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Improving Quality of Care through Integration in a Hospital Setting: A Human Systems Integration Approach

Glover, W., Li, Q., Naveh, E., & Gross, M.

ABSTRACT - While many studies suggest that integration is positively associated with improved quality of care, others assert that this may not be so. The inconsistent success of integration to improve performance is not limited to healthcare operations, but is prevalent in operations and engineering management in general. We suggest that this inconsistency exists because many integration studies examine technical components of integration, but not human components of integration. We use recent works on the theory of Human Systems Integration (HSI) to explain how the technical components of a system, examined through *formal integrative practices* and *informal integrative practices*, and the human components of a system, examined through *belief in integration* and *understanding of integration*, interact to influence quality of care. In a study of 34 hospital departments, we found strong support for the interaction between the technical and human components, such that *formal integrative practices* are associated with higher quality of care when *understanding of integration* is high rather than low as we theoretically suggest. Unexpectedly, our results also suggest that not all integration practices influence quality of care; we discuss the implications of these findings for practice and future research applications.

Managerial Relevance - Organizational leadership often emphasizes the importance of integration in achieving performance. However, there are few examples where integrative practices have been successfully implemented to yield improved performance. Moreover, organizations find integrative practices difficult to incorporate because staff, particularly in hospitals, are not necessarily incentivized to implement these cross-unit practices, perhaps perceiving them as yet another additional task that takes away from their primary responsibilities. Our study shows that integrative practices are important since they influence quality. Moreover, our study suggests practical implications for the design and implementation of formal integrative practices. Hospital leadership should design formal integrative practices while also providing cross-unit training that helps staff gain an external perspective on inter-unit relations.

1. INTRODUCTION

More than a decade ago, the critical issue of quality of care in hospitals was placed at the forefront of the global healthcare agenda, as leading health organizations called for the prioritization of quality of care among clinical and healthcare administrative professionals [1]. Yet quality of care is a continuing concern for health care organizations. The Institute of Medicine has defined quality of care as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge" [1, p. 232]. Researchers evaluate quality of care using a variety of dimensions [2]–[4], including adherence to standards and guidelines [2], prevention of medical errors [5], and the elimination of unnecessary rework and readmissions [6].

In order to improve the quality of care, the seminal work *Crossing the Quality Chasm* emphasized that integrating care across patient conditions, departments, and services must be

improved [1]. Many healthcare reforms include *integrative practices* such as formal care coordination procedures, use of performance measures, and a free exchange of information among parts of a healthcare system [7]–[10]. Yet there are few examples where integrative practices have yielded improved performance [11], [12]. Of the few studies that examine integration and quality of care, some find a positive relationship [13]. For example, Gittell et al. [6] found a positive relationship between the use of integrative practices (e.g., formal meetings) and patient-perceived quality of cross-functional orthopedic care. However, others suggest that increasing implementation of integrative practices may not necessarily result in better quality of care [11], [12]. In a review of the integration literature, Evans et al. [10] propose that differences in a range of organizational factors, including organizational bureaucracy, information technology, organizational culture, and commitment to quality improvement may be partly responsible for the mixed experiences and performance outcomes described in the literature about integration.

This inconsistent success of integration is not limited to healthcare and can be seen in operations management and engineering management in general. Overall, the literature suggests that integrative practices positively impact performance [14]. However, there are some cases where integration did not linearly improve performance [15]. Furthermore, integration studies often do not state their theoretical basis [16], [17], suggesting that there is an opportunity for theoretical contributions that may explain the inconsistent effectiveness of integrative practices.

We believe that this inconsistency exists due to a lack of systems thinking in the integration literature. A systems view recognizes that systems have identifiable and often hierarchical units (or subsystems) that create value; a system also has technical and human components that may be motivated or driven differently [18]. Human Systems Integration (HSI) is one systems perspective that accounts for both human components (e.g., cognitive factors) and technical components (e.g.,

cross-unit activities and process-related factors), when examining the overall performance of complex systems, particularly quality [19].

The overall research agenda for integration covers a wide variety of types of integration and levels of analysis. For example, some studies have focused solely on the flow of supplies [20] or information [21], or on work relations [6]. The level of analysis has also varied from unit [6] to hospital [20] to inter-organizations [22]. This suggests that the focal entity being integrated and the level of analysis may influence the effectiveness of integration practices. Because the integration literature is so broad and considering that the technical and human components of integration has received limited attention so far, we concentrated on a specific context, i.e., the situational opportunities and constraints that affect the occurrence and meaning of organizational behavior as well as functional relationships between variables [23], i.e., integration and quality of care in our case. This study does not attempt to include all of these aforementioned conditions, but rather to add evidence about a specific area, i.e., joint work across units.

