HIGH PERFORMANCE WORK SYSTEMS AND ORGANIZATIONAL OUTCOMES: THE MEDIATING ROLE OF INFORMATION QUALITY

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Using data on registered nurses and nursing assistants in 50 acute-care hospital units, the author explores the relationships among high performance work systems, information quality, and performance quality within a context shaped by equivocal information—information that can be interpreted in multiple and sometimes conflicting ways. He finds that the quality of information available for decision-making, which largely depends on the interpretative skills of the workers who are exposed to important equivocal information, partially mediates how employee knowledge, work design, and total quality management systems affect organizational performance (which is measured as the inverse of medication error incidence). Providing employees with extensive relevant knowledge and enabling them to use their skills during even seemingly routine tasks improves the effective quality of information they bring to decision-making, and thereby promotes high performance quality.

High performance work systems (HPWSs) have found favor among academics and practitioners as a tool to improve organizational performance and such employee outcomes as work satisfaction and lower job stress. While the research on this subject has identified organizational and employee outcomes arising through the adoption of specific work organization and human resource systems, it has several shortcomings. First, the vast majority of studies have been conducted in manufacturing settings, thus limiting the potential generalizability of the findings. Second, the mechanisms through which high performance systems shape critical outcomes have been poorly defined and have rarely been examined directly (Becker and Gerhart 1996; Wright and Gardner 2001).

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A data appendix with additional results, and copies of the computer programs used to generate the results presented in the paper, are available from the author at the Weatherhead School of Management, Case Western Reserve University, 10900 Euclid Avenue, Cleveland, OH 44106-7235; gap4@po.cwru.edu.

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This paper extends the existing literature in two important ways. First, I focus on the effect of HPWS dimensions in hospitals—a service setting characterized by demands on the work system very different from those found in manufacturing. In particular, hospital work systems must support employee capacity to interpret equivocal information as part of ongoing decision-making. Equivocal information lends itself to being interpreted in multiple and potentially conflicting ways (Daft and Macintosh 1982) and thus places unique demands on work systems. Second, I propose and test the proposition that a central mediating factor between HPWSs and organizational outcomes is the quality of information available for use in decision-making.

This paper also addresses an important issue in the current health care environment. In response to increasing cost pressures, hospital care has undergone dramatic restructuring, including changes in skill utilization and work design. At the same time, there is increasing concern about the prevalence of medication errors in health care. A recent study by the Institute of Medicine found that medication errors result in an estimated 7,000 patient deaths annually in the United States (Kohn, Corrigan, and Donaldson 1999). Moreover, the report suggested that poor information is one factor leading to these errors. This paper addresses this issue by examining the role of information quality in mediating the relationship between HPWS dimensions and performance quality, measured as medication error frequency.

High Performance Work Systems, Information, and Performance Quality

A central characteristic of organizations is their need to process information (Thompson 1967; Galbraith 1973; Tushman and Nadler 1978; Kogut and Zander 1992). Organizational systems must also be designed to meet the specific demands placed on them (Galbraith 1973; Van de Ven and Delbecq 1974). As a result, systems that support information processing and ensure information that is accurate, trustworthy, and sufficient for decision-making will improve organizational performance (Argote 1982; Tushman and Nadler 1978; Stinchcombe 1990). For example, Argote (1982) found that the use of pre-specified plans, programs, and relationships supported hospital emergency room effectiveness when the range of patient diagnoses was limited, whereas non-programmed coordination tools enabled smoother information transfer, and thus improved outcomes, in hospitals facing a broad range of diagnoses.

One way high performance work systems enhance performance may be by improving information quality in organizational processes and decisions. First, HPWSs may improve information quality by granting responsibility over information interpretation to employees who hold critical knowledge and by making this information available for ongoing process improvement (Adler and Borys 1996; Leonard 1995). Information is not inert, but a resource that acquires more or less utility or "quality" depending on how well it is interpreted and then integrated into decision-making. In addition, when the transfer of information may reduce information quality, organizations can improve performance by granting decision-making responsibility to those with first-hand access to the necessary information (Galbraith 1973; Jensen and Meckling 1992; Wagner et al. 1997). For example, in hospitals, registered nurses may observe patient developments (symptoms, morale, degree of recovery, and so on) as part of their job. Rules barring registered nurses from acting directly on such information, and requiring them instead to inform physicians of all patient developments and let the physicians decide what course of action to take, would potentially reduce both information and performance quality.

