the number of QI tools used were positively associated with average cash flow over the study period.

Table 4. GLM regression of cash flow variability on hospital QI practices

	Full Model		Scope		Intensity	
	Beta	SE	Beta	SE	Beta	SE
Intercept	7.88	0.82***	8.16	0.73***	7.60	0.81***
Market concentration	−1.25	0.42**	−1.18	0.42**	−1.27	0.42**
Perceived number of hospital competitors	−0.22	0.34	−0.33	0.34	−0.23	0.34
Perceived hospital competition intensity	0.14	0.07*	0.15	0.07*	0.14	0.07*
Managed care penetration	0.34	0.72	0.37	0.72	0.33	0.72
Pct of patients private managed care	−0.04	0.02	−0.04	0.02	−0.04	0.02
Teaching hospital status (binary)	−0.06	0.27	−0.25	0.26	−0.06	0.27
Private ownership	−0.22	0.25	−0.33	0.25	−0.19	0.25
HMO ownership	−0.07	0.27	−0.10	0.27	−0.08	0.27
PPO ownership	−0.18	0.26	−0.20	0.26	−0.15	0.26
Indemnity ownership	0.14	0.34	0.18	0.35	0.14	0.34
Number of physician arrangements	−0.12	0.09	−0.16	0.09 M	−0.13	0.09
Outpatient/inpatient ratio	−0.82	0.48 M	−0.70	0.48	−0.85	0.48 M
Outpatient visits (adjusted by beds)	−0.51	0.19**	−0.53	0.19**	−0.51	0.19**
Years of formal involvement in QI	−0.56	0.16***	−0.60	0.16***	−0.58	0.16***
No governing board	0.42	1.19	0.35	1.20	0.41	1.20
Metropolitan statistical area	0.11	0.07	0.08	0.07	0.13	0.07 M
Total expenses for QI (adjusted by beds)	0.00	0.00 M	0.00	0.00*	0.00	0.00 M
Diffusion of QI across hospital units	−0.15	0.06*	−0.16	0.06**		
Percentage of FTEs on QI teams	0.02	0.51	−0.04	0.50		
Percentage of managers on QI teams	−0.36	0.32	−0.33	0.32		
Percentage of physicians on QI teams	−0.14	0.43	−0.05	0.43		
Number of guidelines developed	−0.27	0.09**			−0.27	0.09**
Use of QI tools	−0.35	0.22			−0.38	0.22 M
CQI approach to improvement	0.14	0.16			0.01	0.15
Physician use of guidelines	1.88	1.05 M			1.68	1.05
Use of QI data by conditions/procedures	0.52	0.24*			0.46	0.24 M
N	1720		1720		1720	
Adjusted R-squared	0.20		0.16		0.15	

M $p < 0.10$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

However, one QI intensity measure, more extensive use of QI data, displayed a negative and significant association with average cash flow. Percentage of hospital staff participating on QI teams, percentage of senior managers participating on QI teams, hospital approach to quality improvement and physician use of guidelines did not show statistically significant associations with average cash flow. Finally, it is noteworthy that length of hospital experience with QI was positively related to average cash flow over the study period.

Table 4 displays results of the models predicting volatility of hospital cash flow over the 5-year study period. Taken as a whole, both QI scope and intensity were less robust predictors of this dependent variable than they were of average cash flow. Only one scope variable and two intensity variables were associated with volatility in cash flow. Specifically, diffusion of QI across hospital units (scope) and number of guidelines developed (intensity) were negatively associated with profit volatility in hospitals. These associations were in the direction predicted by hypotheses. However, more extensive use of data by QI teams was associated with greater volatility in hospital cash flow. Finally, the longer a hospital's experience with QI programs, the lower the volatility in hospital cash flow.

Table 5. GLM regression of cost per case on hospital QI practices

	Full Model		Scope		Intensity	
	Beta	SE	Beta	SE	Beta	SE
Intercept	6121.55	261.69***	5784.10	231.56***	6067.19	258.20***
Market concentration	−512.72	133.40***	−521.84	133.65***	−501.47	133.52***
Perceived number of hospital competitors	−283.80	108.27**	−284.73	108.15**	−280.64	108.44**
Perceived hospital competition intensity	−11.20	23.17	−14.20	23.18	−12.52	23.18
Managed care penetration	−525.53	231.44*	−535.21	231.47*	−513.39	231.68*
Pct of patients private managed care	5.49	7.46	5.76	7.48	6.08	7.46
Teaching hospital status (binary)	599.80	86.52***	599.03	84.43***	629.61	85.88***
Private ownership	−444.51	79.55***	−450.85	78.75***	−437.30	79.51***
HMO ownership	20.85	86.49	22.00	86.53	27.69	86.55
PPO ownership	−216.58	81.38**	−233.64	81.50**	−215.76	81.31**
Indemnity ownership	1.18	109.72	13.46	109.86	6.65	109.83
Number of physician arrangements	−0.05	28.56	5.60	28.42	1.32	28.59
Outpatient/inpatient ratio	312.91	153.46*	328.89	153.06*	316.15	153.08*
Outpatient visits (adjusted by beds)	−183.09	61.72**	−185.04	61.88**	−187.83	61.69**
Years of formal involvement in QI	−128.23	50.30*	−130.38	49.66**	−138.85	50.23**
No governing board	828.84	380.73*	790.35	381.52*	850.43	381.17*
Metropolitan statistical area	−2.85	22.53	−6.63	22.30	−4.68	22.18
Total Expenses for QI (adjusted by beds)	0.00	0.01	0.00	0.01	0.00	0.01
Diffusion of QI across hospital units	19.62	20.19	9.60	18.87		
Percentage of FTEs on QI teams	−309.16	161.26*	−339.28	160.02*		
Percentage of managers on QI teams	−213.47	101.33*	−217.91	100.43*		
Percentage of physicians on QI teams	152.16	136.75	145.55	136.49		
Number of guidelines developed	−66.06	29.70*			−61.50	29.68*
Use of QI tools	112.14	71.17			87.34	70.68
CQI approach to improvement	−147.51	51.66**			−155.80	49.22**
Physician use of guidelines	920.80	333.43**			910.50	333.14**
Use of QI data by conditions/procedures	2.17	76.40			2.06	76.18
N	1721		1721		1721	
Adjusted R-squared	0.28		0.23		0.25	