Specifically, the context of this study is integration among departments within a hospital. This context provides a platform for understanding integration through the theory of HSI through the availability of department level data of both the technical and human components of the joint work. Also, consideration of the human component in tandem with the technical component is particularly useful in healthcare because of its more relational-based nature [6], [24]. For example, a patient can be transferred from the Internal Medicine Department to the Imaging Department for an MRI scan; however, this does not mean that the Imaging Department's staff is familiar with the Internal Medicine Department's needs and activities, understands how its work relates to that other department, or believes cooperation with the other unit will lead to the best performance.

The following uses HSI to review the relationship between integrative practices and quality of care. We focus on examining the relationship between two important technical component factors (formal integration and informal integration) and quality of care, and two key human component factors (belief in integration and understanding of integration) that moderate this relationship. Next, we hypothesize about the relationships between these factors and quality of care.

2. THEORY DEVELOPMENT

Researchers have considered the relationship between the technical components of a system (e.g., cross-unit activities and process-related factors) and the human components of a system (e.g., cognitive factors) in a variety of ways. The following explains this relationship.

2.1 The Technical Component: Formal and Informal Integration and Quality of Care

Integrative practices are broadly defined as bundles of behavioral routines, tools, and concepts. Referring to cross-unit activities and process-related factors studies tend to specify two categories of integrative practices, formal and informal integrative practices [25], [26].

We suggest that both formal and informal integrative practices represent the key technical component factors because they are the practices by which organizations execute tasks and explicitly process knowledge [27]. In formal integrative practices jobs, authority, responsibility and accountability are clearly defined. Employees follow formal relationship, rules, and policies. Formal integrative practices are official routines and measures that codify interactions across units and are frequently studied. These practices refer to bureaucratic and administrative systems, shared record systems, information systems, protocols and procedures, and workflow systems [28].

For example, formal information sharing via databases and intranet systems has been found to increase product quality in advanced manufacturing and supply-chain settings [18]. Transactional support IT systems have been found to effect productivity and operating costs in healthcare settings

[29]; however, there is less understanding of how such formal integrative practices influence quality. Informal integrative practices are unofficial yet still explicit and refer to, casual cross-unit information exchanges using the full range of communications systems from paperwork to corridor conversations, by way of 'phones, videoconferencing, apps and e-mail. There are no defined channels of communication, and employees can interact with other members freely. These are less commonly included in integration studies, but have been found to significantly impact outcomes. For example, Zacharia et al. [30] found that more informal information sharing, or a "free flow of ideas" between supply-chain collaborators, resulted in both lower costs and improved quality.

Table 1 provides examples of empirical studies that examined the role of integration in healthcare settings to achieve improved performance. To get a broad view of the kind of integration activities studied, we include examples from healthcare delivery, healthcare supply chain integration, and healthcare innovation.

INSERT TABLE 1 ABOUT HERE

As Table 1 illustrated, including informal integration mechanisms where staff members freely exchange information outside of formalized procedures and routines is not often included in integration studies, even in more mature areas of integration study such as supply chain integration. Though there is a growing emphasis on quality in health care, Table 1 also shows that some studies in hospital settings had no explicit performance outcome or examined efficiency and not quality of care. This study takes an in-depth look at how both formal and informal integration practices between hospital units influence quality of care. We hypothesize the following:

Hypothesis 1: Formal integrative practices are positively associated with quality of care.

Hypothesis 2: Informal integrative practices are positively associated with quality of care.

2.2 The Human Component: How Belief and Understanding Influence Integration and Quality of Care

Sociotechnical systems (STS) thinking emphasizes joint optimization between the task or technical environment and the social system within a given organization [31]–[33]. For example, in cellular manufacturing, Huber and Brown [34] posited that human resource activities, e.g., training and employee relations, may impact the success of transitioning from traditional to cellular manufacturing. In the study of artificial intelligence technologies to make medical diagnoses, Sharma, Conrath, and Dilts [27] found that there is a "technical component that concerns the task domain and the knowledge engineering process" and a "social dimension of how users and managers relate to the system" (p. 14). However, the use of STS in both of these examples is conceptual and carries limited empirical analysis.