Employee Knowledge, Information, and Performance Quality

When employees are responsible for interpreting information through the work

process, the "post-interpretation" quality of information—what I will refer to as the *effective* information quality—depends on the knowledge they have brought to the task of interpretation. The role of employees' knowledge increases when their decision-making involves the interpretation of equivocal information—information conveying multiple meanings regarding organizational activities and interpretable in multiple and potentially conflicting ways (Daft and Macintosh 1982). In contrast, unequivocal information is easily interpreted.

In the settings typically examined within the HPWS literature, the parameters of performance quality and the information necessary to ensure high performance quality are clearly established. For example, in manufacturing plants, statistical process control charts highlight the information used to ensure high-quality decisions and outcomes. Moreover, because that information is relatively unequivocal, employees can easily interpret it for on-going decision-making. Where the information necessary for making a decision is equivocal, knowledge held by core employees becomes increasingly important in shaping the effective quality of the information. Core employees are typically the largest group of employees in the work process and have access to critical information. Those core employees must have the necessary pre-existing knowledge to make optimal choices across competing interpretations and use information of the highest effective quality for decision-making (Choudhury and Sampler 1997). Chi, Glaser, and Rees (1982) reported that experts in a given subject are attentive to different parts of the information presented to them, as compared to novices in that subject. In addition, Bower and Hilgard (1981) suggested that people holding more complex knowledge can understand and acquire new knowledge more easily. Similarly, research on organizations suggests that the ability to absorb new knowledge is related to the presence of existing knowledge (Cohen and Levinthal 1990). Within a context characterized by equivocal information, higher levels of employee knowledge would improve effective information quality.

To optimize the effective quality of available information, both scientific knowledge and experience-based knowledge are important. Scientific knowledge provides a set of explicit theories through which information can be understood and interpreted, while experience-based knowledge provides the specific detail and tacit knowledge for understanding information (Stinchcombe 1990; Kogut and Zander 1992). As such, both scientific and experience-based knowledge among core employees should support the ongoing interpretation of equivocal information, thus improving the effective quality of information available for decision-making.

Hypothesis 1. Higher employee knowledge will increase the effective quality of information available for decision-making.

Work Design and Information Quality

Beyond employee knowledge, work design can influence the effective quality of information. Research finds that outcomes can improve as front-line production workers are granted broad task responsibilities (MacDuffie 1995; Berg et al. 1996). These broad jobs increase employees' capacity to give meaning to information and use it to improve outcomes. Moreover, organizations thereby reduce the need to transfer information, reducing the potential for errors in using it.

In settings with equivocal information, organizations face a similar, yet distinct, challenge. In these settings, while skilled employees are typically granted decision-making authority in the use of information they acquire during their skilled operations—tasks explicitly established for information interpretation—they must also have the opportunity to bring their superior interpretative ability to seemingly routine tasks that might harbor important equivocal information. For example, bathing a patient may not only maintain the patient's hygiene, but also present an opportunity for a skin examination. Moreover, these

tasks may provide important contextual knowledge to support information interpretation.

In contrast, when these same routine tasks are performed by low-skilled workers, the work tends to serve no end beyond itself, and any equivocal information of potential value may be lost (Jensen and Meckling 1992; Kogut and Zander 1992). Hospitals could ask these low-skilled workers to transfer information to skilled workers for interpretation and decision-making. This approach, however, fails to address the potential degradation of information as it is transferred. The value of information is highest when the information is interpreted immediately within the particular context. In addition, low-skilled workers may not recognize that certain equivocal information is potentially important and thus may fail to communicate it. As a result, broad task responsibility over routine tasks for low-skilled workers is expected to reduce the effective quality of information.

Hypothesis 2. Broad task responsibilities for high-skilled workers over routine tasks will increase the effective quality of information available for decision-making.

Hypothesis 3. Broad task responsibilities for low-skilled workers over routine tasks will decrease the effective quality of information available for decision-making.

Total Quality Management and Information Quality

An additional dimension of HPWSs is the adoption of total quality management (TQM). TQM practices emphasize commitment to the customer and continuous improvement through the use of data-driven decisions based on the empowerment of employee teams (Hackman and Wageman 1995; Batt 1999). In particular, TQM promotes the use of formal tools, such as statistical process control charts and cause and effect diagrams, to gather and use information and solve problems (Deming 1993). These tools focus on understanding the source of work process variance and developing strategies that minimize variance and improve quality.