M $p<0.10$; $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$.

Hospital cost per case

When cost per case is used as a measure of hospital performance, our results again provide general support our hypotheses that QI scope and intensity are related to better hospital performance. As predicted, results in Table 5 indicate that higher proportions of hospital staff and senior managers on QI teams (scope) are associated with lower average cost per case over the 5-year study period. With respect to QI intensity, both number of guidelines employed by the hospital and QI emphasis over quality assurance are negatively associated with average cost per case over the study period. Unexpectedly, however, greater physician use of guidelines was associated with higher average cost per case. Results in Table 6 suggest that only hospital emphasis on quality improvement (versus quality assurance) is significantly associated with volatility in cost per case. The negative sign of the coefficient of QI emphasis is consistent with our prediction. Finally, the greater the hospital's experience with QI programs, the lower the volatility in hospital cost per case.

Although these results are generally supportive of our hypotheses, the unexpected findings with respect to physician participation on QI teams and physician use of guidelines warrant further

Table 6. GLM regression of cost per case variability on hospital QI practices

	Full Model		Scope		Intensity	
	Beta	SE	Beta	SE	Beta	SE
Intercept	1071.01	121.98***	948.47	107.56***	1056.06	120.04***
Market concentration	10.49	61.95	8.30	61.92	12.21	61.88
Perceived number of hospital competitors	−60.40	50.48	−62.30	50.31	−61.05	50.45
Perceived hospital competition intensity	10.59	10.78	9.52	10.76	9.86	10.76
Managed care penetration	69.25	107.43	62.12	107.19	75.97	107.32
Pct of patients private managed care	−3.08	3.47	−2.98	3.47	−2.75	3.46
Teaching hospital status (binary)	42.26	40.27	40.09	39.18	41.81	39.89
Private ownership	−104.77	36.91**	−108.91	36.47***	−105.21	36.81**
HMO ownership	−7.94	40.29	−7.91	40.22	−9.70	40.24
PPO ownership	−67.44	37.86 M	−72.86	37.82 M	−66.64	37.75 M
Indemnity ownership	39.35	50.92	42.10	50.86	36.84	50.86
Number of physician arrangements	−17.67	13.27	−16.93	13.18	−18.07	13.26
Outpatient/inpatient ratio	64.80	71.27	77.50	70.92	75.32	70.95
Outpatient visits (adjusted by beds)	−51.81	28.81 M	−52.85	28823.63 M	−54.78	28.74 M
Years of formal involvement in QI	−136.11	23.33***	−137.06	22.98***	−135.67	23.26***
No governing board	107.57	176.55	93.63	176.51	111.48	176.38
Metropolitan statistical area	−5.63	10.45	−7.11	10.32	−8.12	10.27
Total expenses for QI (adjusted by beds)	0.02	0.01**	0.02	0.01***	0.02	0.01**
Diffusion of QI across hospital units	2.49	9.38	−1.58	8.75		
Percentage of FTEs on QI teams	57.45	74.79	39.82	74.04		
Percentage of managers on QI teams	−60.96	47.07	−65.53	46.55		
Percentage of physicians on QI teams	59.77	63.42	63.20	63.15		
Number of guidelines developed	−18.27	13.80			−17.50	13.76
Use of QI tools	15.10	33.03			11.88	32.74
CQI approach to improvement	−52.22	24.00*			−49.36	22.82*
Physician use of guidelines	253.50	154.89			254.61	154.43 M
Use of QI data by conditions/procedures	34.13	35.47			34.81	35.31
N	1715		1721		1721	
Adjusted R-squared	0.15		0.14		0.15	

M $p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

examination. By introducing interaction terms in the models (e.g., physician use of guidelines × years of formal involvement in QI), we first examined whether length of experience with QI programs moderated the relationship between the physician variables and organizational performance. For example, does it take time for physicians to become accustomed to working within a QI model and thus for QI to have an impact on organizational performance? None of the interaction terms proved to be statistically significant. Second, by introducing a squared term for the physician variables in the models, we explored whether the relationship of the physician variables to organizational performance would assume a non-linear form such that a threshold of physician participation in QI teams or use of guidelines would be necessary before an impact on organizational performance is observed. The results of this analysis suggest that a non-linear relationship exists between physician use of guidelines and organizational performance for all four organizational performance measures. However, the plots of these significant non-linear associations reveals that the strength of the negative association between physician use of guidelines and organizational performance actually increases as the number of guidelines in use by physicians increases.