Many works refer to the need for STS applications such as structured coordination mechanisms in healthcare [35] because in healthcare, outcomes emerge from the interaction of people and technologies; thus, organizational or technical systems should not be developed independently of each other [36] in order to address the quality problems in health care [37]–[39]. HSI expands STS thinking, including concepts from systems engineering and human factors, to explain how human and technical components coexist symbiotically [19]. As stated by Pirsig [40], "The machine that appears to be "out there" and the person that appears to be "in here" are not two separate things. They grow toward Quality or fall away from Quality together."

Many human factors studies, on which HSI is built, refer to working across organizational boundaries in healthcare systems, demonstrating the need to increase our capability for collaboration [41]–[44]. In particular, cognitive factors such as situational awareness, team awareness [45], and organizational awareness [46] have been found to improve the performance

of healthcare providers. We leverage HSI to explain how integrative practices impact the quality of care in a healthcare setting.

HSI scholars note that integration can be difficult for organizations because in order to implement technical integrative changes, they must also change former "human subsystem" or cultural norms, e.g., interdepartmental resource competition, and break down silos for groups to work together that typically worked independently [47]. Organizational behavior literature states that in-group favoritism exists and tends to prevail over favoring out-groups to the point that animosity against outsider groups can arise, even in the presence of intergroup interdependence [48]. In a healthcare setting, this means that groups specializing in a certain function tend to prefer devoting efforts to one's specialty or department as opposed to coordinating care across functions. Incentivizing policies aim to change this in-group preference and encourage coordination for improved quality of care, e.g., coordinated care payment incentives to reduce readmissions into the U.S. Affordable Care Act [11]. However, these incentives may not be effective because healthcare professionals may not understand the human-related changes, such as identities, norms, and cognitive factors, that may be needed for the successful implementation of integration [49]. In order to cross group boundaries, HSI suggests that human component factors must be adopted symbiotically with technical component factors to achieve success [50]. We examine *belief in* and *understanding of integration* as human component factors of awareness and knowledge for overall system success [6].

2.2.1 Belief in integration. Having superordinate beliefs can prevent discriminatory out-group behavior [51] and de-escalate group conflicts [52]. Shared superordinate beliefs have been found to enhance productivity in healthcare [53], but have not been directly tested on integration or quality of care.

We posit that a high *belief in integration* indicates that employees believe that integrative work with other units is helpful for achieving successful results, while a low *belief in integration* indicates that units do not believe that integrative practices are helpful or necessary to achieve successful results. For example, regarding the traditionally highly specialized nature of hospitals, Nembhard and Edmondson [54] suggest that professionals may not deem it necessary to work with other units in order to achieve better quality of care. However, in studies of total quality management (TQM), hospitals that share common beliefs and goals about TQM have been found to be more successful in applying TQM practices than hospitals that do not share common beliefs and goals [55]. Thus, we suggest that interactions between formal and informal integrative practices and *belief of integration* are associated with quality of care and we hypothesize the following:

Hypothesis 2a: Formal integrative practices are associated with higher quality of care when belief in integration is high rather than low.

Hypothesis 2b: Informal integrative practices are associated with higher quality of care when belief in integration is high rather than low.

2.2.2 Understanding of Integration. Studies in healthcare show that the mere fact of having a shared belief of providing optimal quality care does not dissipate all group tensions [56]. Integration problems also arise due to misunderstanding of processes outside the unit [28]. For example, even if a staff member's *belief in integration* is high, the complex interplay of multiple specialties and functions may make it challenging for hospital units to systemize and explicitly understand how they are interrelated [57].

We define *understanding of integration* as the extent to which a unit is familiar with the way in which its work relates to other units. The ability of unit employees to reflect on the relationship

between their work and that of other units is a cognitive strategy that has been found to influence work effectiveness in industrial settings [58]. Hospital units may tend to be low in *understanding of integration* because their professionals are socialized to focus on their area of specialty without awareness of the activities of other specialties and the interdependencies between units, e.g., [54]. However, a greater understanding of the shared work with others may increase overall performance [6]. We suggest that interactions between formal and informal integrative practices and *understanding of integration* are associated with quality of care. Thus, we hypothesize the following:

Hypothesis 3a: Formal integrative practices are associated with higher quality of care when understanding of integration is high rather than low.

Hypothesis 3b: Informal integrative practices are associated with higher quality of care when understanding of integration is high rather than low.