Organizations can improve performance quality not only by employing specific tools, but also by involving employees who hold tacit knowledge (Adler and Borys 1996). By involving employees in assessing process improvement, formal TQM processes elicit tacit knowledge from employees as they devise new ways to organize work. The incorporation of this tacit knowledge into processes then improves the effective quality of information. TQM can also increase employees' learning regarding work processes and one another's skills (Hackman and Wageman 1995). As employees use their knowledge to improve processes, they gain a better understanding of how the processes operate. In addition, employee involvement improves information and knowledge sharing across people (Locke and Schweiger 1979; Wagner et al. 1997). Some organizations, however, simply adopt the rhetoric of TQM, or adopt TQM tools without providing the structures, practices, and policies to ensure their vitality over time as a source of continuous improvement (Hackman and Wageman 1995). In addition, Lawler (1994) suggested that TQM and employee involvement operate under different assumptions, putting them at odds with each other. Nevertheless, I expect that broader use of TQM will improve information quality.

Hypothesis 4. More extensive use of total quality management will improve the effective quality of information available for decision-making.

High Performance Work Systems, Information, and Performance Quality: Direct and Mediated Effects

Overall, research on high performance work systems finds strong evidence that these systems improve organizational performance (MacDuffie 1995; Appelbaum et al. 2000; Batt 2002). While I focus, in this paper, on effective information quality as a vital mediating factor affecting performance, variations in work design and in the extent of knowledge available to em-

ployees can, in some cases, affect performance directly, without information as a mediating factor. For example, broad jobs for skilled employees, and availability to employees of high levels of knowledge, would enable employees to deliver higher-quality outcomes. In contrast, broad jobs for low-skilled workers would increase coordination challenges across employees, thus potentially reducing performance quality. As such, I hypothesize that both the level of knowledge available to employees and broad jobs for skilled workers are directly, positively related to performance quality. In contrast, I predict a negative correlation between broad jobs for lower-skilled workers and performance quality.

Although the extent of employees' knowledge and the skill levels of those workers to whom broad jobs are assigned clearly have direct effects on performance, it is just as clear that some of their effects are mediated by information quality. Through the adoption of HPWSs, information previously unavailable is incorporated into decision-making. This results in improved decision quality and a more rapid response among core employees to evolving developments (Tushman and Nadler 1978; Daft and Macintosh 1982). While information quality is not the only mechanism through which high performance systems shape outcomes, the apparently direct effects of work practices on performance quality will be reduced after the analysis controls for the quality of information available to employees.

Hypothesis 5. The extent of knowledge available to employees is positively related to performance quality.

Hypothesis 6. Broad task responsibility will be positively related to performance quality for high-skilled workers and negatively related to performance quality for low-skilled workers.

Hypothesis 7. The effects on performance quality of employee knowledge and task responsibility are partially mediated by the quality of information available.

Research Context

Information Equivocality in Hospital Care

I examine the role of HPWSs and information in shaping performance quality in acute-care hospital units—a setting in which information is highly equivocal. While nurses conduct a series of tasks as part of their work, such as taking patients on walks and giving them advice for reducing recovery time, the success of the care process rests on the constant interpretation and use of equivocal information. Accurate information is critical for determining which medications to prescribe, how to care for a patient, and how much self-care a patient can manage once discharged. At times, the necessary information is easily obtained. At other times, however, changes that have important implications for care decisions are subtle, and can be identified only by interpreting (for example) a patient's casual comment. Equivocal information must, therefore, be continuously interpreted for use in care processes (Strauss, Fagerhaugh, Suczek, and Weiner 1985).

Sample

I analyze responses from 935 surveys completed by registered nurses and 182 completed by nursing assistants in 1995. The respondents worked in 50 acute-care, inpatient hospital units in 13 hospitals in Minneapolis/St. Paul, Minnesota. Overall, nearly 80% of registered nurses and 60% of all health care workers in the region were union members. All of the hospitals were not-for-profit or public hospitals.

Hospital units were selected for participation according to the types of patients treated, including cardiology, intensive care, medical/surgical, obstetrics/gynecology, orthopedics, and pediatrics. Overall, I sought to include unit types that existed across as many hospitals in the sample as possible. Response levels among unit employees ranged from approximately 40% to over 85%, with an overall response rate of

69%. To ensure that responses reflect group-level phenomena, I only incorporate in the analyses those units with a response rate of over 60%. More than 80% of the units surveyed achieved that threshold.

Measures

Information quality. High-quality information is information that is accurate, trustworthy, and sufficient for decision-making (Tushman and Nadler 1977; Stinchcombe 1990). To sort out the distinct components of information quality, I asked each registered nurse four yes/no questions: whether, in treating patients during the three previous shifts, she had (1) received inaccurate information about a patient; (2) felt uncomfortable with available information about a patient; (3) felt a need to check the accuracy of available information about a patient; or (4) felt uncertain about the physician's recommended care plan for a patient. Responses were coded so that higher scores reflect higher-quality information. First, an individual level measure was generated by averaging responses to the four questions above. This score reflects the information quality available to an individual registered nurse. The Kuder-Richardson Formula 20 (KR–20) for this measure is .67. A unit-level measure of information quality was then generated by averaging individual scores in the unit. (See the Appendix for a full list of measures and alpha levels.)