Discussion

Hospitals operate on the assumption that improving clinical processes through QI will improve financial performance by reducing variability in care process/inputs, thereby increasing efficiency, and by improving the competitive position of the hospital by improving the quality of the services provided and making the hospital more attractive to patients and payers. Our results suggest that QI has a measurable impact on measures of hospital organizational performance and that approaches to QI that emphasize learning and those that emphasize control are both important to positive performance in these settings. Hospitals that implement QI effectively can reasonably expect, *ceteris paribus*, to improve their financial and cost performance, or at least not to place the hospital at risk for investing in quality improvement. However, these outcomes are to some extent relative to the specific dimension of QI. Widespread physician participation and uniform compliance, for example, do not appear to be necessary for success, and may, in fact, result in poorer performance. Claims that investment in quality improvement damages the financial performance of hospitals may be largely unfounded. This conclusion is reinforced by the finding that monetary investment in QI programs does not appear to be significantly related to hospital financial performance.

These results are generally consistent with the work of researchers in other industries who provide evidence that effective QI implementations improve organizational financial performance (Hendricks & Singhal, 1996, 2001; Ittner & Larcker, 1996). Ours is one of the very few studies, however, that has examined these issues in the hospital industry with objective financial data and specific measures of QI implementation. Investing in a broader, deeper and more mature QI program should result in higher quality of care with little negative impact and some improvement to the hospital's financial situation. Although our findings do not suggest a dramatic improvement in financial performance for hospitals as a function of QI implementation, they are important in terms of setting realistic expectations for what QI programs can deliver. For example, those responsible for implementing QI programs can reasonably claim that QI will not damage the hospitals financial position, but at the same time neither will it result in substantial financial improvements. In a related vein, based on our findings, hospitals may be better able to estimate the cost-benefits associated with QI by assessing which implementation dimensions are associated with better or poorer financial performance. Such costs may take the form of training, information and performance measurement systems, or redeployment of resources. Although such costs have been well known by hospitals and other firms for some time, information on the possible financial benefits has been scarce.

Less evidence was found for the effects of QI implementation on financial volatility relative to average financial performance, although more extensive diffusion of guidelines and participation in QI efforts across multiple hospital units appears to be related to greater stability of cash flow. This may be the case because institutionalizing QI in hospitals serves to provide the deep changes in routines and practices necessary to reduce performance volatility. It may also suggest that the hospitals have achieved an important balance between sustaining effective practice routines and the ability to change and adapt to problems and changing conditions.

One curious and somewhat anomalous finding was that physician participation in QI teams was negatively associated with hospital cash flow and physician use of guidelines was positively associated with cost per case. This may reflect the tendency for physicians to emphasize quality over cost in most situations, or alternatively that high cost hospitals tend to be those that also are engaged in widespread QI efforts. Controlling for teaching status, however, somewhat mitigates this second explanation. Whatever the explanation, the consequences of these findings may be significant for hospitals and their quality improvement efforts. Many believe that lack of physician involvement represents the single most important obstacle to the success of hospital quality improvement (Berwick, Godfrey, &

Roessner, 1990; Blumenthal & Edwards, 1995; Board, 1992; Health Care Advisory Board, 1992; McLaughlin & Kaluzny, 1994; Shortell, 1995). Physicians play a central role in clinical resource allocation decisions and possess the clinical expertise needed to differentiate appropriate from inappropriate variation in care processes. Yet, reports indicate that physicians are reluctant to participate in QI projects due to distrust of hospital motives, lack of time, and fear that reducing variation in clinical processes will compromise their ability to vary care to meet individual needs (Blumenthal & Edwards, 1995; Shortell, 1995; Shortell et al., 1995a). Study results suggest that widespread physician participation in QI teams, while perhaps desirable, might not be necessary. Widespread participation of hospital staff and senior managers, it seems, is more important, at least for the hospital-level performance indicators examined here. Rather than attempting to mobilize much of the medical staff, hospital leaders could perhaps secure needed physician input by involving selected physicians on an as-needed basis.

A consistent predictor of positive financial performance was the hospital's experience with QI programs. The longer a hospital's involvement with QI, the higher the cash flow and the lower the cost per case. QI experience also appears to lower the volatility of these important financial performance indicators. This may suggest a process of organizational learning by which hospitals may initially experience negative performance as routines and practices change at the institutional level, but once fully institutionalized, have a positive impact on performance. It is also interesting to note that hospital investment in quality improvement did not have an appreciable impact on level of hospital financial performance, but consistently and negatively affected the stability of both cash flow and cost per case.