3. METHODS

3.1 Participants

Questionnaires were distributed to the general staff at a medium-size, 450-bed, community hospital located in Haifa, Israel, serving 150,000 patients annually. We planned the sampling to be at the team level, so as to match the previously discussed theory. For this study, we surveyed 148 staff members from 31 units. We aimed for and achieved a response rate of 20% for 16 units with less than 20 staff members, and 10% for 15 units with more than 20 staff members in order to have at least 4 responders in each unit (in accord with earlier studies, e.g., [59]). We randomly asked unit members to reply to the questionnaire until we achieved these rates. The response rate was 95%.

The study comprised 17 medical units: cardiology, orthopedics, ophthalmology, ER, pediatric surgery, internal medicine unit (two wards, A and B), pediatrics, gastroenterology, occupational therapy, obstetrics and gynecology, surgery, recovery room, internal medicine unit C/urology, general intensive care, rehabilitation, and anesthesiology. Fourteen service units were also included: microbiology, genetics, social services, reception, chemistry, nephrology, pharmacy, immunology, pathology, blood bank, radiology, radiology (radio-isotope scanning), endocrinology, and infectious diseases.

An average of five hospital front-line staff from each unit completed the independent-variable questionnaire. 89 responders (60% of the responders) were from the medical units. Out of them 63% were male; 33% were doctors, 60% nurses, and the rest administrative. Their average age was 40.4 (SD=11.5), average years in current role was 10.7 (SD=8.3), which was same as averages and standard deviations for years worked in the hospital and in the department. From the service units there were 59 responders: 80% male; 37% were doctors, 18% nurses, 22% technicians, and the rest administrative. Average age was 42.4 (SD=12.6), average years in current role 11.5 (SD=9.2), which was same as averages and standard deviations for years worked in the hospital and in the department.

Sixty-nine upper-level staff (not the same staff that filled the independent-variable questionnaire), two to three from each unit, completed the performance questionnaire. The response rate for the dependent variable was 95%.

The sample size of this study is similar to influential works by researchers published in leading journals. These researchers suggested hypotheses that were tested using a similar research design and that studied quality and related quality dimensions such safety and other human components such as climate. For example, in Management Science, Katz-Navon, Naveh and Stern

(2005) studied 123 individuals from 25 departments [60]. In the Journal of Organizational Behavior, Zohar (2002) studied 42 units [61]. In the Journal of Applied Psychology, Hofmann, Lei, and Grant (2009) studied 18 units and 146 individuals [62]. Across these studies examining theory at the team level of analyses, the research design commonly includes multiple departments in one organization, with the number of respondents in each department ranging from 3 to 15.

3.2 Measures

All independent and dependent variable items used a 5-point Likert scale, ranging from "Not at all" to "A great deal." The factors' items for the medical and service units are provided in Table 2. In order to have high reliability and validity, the factor items were adapted from earlier works. Each factor was based on a different literature source but the individual items per factor were all taken from the same source. For example, our literature sources for *formal integrative practices* and *informal integrative practices* were different, but all of the items for *formal integrative practices* came from the same source (this approach is common, for example [63]). The independent variables items used are not specifically related to quality of care but in accord with the theory present in this study are general suggesting that integration in general is associated with quality of care.

3.2.1 Independent Variables. Integration's technical component factors: Four items for *formal integrative practices* were adapted from Gittell et al. [6]. *Informal integrative practices* were evaluated through three items adapted from Zahra and Nielson's measure of integration [64].

Moderators – integration's human component factors: *understanding of* and *belief in integration* were evaluated through three items adapted from Groesbeck [65] and three items adapted from Erez and Early (1997), respectively.

3.2.2 Dependent variable. Quality of care was measured with five items related to adherence to standards and guidelines, prevention of medical errors, and work accurately and elimination of unnecessary rework and readmissions [5], [6]. Adaptation were made to the service units in three of the items (see Table 2).

***3.2.3 Control Variable*.** One item factor controlled for the extent to which the unit is required to work with other units [67]. A variable to control for the differences between medical and service units (1=medical, 2=service).

INSERT TABLE 2 ABOUT HERE

3.3 Data Collection Procedures

All data were collected by means of voluntary, unidentified, and confidential questionnaires. Prior to administering the questionnaire, we obtained the number of hospital staff in each unit and used it to establish the number of respondents to be sampled. Research assistants then distributed the questionnaires to hospital staff during working hours. These questionnaires were either completed immediately or retrieved at a later time. The dependent variable quality of care questionnaire was given to two to three staff members that were either unit heads or senior in rank. A research assistant came to each respondent several times to ask for their response to the dependent variable questionnaire; this enabled us to receive a high response rate. In order to eliminate common source bias and improve the study reliability, the respondent for the dependent and to the independent variable questionnaires were different individuals. Those who completed the quality of care questionnaire did not receive the questionnaire containing the independent variables.