Performance quality. Performance quality was measured by the frequency of medication errors in the unit as perceived by the registered nurses in the unit. Each Registered Nurse was asked, "How often does a patient receive incorrect medications or an incorrect dosage on your shift?" Responses ranged from several times per week to less than once per month. These responses were then converted to medication errors per week and averaged across registered nurses to create a unit level measure of medication error frequency. While the use of perceptual data in measuring medication errors may be contaminated by other job attitudes, hospital data on medication errors have also been found to be deficient, with nurses only reporting 15–30% of medication errors that occur (Hackel, Butt, and Banister 1996).

Performance quality was also measured through independently conducted patient surveys completed following hospital discharge (Gerteis 1993). These data, however, were available for patients in only 14 hospital units. Patient survey questions addressed the clarity of the information conveyed to patients and the overall nursing care quality (Gerteis 1993). Responses were averaged to generate a single measure of nursing care quality in the unit. The Cronbach's α for this scale is .91. The correlation between registered nurses' perception of medication error frequency and patients' assessment of nursing care quality was –.49, providing some validity for the measure of medication error frequency as a measure of patient care quality.

Employee knowledge. Employee knowledge was measured in two ways. First, *scientific knowledge* was measured by the percentage of registered nurses in the unit with a bachelor's degree in Nursing. Each registered nurse was asked to name the highest education degree she had received. Two possible responses below bachelor's degree were a high school diploma and an associate degree (requiring fewer years of formal education and less training in scientific theory). Second, *experience-based knowledge* was measured as the average seniority level (number of years in the current unit) among registered nurses in the unit.

Work design. Two work design measures were developed for the analyses. The measures examined the extent to which assistant nurses and registered nurses were responsible for the conduct of routine patient care tasks. First, *task responsibilities for low-skilled workers* measured the extent to which nursing assistants were responsible for a broad range of routine patient care tasks. Second, *task responsibilities for high-skilled workers* measured the extent to which registered nurses were responsible for these same patient care tasks.

On the basis of observation, interviews, and existing research, I identified ten rou-

tine tasks for which the responsibility has recently been shifting from registered nurses to nursing assistants, putting these tasks at the focus of job redesign in health care: transport patients, distribute food trays, feed patients, clean patient rooms, draw blood, bathe patients, insert IVs, maintain IV site care, conduct sterile procedures, and take vital signs (Barter, McLaughlin, and Thomas 1994). Each nursing assistant and registered nurse was asked whether she regularly conducted each listed task. Individual responses were averaged to develop a single measure reflecting the extent of task responsibilities held by members of each of the two occupational groups in each unit.

Total quality management. As described above, total quality management has four components: customer focus, continuous improvement, data-driven decisions, and employee involvement. To measure the presence of TQM in each unit, I adopt two indicators. First, *employee involvement* measures nurses' involvement in four decision areas in their hospital unit: setting work schedules, developing care practices, designing training for unit employees, and defining jobs in the unit (1 = none at all, and 4 = a great deal). Greater involvement in decision-making would enable the development of unit practices that support information accumulation and high performance quality. The four employee involvement measures gathered through an employee survey were combined into a single scale as a measure of employee involvement in the unit (Cronbach's alpha = .68).

To address the presence of continuous improvement systems as well as data-driven decisions, I looked at the presence of *process templates* to measure the extent to which systems were in place that integrated all available information and knowledge into ongoing work processes. For patients, such integrated work processes result in "care pathways." Care pathways are tools developed by hospitals to standardize care being delivered to patients following a specific procedure, such as open heart surgery or a cesarean section. Care pathways typically include defined responsibilities for each occupational group interacting with the patient. Over the 1990s, hospitals increasingly adopted care pathways to improve coordination and communication across employees in treating patients with a specific diagnosis and as a way to reduce costs and improve quality (Waggoner 1992). Moreover, hospitals use pathways to improve the care process over time by gathering data on care delivery and recovery paths.

Cross-functional teams typically work with pathways to continuously improve them and to ensure their appropriateness for the unit's patients. I measure the extent to which process templates are present by the percentage of patients in the unit who are covered by care pathways. Each registered nurse was asked what percentage of unit patients were covered by pathways. These responses were averaged to generate the unit score.