Clearly, financial performance is not the only valid measure of the value of QI programs in hospitals. Quality of care, customer/patient satisfaction, and service improvement may also indicate the value added by QI programs. However, many of the arguments against QI have been based on the premise that such programs are expensive and divert scarce resources from other more profitable activities and investments. This has proved not to be the case in our study and therefore should provide proponents of QI with a much stronger position for arguing their case.

Finally, our study results also suggest that a blended approach combining both control and learning approaches to QI might prove most beneficial. This is particularly important in light of the unusual combination of low tolerance for error and relatively uncertain diagnostic and therapeutic technologies that characterize hospital production.

Author biographies

Jeffrey Alexander is the Richard Carl Jelinek Professor of Health Management and Policy in the School of Public Health, University of Michigan. He also holds positions as Professor of Organizational Behavior and Human Resources Management, School of Business, and Faculty Associate, Survey Research Center, Institute for Social Research. His teaching and research interests focus on organizational change in the health care sector, multi-institutional systems, governance, and physician participation in institutional management and policy making.

Bryan J. Weiner, is a PhD and is Director of the Program on Health Care Organizaiton at the Cecil G. Sheps Center for Health Services Research and an associate professor in the Department of Health Policy and Administration at The University of North Carolina at Chapel Hill. His research focuses on organizational change, adoption and implementation of innovations, and inter-organizational relationships.

John Griffith is the Andrew Pattullo Collegiate Professor of health Management and Policy, in the School of Public Health, University of Michigan. He is the senior author of the widely used text-book, *The Well-Managed healthcare organization* and has published extensively on the management of hospitals.

References

Alexander, J. A., & D'Aunno, T. A. (1990). Transformation of Institutional Environments: Perspectives on the Corporatization of US Health Care. In S. S. Mick, et al. (Eds.), *Innovations in health care delivery: Insights for organizational theory* (pp. 53–85). San Francisco, CA: Jossey-Bass.

Alexander, J. A., Weiner, B. J., Shortell, S. M., Baker, L. C., & Becker, M. P. (2006). The role of organizational infrastructure in implementation of hospitals' quality improvement. *Hosp Top, 84*, 11–20.

Barsness, Z. I., Shortell, S. M., Gillies, R. R., Hughes, E. F. X., O'Brien, J. L., Bohr, D., Izui, C., & Kravolec, P. (1993a). The quality March: National survey profiles quality improvement activities. *Hospital and Health Networks, 5*, 52–55.

Barsness, Z. I., Shortell, S. M., Gillies, R. R., Hughes, E. F. X., O'Brien, J. L., Bohr, D., Izui, C., & Kravolec, P. (1993b). The quality March: National survey profiles quality improvement activities. *Hospital and Health Networks, 20*, 40–42.

Begun, J. W., Zimmerman, B. J., & Dooley, K. J. (2003). Health Care Organizations as Complex Adaptive Systems. In S. S. Mick, & M. E. Wyttenbach (Eds.), *Advances in health care organization theory* (pp. 253–288). San Francisco, CA: Jossey-Bass.

Berwick, D. M. (1989). Continuous improvement as an ideal in health care. *N Engl J Med, 370*, 53–56.

Berwick, D. M. (1990). Peer review and quality management: Are they compatible? *Quality Review Bulletin, 16*, 72–87.

Berwick, D. M., Godfrey, A. B., & Roessner, J. (1990). *Curing Health Care: New Strategies for Quality Improvement.* San Francisco, CA: Jossey-Bass Inc.

Blumenthal, D., & Edwards, J. N. (1995). Involving physicians in total quality management: Results of a study. In D. Blumenthal, & A. C. Scheck (Eds.), *Improving clinical practice: Total quality management and the physician* (pp. 229–266). San Francisco, CA: Jossey-Bass.

Blumenthal, D., & Kilo, C. M. (1998). A report card on continuous quality improvement. *Milbank Quarterly, 76*, 625–648, 511.

Board, H. C. A. (1992). *Tqm: Directory of Hospital Projects.* Washington, DC: The Advisory Board Company.

Cabana, M. D., Rand, C. S., Powe, N. R., Wu, A. W., Wilson, M. H., Abbound, P. C., & Rubin, H. R. (1999). Why don't physicians follow clinical practice guidelines? *JAMA, 282*, 1458–1465.

Carman, J. M., Shortell, S. M., Foster, R. W., Hughes, E. F., Boerstler, H., O'Brien, J. L., & O'Conner, E. J. (1996). Keys for successful implementation of total quality management in hospitals. *Health Care Management Review, 21*, 48–60.

Carey, K. (2003). Hospital cost efficiency and system membership. *Inquiry, 40*, 25–38.

Casalou, R. F. (1990). Total Quality Management in Health Care. *Hospital & Health Services Administration, 36*, 134–146.

Conrad, D. A., & Shortell, S. M. (1996). Integrated health systems: Promise and performance. *Frontiers of Health Services Management, 13*, 3–40.

Dean, N. C., Suchyta, M. R., Bateman, K. A., Aronsky, D., & Hadlock, C. J. (2000). Implementation of admission decision support for community-acquired pneumonia. *Chest, 5*, 1368–1377.

Deitrick, J. E. (1986). Hospital cost containment and medical education. *Bulletin of the New York Academy of Medicine, 62*, 702–704.

Deming, W. E. (1986). *Out of the Crisis.* Cambridge: Massachusetts Institute of Technology center for advanced engineering study.

Eisenhardt, K. M. (1993). High reliability organizations meet high velocity environments: Common dilemmas in nuclear power plants, aircraft carriers, and microcomputer firms. In K. H. Roberts (Ed.), *New Challenges to Understanding Organizations* (pp. 117–135). New York: Macmillan.

Fennell, M. L., & Alexander, J. A. (1993). Perspectives on organizational change in the US medical care sector. *Annual Review of Sociology, 19*, 89–112.

Gandjour, A., & Lauterbach, K. W. (2001). A method for assessing the cost-effectiveness and the break-even point of clinical practice. *International Journal of Technology Assessment in Health Care, 17*, 503–516.

Gilman, S. C., & Lammers, J. C. (1995). Tool use and team success in CQI: Are all tools created equal? *Quality Management in Health Care, 4*, 56–61.

Greene, W. H. (2000). *Econometric analysis* (4th ed.). Saddle River, NJ: Prentice Hall.

Griffith, J. R., & White, K. R. (2002). *The well-managed healthcare organization* (pp. 179–180, 191–198). Chicago: Health Administration Press.

Grimshaw, J. M., & Russell, I. T. (1993). Effect of clinical guidelines on medical practice: A systematic review of rigorous evaluations. *Lancet, 342*, 1317–1322.

Gustofson, D., Risburg, L., Gering, D., Hundt, A. S., Levine, H., Escarmilla, S., & Wenneker, M. (1997). *Case studies from the quality improvement support system* (No. DHHS pub. no. 97-0022). Rockville, MD: Agency for Health Care Policy and Research.

Hackman, J. R., & Wageman, R. (1995). Total quality management: Empirical, conceptual and practical issues. *Administrative Science Quarterly, 40*, 309–342.

Health Care Advisory Board. (1992). *TQM: Directory of hospital projects.* Washington, DC: The Advisory Board Company.

Hendricks, K. B., & Singhal, V. R. (2001). Firm characteristics, total quality management and financial performance. *Journal of Operations Management, 19*, 269–285.

Hendricks, K. B., & Singhal, V. R. (1996). Does implementation an effective TQM program actually improve operating performance? Empirical evidence from firms that have won quality awards. *Management Science, 43*, 1258–1274.

Hoff, T., Jameson, L., Hannan, E., & Flink, E. (2004). A review of the literature examining linkages between organizational factors, medical errors, and patient safety. *Medical Care Research and Review, 61*, 3–37.

Institute of Medicine. (1999). *To Err is human: Building a safer health system.* Washington, DC: National Academy Press.

Ishikawa, K. (1985). *What is total quality control? The Japanese way.* Translated by D. Lu. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Ittner, C. D., & Larcker, D. F. (1996). Measuring the impact of quality initiatives on firm financial performance. In D. F. Fedor, & S. Ghosh (Eds.), *Advances in management of organizational quality* (Vol. 1, pp. 1–37). Greenwich, CT: JAI Press.

James, B. C. (1989). *Quality management for health care delivery.* Chicago: Hospital Research and Educational Trust.

James, B. C. (1990). Implementing continuous quality improvement. *Trustee, 43*, 17–26.

Juran, J. M. (1988). *Juran on planning for quality.* New York: Free Press.

King, B. (1990). Healthcare as a quality trendsetter. *Healthcare Forum Journal, 33*, 17–18.

Kishnan, R., Shani, A. B., Grant, R. M., & Baer, R. (1993). In search of quality improvement: Problems of design and implementation. *Academy of Management Executive, 7*, 7–20.

Klein, K. J., & Sorra, J. S. (1996). The Challenge of implementation. *Academy of Management Review, 21*, 1055–1080.

Klein, K. J., Conn, A. B., & Sorra, J. S. (2001). Implementing computerized technology: An organizational analysis. *Journal of Applied Psychology, 86*, 811–824.

Koska, M. T. (1991). New JCAHO standards emphasize continuous quality improvement. *Hospitals, 65*, 41–44.

Laffel, G., & Blumenthal, D. (1989). The case for using industrial quality management science in health care organizations. *JAMA, 262*, 2869–2873.

Larson, K. (1990). Hospital trustees lead quality efforts. *Quality Progress, 23*, 31–34.

Larson, E. (2003). Status of practice guidelines in the United States: CDC guidelines as an example. *Preventive Medicine, 36*, 519–524.

Leape, L. L. (1994). Error in medicine. *JAMA, 272*, 1851–1857.

Lederer, P. J., & Rhree, S. (1995). Economics of total quality management. *Journal of Operations Management, 12*, 353–367.