Control variables. Two control variables were included in the study—unit technical system and unit size. *Unit technical system* measures work process complexity in the unit (Schoonhoven et al. 1980). Controlling for unit technical system is important given previous findings that higher levels of complexity increase information-processing demands (Daft and Macintosh 1981). Following the work developed by Schoonhoven et al. (1980), the Vice President of Nursing at each hospital completed a survey assessing six components of nurses' work in treating patients with the most common diagnoses: the frequency with which contingencies arise that require judgment, the frequency of required care tasks in treating patients, the number of different care tasks that must be provided, the number of possible alternative care tasks among which nurses can choose in treating patients, the level of technical equipment used by nurses in treating the patients, and the extent to which nursing care can be routinized or standardized (1 = very infrequently or low, 6 = very frequently or high). Each diagnosis was first given a score based on the average of the above six components (alpha = .94). Each type of unit was then given a score based on the diagnoses treated

in the unit type. For example, the complexity of nursing work across cardiology diagnoses was aggregated to create a single measure of unit technical system for Cardiology units, and Obstetric/Gynecology departments received a distinct score based on the types of diagnoses treated in OB/GYN units.

The second control variable, *unit size,* was the number of nursing care providers in the unit. Larger hospital units may face additional challenges in ensuring the availability of high-quality information and may adopt distinct practices due to the potential for economies of scale.

Aggregation and common method issues. Because several important variables were conceptualized at the group level yet measured at the individual level, I must justify aggregation through an examination of both between-group differences and within-group agreement. Between-group differences were all confirmed through examination of ANOVA F-scores. Coefficients on variables measuring performance quality—perceived medication error frequency ($F = 4.41$, $df = 50$, $p < .001$), information quality ($F = 3.34$, $df = 50$, $p < .001$), employee involvement ($F = 1.64$, $df = 50$, $p < .005$), and the use of process templates ($F = 78.02$, $df = 50$, $p < .001$)—all meet required levels for aggregation (Hays 1981). The other variables were all defined at or measured at the group level.

To examine within-group and between-group correlations, I conducted a WABA II analysis as suggested by Dansereau, Alutto, and Yammarino (1984). According to the criteria they established, the results from the WABA analyses are equivocal, suggesting that the phenomena may operate both at an individual and at a group level and that analyses at both levels are valid. While group-level regressions are presented, individual-level analyses confirm group-level results. Though the individual-level analyses permit the inclusion of additional control variables, including hospital dummy variables and measures of unit staffing levels, the results on the dimensions of HPWSs are consistent with those reported in the group-level analysis.

One concern with the measures is the potential for common method bias. Bias may arise because important measures, including information quality, performance quality, and employee involvement, were all collected from the same group in each unit—all of the unit's registered nurses. To address this potential problem, I conduct a split sample analysis whereby the group-level measures are aggregated using two distinct subsamples of registered nurses in each hospital unit (Podsakoff and Organ 1986). Through this process, a randomly selected group within each unit is used to generate the independent variables, while the remaining group is used to generate the dependent variable.

Method of Analysis

To test for the effect of HPWS dimensions on information quality and the mediating role of information quality in shaping performance quality, I conduct two separate analyses. First, I examine the hypothesized relationships between HPWS dimensions and information quality. I then examine the direct and mediated effects of these dimensions on performance quality. If the hypothesis that information quality plays a partial mediating role is correct, four outcomes should be observed: statistically significant effects of HPWSs on performance quality; a statistically significant relationship between HPWSs and information quality; a statistically significant effect of information quality on performance quality; and a diminution of the estimated effect of HPWSs on outcomes when information quality is included as a control variable (Baron and Kenny 1986).

Table 1 provides the means, standard deviations, ranges, and first order correlations for the variables. I conduct a stepwise regression to examine the added contributions of specific HPWS dimensions in shaping information quality. In addition, robust standard errors are used in the analyses (Huber correction). Robust standard errors are preferred to control for common variation among those units within a single hospital.

Table 1. Descriptive Statistics and Correlation Matrix (N = 50 units).

Variable	*Mean*	*S.D.*	*Range*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1. Performance Quality (Medication Errors)	3.92	1.44	1.6–7.3									
2. Information Quality	0.62	0.12	0.38–0.83	–.64**								
3. Scientific Knowledge	0.33	0.13	0.06–0.64	–.14	.20							
4. Experience-Based Knowledge	13.4	3.22	6.4–22.8	–.46**	.19	–.45**						
5. Task Responsibilities for Low-Skilled Workers	4.42	2.23	0–8	.27	–.32**	.26	–.16					
6. Task Responsibilities for High-Skilled Workers	7.38	1.10	4.57–9.41	–.22	.18	.13	–.14	.07				
7. Employee Involvement	1.95	.16	1.64–2.33	.08	–.01	.03	–.01	.03	–.13			
8. Processes Templates	52.7	27.5	8.4–87	–.06	.04	–.07	.05	–.02	–.45**	.01		
9. Unit Technical System	3.26	.26	2.8–3.6	.29**	–.25	–.15	–.12	–.02	–.18	–.11	.40**	
10. Hospital Unit Size	50.9	22	15–139	.15	–.15	.20	–.16	.50**	–.35**	.10	.57**	.31**

**Statistically significant at the .05 level.

Results

High Performance Dimensions and Information Quality

As shown in Table 2, consistent with Hypothesis 1, employees' scientific knowledge is positively related to the quality of information ($p < .05$). Moreover, the effect of experience-based knowledge is in the same direction and approaches conventional levels of statistical significance ($p = .07$). Information quality is thus higher in those hospital units where registered nurses hold higher knowledge arising from more formal education and greater experience. In addition, broad task responsibilities for skilled, core workers are positively related to information quality, supporting Hypothesis 2. Broad jobs improve information quality by providing opportunities to interpret equivocal information during the conduct of routine tasks. In contrast, consistent with Hypothesis 3, broad task responsibilities for low-skilled workers have a statistically significant, negative effect on information quality in the unit. As low-skilled workers hold broader task responsibilities, the quality of available information decreases. It is important to note, however, that task responsibilities for low-skilled workers are frequently broadened with only limited additional training. Overall, the responsibility over even routine tasks shapes opportunities for employees to interpret equivocal information and thus influences the quality of information available for decision-making.

The inclusion of the employee knowledge and work design measures in the regression significantly improves the explanatory power of the analyses, with increases in the R^2 of .11 and .18, respectively. Finally, Hypothesis 4 is not supported. The prevalence of TQM does not appear to shape information quality. Neither the use of process templates nor the extent of employee involvement in unit decision-making significantly affects information quality.

Direct and Mediated Effects of HPWSs on Performance Quality

To test for the proposed partial mediation model, I first regress the HPWS dimensions on performance quality (Table 3, step 1). Overall, I find that employee knowledge and task responsibilities affect performance quality in the hypothesized direction. Note that since performance quality is measured as the perceived frequency of medication errors in the unit, a negative coefficient suggests that the specific dimension results in fewer medication errors and thus higher performance quality. In gen-

Table 2. Determinants of Information Quality in Organizations (n = 50 units).[a]

	Information Quality			
Variable	*Step 1 [t-Value]*	*Step 2 [t-Value]*	*Step 3 [t-Value]*	*Step 4 [t-Value]*
Control Variables				
Unit Technical System	–.107 [–1.66] (.064)	–.057 [–0.78] (.074)	–.091 [–1.32] (.069)	–.108 [–1.48] (.073)
Unit Size	–.000 [–0.56] (.001)	–.001 [–0.99] (.001)	.001 [1.10] (.001)	.012 [0.37] (.007)
Employee Knowledge				
Scientific Knowledge		.321 [2.29]** (.140)	.334 [2.41]** (.138)	.342 [2.49]** (.138)
Experience-Based Knowledge		.012 [1.70] (.007)	.012 [1.86] (.007)	.012 [1.78] (.007)
Work Design				
Task Responsibilities for Low-Skilled Workers			–.028 [–3.38]*** (.008)	–.024 [–2.91]*** (.008)
Task Responsibilities for High-Skilled Workers			.029 [1.88] (.015)	.033 [2.06]** (.016)
Total Quality Management				
Employee Involvement				–.003 [–0.03] (.103)
Process Templates				.001 [1.21] (.001)
Sample Size	50	50	50	50
F	1.74	3.47**	6.78***	5.95***
R^2	.07	.18	.36	.38
Change in R^2		.11	.18	.02
F-Test for Change in R^2		2.89	6.97***	.81

Notes: Huber correction for robust standard errors. Unstandardized coefficients are reported. Standard errors are in parentheses and t-values are in brackets.

**Statistically significant at the .05 level; ***at the .01 level.

eral, these results provide strong support for Hypotheses 5 and 6, showing that high employee knowledge and broad task responsibilities are related to higher performance quality for high-skilled workers, while broad task responsibilities for lower-skilled workers are related to lower performance quality. In addition, the use of process templates has a marginally significant relationship with performance quality: more extensive use of these templates is weakly correlated with fewer medication errors. In contrast, employee involvement in decision-making has no direct effect on performance quality. Finally, the statistically significant coefficient on unit technical system suggests that in those units with more complex care processes, nurses report more medical errors.