Lurie, J. D., Merrens, E. J., Lee, J., & Splaine, M. E. (2002). An approach to hospital quality improvement. *Medical Clinics of North America, 86*, 825–845.

March, J. G. (1996). In M. D. Cohen, & L. S. Sproull (Eds.), *Exploration and exploitation in organizational learning in organizational learning.* Thousand Oaks, CA: Sage.

McLaughlin, C. P., & Kaluzny, A. D. (1994). *Continuous quality improvement in health care: Theory, implementation, and applications.* Gaithersburg, MD: Aspen Publishers, Inc.
Mick, S. S., & Morlock, L. L. (1990). America's rural hospitals: A selective view of 1980s research. *Journal of Rural Health, 6*, 437–466.
Mitchell, P. H., & Shortell, S. M. (1997). Adverse outcomes and variations in organization of care delivery. *Medical Care, 35*, N19–N32.
O'Brien, J. A., Jacobs, L. M., & Pierce, D. (2000). Clinical practice guidelines and the cost of care. *International Journal of Technology Assessment in Health Care, 16*, 1077–1091.
O'Brien, J. L., Shortell, S. M., Hughes, E. F., Foster, R. W., Carman, J. M., Boerstler, H., & O'Conner, E. J. (1995). An integrative Model for organization-wide quality improvement: Lessons from the field. *Quality Management in Health Care, 3*, 19–30.
O'Leary, D. S. (1991). Accreditation in the quality improvement mold—a vision for tomorrow. *Quality Review Bulletin, 17*, 72–77.
Powell, T. (1995). Total quality management as competitive advantage: A review and empirical study. *Strategic Management Journal, 16*, 15–37.
Sahney, V., & Warden, G. (1991). The quest for quality and productivity in health services. *Frontiers of Health Services Management, 7*, 2–40.
Shortell, S. M., Jones, R. H., Rademaker, A. W., Gillies, R. R., Dranove, D. S., Hughes, E., Budetti, P. P., Reynolds, K., & Huang, C. F. (2000). Assessing the impact of total quality management and organizational culture on multiple outcomes of care for coronary artery bypass graft surgery patients. *Medical Care, 38*, 207–217.
Shortell, S. M. (1995). Physician involvement in quality improvement: Issues, challenges, and recommendations. In D. Blumenthal, & A. C. Scheck (Eds.), *Improving clinical practice: Total quality management and the physician* (pp. 205–228). San Francisco, CA: Jossey-Bass.
Shortell, S. M., Bennett, C. L., & Byck, G. R. (1998). Assessing the impact of continuous quality improvement on clinical practice: What it will take to accelerate progress. *The Milbank Quarterly, 76*, 593–624.
Shortell, S. M., Gillies, R. R., & Anderson, D. A. (1994). The new world of managed care: Creating organized delivery systems. *Health Affairs, 13*, 46–64.
Shortell, S. M., Gillies, R. R., Anderson, D. A., Erickson, K. M., & Mitchell, J. B. (1996). *Remaking Health Care in America.* San Francisco, CA: Jossey-Bass Publishers.
Shortell, S. M., Levin, D. Z., O'Brien, J. L., & Hughes, E. F. X. (1995a). Assessing the evidence on CQI: Is the glass half empty or half full? *Hospital & Health Services Administration, 40*, 4–24.
Shortell, S. M., Morrison, E. M., & Friedman, B. (1990). *Strategic choices for America's hospitals: Managing change in turbulent times.* San Francisco, CA: Jossey-Bass.
Shortell, S. M., O'Brien, J. L., Camran, J. M., Foster, R. W., Hughes, E. F. X., Boerstler, H., & O'Conner, E. J. (1995b). Assessing the impact of continuous quality improvement/total quality management: Concept versus implementation. *Health Services Research, 30*, 377–401.
Sitkin, S. B., Sutcliffe, K. M., & Schroeder, R. G. (1994). Distinguishing control from learning in total quality management: A contingency perspective. *The Academy of Management Review, 19*, 537–564.
Topping, S, & Hernandez, S. R. (1991). Health care strategy research, 1985–1990: A critical review. *Medical Care Review, 48*, 47–89.
Van de Ven, A. H., & Polley, D. (1992). Learning while innovating. *Organizational Science, 3*, 92–116.
Walton, M. (1990). *Deming management at work.* New York: G.P. Putnam.
Weil, T. P. (1996). Competition versus regulation: Constraining hospital discharge costs. *Journal of Health Care Finance, 22*, 62–74.
Weiner, B. J., & Alexander, J. A. (1993). Hospital Governance and Quality of Care: A Critical Review of Transitional Roles. *Medical Care Review, 50*, 375–409.
Weiner, B. J., Alexander, J. A., & Shortell, S. M. (1996). Leadership for quality improvement in health care: Empirical evidence on hospital boards, managers and physicians. *Medical Care Research and Review, 53*, 397–416.
Weiner, B. J., Shortell, S. M., & Alexander, J. A. (1997). Promoting clinical involvement in hospital quality improvement efforts: The effects of top management, board, and physician leadership. *Health Services Research, 32*, 491–510.
Weiner, B. J., Alexander, J. A., Shortell, S. M., Baker, L. C., Becker, M., & Geppert, J. J. (2006). Quality improvement implementation and hospital performance on quality indicators. *Health Services Research, 41*, 307–334.