I next include information quality in the regression to test for its hypothesized mediating role. Though the effects of both employee knowledge and task responsibilities on performance quality remain statistically significant, the level of significance decreases on some dimensions, with the coefficients decreasing on all dimensions following the inclusion of information quality. In addition, information quality significantly predicts performance quality in nursing units. Finally, there is a statistically significant increase in the R^2, which rises from .60 to .66. These results support both the hypothesis that information quality di-

Table 3. Determinants of Performance Quality: Examining the Direct and Mediated Role of Organizational Practices (n = 50 units).[a]

	Medication Error Frequency	
Variable	*Step 1: Direct Effects [t-Value]*	*Step 2: Mediated Effects [t-Value]*
Control Variables		
Unit Technical System	1.28 [2.09]** (.613)	.888 [1.90] (.468)
Unit Size	–.006 [–0.62] (.010)	–.004 [–0.45] (.010)
Employee Knowledge		
Scientific Knowledge	–4.55 [–3.47]*** (1.31)	–3.31 [–2.29]** (1.44)
Experience-Based Knowledge	–.278 [–5.28]*** (.053)	–.236 [–4.79]*** (.049)
Work Design		
Task Responsibilities for Low-Skilled Workers	.231 [3.07]*** (.075)	.143 [1.84] (.078)
Task Responsibilities for High-Skilled Workers	–.494 [–3.24]*** (.153)	–.375 [–2.73]*** (.137)
Total Quality Management		
Employee Involvement	.532 [0.62] (.859)	.520 [0.68] (.761)
Process Templates	–.014 [–1.83] (.007)	–.010 [–1.38] (.007
Information Quality		–3.63 [–2.72]** (1.33)
F	10.13***	9.75***
R^2	.60	.66
Change in R^2		.06
F-Test for Change in R^2		7.41***

Notes: See notes to Table 2.

rectly influences performance quality in organizations and the hypothesis (Hypothesis 7) that it partially mediates the relationship between HPWS dimensions and performance quality.

To confirm the effect of information quality on performance quality, I examine the correlation between information quality and the patient assessment of nursing care quality. Though the analysis is constrained due to the small sample size (n = 14), the correlation between information quality and the patients' view of nursing care quality is .58, providing further support for the importance of information quality in shaping outcomes.

Conclusion

I have explored two issues that are critical for understanding the relationship between high performance work systems and the quality of organizational outcomes. First, I focus on the processes through which specific dimensions of HPWSs shape performance quality. By increasing the quality of information available and helping to ensure appropriate interpretation of equivocal information, HPWSs improve performance quality. Overall, I find that information quality is an important factor linking high performance work systems and organizational performance quality.

While this paper does not directly examine other mechanisms that have been proposed as links between HPWSs and organizational outcomes, those processes, such as flexible deployment of employees and employee discretionary effort, may operate in conjunction with an enhanced capacity to integrate evolving information into decision-making and organizational actions. For example, the benefits of employee flexibility in responding to production bottlenecks may partly depend on employees' capacity to use high-quality information within a specific context. Similarly, higher information quality would increase the benefit of discretionary effort as employees use information to improve work processes. Finally, human resource complementarity in improving outcomes may arise as specific practices support the development and interpretation of previously unavailable information and the use of that information in decision-making. Through broader jobs, higher knowledge, and TQM, employees more easily interpret and use critical information to improve outcomes.

The second important issue addressed in this paper is the nature of the demands placed on high performance work systems in a context dramatically different from those previously examined—one in which the information necessary for decision-making is equivocal. In such contexts, information quality and performance quality are shaped by employee knowledge and the capacity to use this knowledge to interpret information. Organizations must ensure that skilled employees have the responsibility to interpret equivocal information even in the conduct of routine tasks. Such tasks are very common in hospital settings—bathing patients, for example, and taking them on walks.

These findings contrast with the results of previous research, in which the focus has been on the adoption of HPWSs for frontline production workers. In a context in which information is equivocal, organizations must use systems that provide for high levels of employee knowledge together with opportunities to use that knowledge in interpreting information. Thus, for example, in health care, the critical employee group for ensuring the interpretation and use of high-quality information is registered nurses rather than nursing assistants. Similarly, Appleyard and Brown (2001) found that skilled engineers, rather than frontline technicians, primarily affect performance quality in semiconductor plants following shifts in technical systems. These findings suggest that the effectiveness of HPWSs is contingent on the location and nature of information necessary for decision-making. The target and focus of high performance work systems should be employees who have access to equivocal and hard-to-transfer information. In addition, the specific dimensions of HPWSs must ensure that these employees are able to interpret and use this information for ongoing decision-making and process improvement.

Finally, while I expected that total quality management would improve information and performance quality, I found only limited support for this hypothesis. It is possible that the form of participation examined here does not have a direct effect on information and performance quality. In contrast, direct employee involvement in the design of the process template tools may yield different results due to the unique information available to employees (Wagner et al. 1997). In addition, my analyses provide evidence of only modest effects of process templates on information and performance quality. While it is possible that the specific measure used in this paper does not address the full scope of TQM in organizations, my findings do provide some support for the skepticism expressed by some researchers about the effectiveness of TQM in contexts in which it is hard to standardize the work process (Hackman and Wegman 1995).

One question raised by the finding that broad job responsibilities for low-skilled workers reduce information and performance quality is whether alternative strategies could ameliorate or eliminate this adverse effect. For example, would information and performance improve if nursing assistants were assigned graduated respon-

sibilities as they gained experience? In separate analyses, I found that nursing assistants' tenure had no effect on information or performance quality, suggesting that nursing assistants' facility in interpreting information as it is collected does not necessarily increase with experience on the job. Would extensive training help? Given the limited range of training provided to nursing assistants in the current health care environment (typically 1–4 weeks), I was unable to evaluate the link between training and the quality of information and performance. At this writing, it is common practice for nursing assistants to be given broader task responsibilities without any increase in training (Barter et al. 1994).

The implications for health care delivery are critical. In their search to develop cheaper methods to deliver patient care, hospital administrators have adopted work systems that diminish information quality and increase medication errors. Moreover, while there may be trade-offs between cost and quality, existing research suggests that the lower labor costs achieved by these systems may come only at the price of yet higher overall hospital operating costs. In a study of medication errors, Simpson (2000) found that medication errors increased hospital costs by $4,700 per admission, amounting to a total increase of $2.8 million a year for a 700-bed teaching hospital. Researchers should directly examine the potential tradeoff between cost and quality within health care. In so doing, if they find that certain work systems increase medication errors, and potentially other medical errors, they should view those effects as part of overall hospital performance.

Although the setting examined by this study is unusual in some respects, it also has much in common with other organizations. Clearly, the findings reported here have some application to professional concerns such as consulting, investment banking, and law firms, but the study's implications are not limited to high-skilled service settings. As mentioned above, engineers in semiconductor firms must similarly confront equivocal information, and so it is not surprising that organizational performance in these firms depends critically on their work design (Appleyard and Brown 2001). In general, any organization in which employees must interpret critical, equivocal information faces challenges in designing work systems that enable the successful interpretation and use of this information.

Information, as understood in this study, is not a simple static thing that firms can stock and use the way they do pencils or coal; nor is it something that firms can assume will be similarly understood by a diverse group of workers; it is a dynamic entity that takes shape partly through the perceiver's act of interpretation. An organization's ability, through its employees, to interpret and use information in meeting objectives is critical for building organizational performance. This paper shows that one way HPWSs improve performance is by improving the effective quality of information available. Research on HPWSs and on other designs for improving workplace performance in other work settings must identify the kinds of information that are critical to the performance of the organization in question and also identify who has the capacity to interpret that information for effective use. Organizational practices must ensure that employees can interpret information and use it for decision-making toward improving organizational performance.

Appendix
Variable Measurement

Dependent Variables

Information Quality: Kuder-Richardson Formula 20 (.67)

Think about all of the patients you treated over your past three shifts on this unit. In the course of treating those patients, did the following things occur?

You received incorrect information from other nurses who treated the patient.
You had to recheck information received from nurses who treated the patients.
You felt uncomfortable with the extent of patient information you had when the shift began.
You were uncertain about a physician's overall care plan in treating a patient.

Performance Quality: How often does a patient receive incorrect medications or an incorrect dosage on your shift?

Independent Variables

Employee Knowledge

Scientific Knowledge: Percentage of registered nurses in the unit with a bachelor's degree in nursing.
Experience-Based Knowledge: Average seniority among registered nurses in the unit.

Work Design

Work design is based on the average number of routine tasks conducted by each employee group (registered nurses and nursing assistants) in the unit. Task responsibility for low-skilled workers is based on responses from nursing assistants, and task responsibility for high-skilled workers is based on responses from registered nurses. Routine tasks: transport patients, distribute food trays, feed patients, clean patient rooms, draw blood, bathe patients, insert IVs, maintain IV site care, conduct sterile procedures, take vital signs.

Total Quality Management

Employee Involvement: Cronbach's Alpha = .68.

To what extent do you participate in unit decision-making over the following issues?

Setting work schedules
Care delivery practices
Training for unit employees
Job definitions in the unit

Process Templates: What percentage of your patients are on pathways?

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