APPENDIX: Correlation Matrix

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 Diffusion of QI Across Hospital Units	.																	
2 Total number of FTEs on QI Teams	0.11	.																
3 Number of Managers on QI Teams	0.09	0.26	.															
4 Number of Physicians on QI Teams	0.07	0.36	0.26	.														
5 Use of Quality of Care Data by QI Teams	0.15	0.07	0.09	0.07	.													
6 Number of Guidelines Developed	0.22	−0.02	−15.00	−0.10	0.22	.												
7 Intensity of Process Improvement Tool Use	0.21	0.06	0.12	−0.10	0.16	0.37	.											
8 Emphasis on Quality Improvement	0.34	0.15	0.17	0.02	0.18	0.25	0.47	.										
9 Physician Use of Guidelines	0.22	0.00	0.01	−0.06	0.20	0.87	0.33	0.23	.									
10 Cash Flow (Five-Year Average)	0.08	0.01	0.03	−0.05	−0.02	0.12	0.15	0.11	0.10	.								
11 Cash Flow (Standard Deviation)	−0.09	−0.03	−0.04	−0.04	0.01	−0.07	−0.05	−0.02	−0.05	−0.40	.							
12 Cost Per Case (Five-Year Average)	0.00	−0.07	−0.08	−0.01	−0.01	0.02	−0.01	−0.08	0.04	−0.27	0.19	.						
13 Cost Per Case (Standard Deviation)	−0.02	0.00	−0.03	0.05	0.01	−0.08	−0.09	−0.09	−0.04	−0.26	0.27	0.55	.					
14 Market Concentration	0.02	0.11	0.06	0.27	−0.02	−0.29	−0.25	−0.12	−0.22	0.02	−0.11	−0.08	0.07	.				
15 Perceived Hospital Competition Intensity	0.04	−0.03	0.00	−0.08	0.02	0.17	0.14	0.08	0.14	0.03	0.00	−0.07	−0.06	−0.22	.			
16 Perceived # of Hospital Competitors	0.02	−0.06	0.00	−0.17	0.05	0.17	0.19	0.15	0.13	−0.06	0.08	−0.01	−0.04	−0.38	0.16	.		

(*Continues*)

APPENDIX: (Continued)

17 Managed Care Penetration	0.00	−0.10	−0.06	−0.23	0.02	0.23	0.24	0.14	0.17	−0.04	0.09	−0.01	−0.06	−0.62	0.25	0.32	.	
18 Pct of Patients Private Managed Care	0.00	−0.04	−0.06	−0.08	0.03	0.15	0.10	0.06	0.11	0.04	−0.01	0.05	−0.05	−0.21	0.12	0.20	0.17	.
19 Teaching Hospital Status (Binary)	0.10	−0.13	−0.10	−0.19	0.05	0.37	0.24	0.13	0.30	0.04	0.00	0.17	−0.05	−0.39	0.11	0.17	0.32	0.21
20 Private Ownership	0.05	−0.04	−0.03	−0.13	0.04	0.25	0.22	0.14	0.19	0.12	−0.01	−0.13	−0.12	−0.26	0.12	0.22	0.25	0.06
21 HMO Ownership	0.04	−0.08	−0.02	−0.08	0.06	0.18	0.17	0.09	0.14	0.02	−0.02	0.00	−0.05	−0.17	0.09	0.14	0.25	0.06
22 PPO Ownership	−0.01	−0.04	0.00	0.00	0.04	0.11	0.11	0.07	0.08	0.04	−0.04	−0.07	−0.08	−0.05	0.06	0.10	0.16	0.07
23 Indemnity Ownership	0.01	−0.05	−0.01	−0.03	0.01	0.07	0.06	0.05	0.07	0.02	0.00	−0.02	−0.01	−0.03	0.05	0.05	0.00	0.04
24 Number of Physician Arrangements	0.05	−0.06	−0.03	−0.12	0.02	0.24	0.23	0.09	0.19	0.08	−0.04	−0.01	−0.09	−0.26	0.13	0.18	0.21	0.14
25 Outpatient/Inpatient Ratio	0.00	0.07	0.00	0.13	0.03	−0.02	−0.12	−0.10	−0.08	−0.03	−0.07	0.04	0.04	0.20	−0.08	−0.14	−0.17	−0.06
26 Outpatient Visits (Adjusted by Beds)	0.02	−0.02	0.02	−0.04	−0.02	0.03	0.01	0.01	0.03	0.06	−0.07	−0.06	−0.04	−0.01	0.02	0.00	0.04	0.00
27 Years of Formal Involvement in QI	0.09	0.06	0.06	−0.02	0.13	0.24	0.22	0.17	0.22	0.11	−0.08	−0.06	−0.15	−0.14	0.10	0.10	0.15	0.06
28 No Governing Board	−0.01	−0.02	−0.01	0.11	−0.02	−0.04	0.02	0.02	−0.09	−0.03	0.00	0.02	−0.01	−0.01	0.02	0.01	0.03	0.01
29 MSA	−0.03	−0.15	−0.05	−0.30	0.04	0.34	0.28	0.17	0.26	0.01	0.09	0.03	−0.08	−0.70	0.24	0.38	0.70	0.28
30 Total Expenses on QI	−0.03	0.04	0.01	0.06	−0.04	−0.05	−0.09	−0.10	−0.03	−0.03	0.03	0.01	0.09	0.06	0.00	−0.05	−0.02	0.00
31 CEO Participation in QI Activities	0.13	0.13	0.19	0.13	0.10	0.05	0.18	0.23	0.07	−0.05	0.00	−0.03	−0.03	0.05	−0.02	0.06	−0.04	−0.02
32 Board Monitoring of QI	0.22	0.09	0.12	0.00	0.17	0.24	0.34	0.36	0.24	0.11	0.01	−0.09	−0.06	−0.09	0.05	0.15	0.08	0.04
33 Board Activity in QI	0.14	−0.03	0.05	−0.04	0.12	0.18	0.20	0.17	0.13	−0.01	0.05	0.01	0.01	−0.12	0.05	0.08	0.13	0.05
34 Perceived Barriers to QI	−0.16	−0.12	−0.08	−0.07	−0.13	−0.13	−0.23	−0.46	−0.13	−0.05	0.00	0.03	0.06	0.09	−0.03	−0.05	−0.07	−0.02
35 Clinical IS Capabilities	0.15	0.05	0.06	−0.05	0.14	0.24	0.29	0.27	0.21	0.12	0.02	−0.05	−0.08	−0.15	0.07	0.13	0.12	0.03
36 Clinical Integration (Binary)	0.19	0.00	0.06	−0.07	0.13	0.34	0.28	0.24	0.31	0.05	−0.04	−0.01	−0.06	−0.21	0.13	0.15	0.18	0.10
37 Integrated Data Base	0.06	−0.02	0.05	0.05	0.08	0.02	0.01	0.10	0.04	−0.07	0.10	0.02	0.01	0.01	0.03	0.03	0.00	−0.05
38 Hospital Size (Beds)	0.13	−0.18	−0.13	−0.24	0.10	0.49	0.32	0.15	0.40	0.14	−0.08	0.13	−0.11	−0.43	0.14	0.21	0.34	0.26
39 Hospital Size (Beds-Squared)	0.07	−0.11	−0.12	−0.10	0.07	0.27	0.13	0.05	0.22	0.03	−0.04	0.13	−0.03	−0.20	0.05	0.09	0.14	0.18

APPENDIX: (Continued)

zzz	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
	0.15	.													0.17	−0.26	.				
	0.15	0.13	.												0.17	−0.11	0.23	.			
	0.21	0.13	0.13	.											0.06	−0.09	0.10	0.00	.		
	0.07	0.08	0.34	0.39	.										0.19	−0.07	0.17	0.27	−0.06	.	
	0.21	0.22	0.32	0.34	0.19	.									0.12	−0.02	0.03	0.12	−0.03	0.77	.
	−0.12	−0.12	0.05	0.10	0.05	0.08	.														
	0.07	−0.01	0.06	0.02	0.01	0.04	0.06	.													
	0.16	0.15	0.09	0.09	0.04	0.16	−0.07	0.01	.												
	0.00	0.01	0.04	0.04	0.04	0.04	−0.04	−0.01	0.01	.											
	0.39	0.25	0.19	0.06	0.05	0.29	−0.20	−0.02	0.14	0.02	.										
	−0.06	−0.06	−0.02	−0.02	0.01	−0.02	0.05	0.06	−0.02	0.02	−0.05	.									
	−0.06	−0.03	0.00	0.02	0.04	−0.02	0.00	−0.02	0.01	0.00	−0.06	0.03	.								
	0.06	0.16	0.02	0.01	0.03	0.06	−0.07	0.03	0.15	−0.52	0.11	−0.01	0.23	.							
	0.12	0.06	0.07	0.02	0.05	0.05	−0.08	0.03	0.06	−0.20	0.14	−0.03	0.12	0.32							
	−0.02	−0.12	−0.02	−0.05	−0.01	−0.07	0.06	0.00	−0.09	0.03	−0.10	0.02	−0.20	−0.28							
	0.12	0.13	0.03	0.06	0.03	0.12	−0.10	−0.01	0.16	0.01	0.17	−0.06	0.10	0.23							
	0.22	0.16	0.14	0.12	0.05	0.19	−0.04	0.03	0.16	0.00	0.20	0.01	0.10	0.18							
	−0.03	−0.02	0.01	0.00	0.02	−0.03	0.00	−0.03	−0.01	0.01	−0.01	0.04	0.03	0.06							
	0.59	0.18	0.22	0.14	0.06	0.29	−0.21	−0.11	0.19	0.00	0.48	−0.14	−0.07	0.11							
	0.35	0.03	0.08	0.07	0.03	0.12	−0.09	−0.03	0.08	−0.02	0.23	0.04	−0.03	0.04							