4. RESULTS

4.1 Construct Validation

To test the structure of the independent variables we conducted a confirmatory factor analysis (CFA) using SAS's 9.3 CALIS procedure on the individual level of analysis [68]. The analysis was performed on variance-covariance matrices with pairwise deletion of missing values. We employed a maximum-likelihood estimation method with robust standard errors together with the Satorra–Bentler rescaled chi-square statistic [69].

In validating the factor structure of the technical component of integration, *formal* and *informal integrative practices*, confirmatory factor analysis (CFA) yielded sufficiently significant [70] levels of fits ($\chi^2(38,144)=37.84$, $p<.001$; GFI=0.93; RMSEA=0.13; NFI=0.86; NNFI=0.85; CFI=0.91). All the standardized factor loadings in the model were above .60 (the majority of the loadings were between .75 and .90). In comparison to a one-factor model, the CFA statistics of such model resulted in an unacceptable fit ($\chi^2(35, 144)=87.07$, $p<0.001$; GFI=0.83; RMSEA=0.21; NFI=0.67; NNFI=0.62; CFI=0.70). The difference between the chi-square statistic of the two models, $\chi^2(2, 144)=49.23$, $p<0.001$, suggests that *formal* and *informal integrative practices* best fit a two-factor model.

The confirmatory factor analysis (CFA), in constructing the characteristics factor structure of *understanding of* and *belief in integration*, yielded acceptable fit levels ($\chi^2(30, 159)=25.91$, $p=0.001$; GFI=0.95; RMSEA=0.09; NFI=0.94; NNFI=0.95; CFI=0.96). A one-factor model was created to validate these results ($\chi^2(27, 159)=143.36$, $p<0.001$; GFI=0.74; RMSEA=0.26; NFI=0.64; NNFI=0.57; CFI=0.66). The chi-square difference between the one-factor model and the two-factor model, $\chi^2(2, 144)=117.45$, $p<0.001$, significantly indicates the relative poorness of fit for the one-factor model. See Cronbach's alpha of the variables in Table 3.

4.2 Level of Analysis

All variables focused on the unit level as the unit of analysis. Individual respondents were thus aggregated to the unit level to produce a unit mean for each construct. The $r_{wg(j)}$, ICC(1), and ICC(2) for inter-unit agreement and between-unit variance, as well as ANOVA for between-unit variance, were calculated with R (v2.15.03 for Mac OS Leopard).

Homogeneity of respondents was tested for with $r_{wg(j)}$ [71]. *Formal* and *informal integrative practices* scored a median $r_{wg(j)}$ of 0.73 and 0.70, respectively; *understanding of* and *belief in integration*, resulted in a median $r_{wg(j)}$ of 0.89 and 0.89, respectively. ICC(1) values were 0.17, 0.15, 0.37, 0.14, and ICC(2) were 0.46, 0.31, 0.73, 0.34, respectively. One-way analysis of variance (ANOVA) was conducted on the individual level. The four factors of integration have significant between-unit variance (*formal integrative practices*: $F=1.451$, $p<0.05$; *informal integrative practices*: $F=1.85$, $p<0.01$; *understanding of integration*: $F=2.13$, $p<0.01$; and *belief in integration*: $F=1.607$, $p<0.01$). Thus, inter-unit homogeneity and intra-unit variance were highly significant, and aggregation to the unit level was permissible [72].

The scales of the dependent variable, quality of care, exhibited sufficiently high agreement (median $r_{wg}=.95$). Intra-class correlations (ICCs) indicated that the dependent variable measure was sufficiently reliable to model effects at the unit level (ICC(1) =.70**; ICC(2) =.81** with **$p<0.01$). In order to demonstrate the measures' reliability we also calculated the correlation between the managers' scores, which was relatively high ($r=.71$). We calculated the mean score of quality of care for each unit by averaging the corresponding two (or three) managers' means scores, and assigned each unit its mean quality of care score.

4.3 Hypotheses Testing

Table 3 summarizes the means, standard deviations, and correlations among the variables.

INSERT TABLE 3 ABOUT HERE

Because of the data's multi-level nested structure (a unit within a medical or service unit), we used a mixed-model data analysis method. Mixed models take into account the fact that units within the medical group may be more similar to one another than to units in the service group [73]. In order to test our hypotheses, we used the SAS MIXED procedure [74] because it suits statistical models with non-independence of observations.

The analysis begins with the fitting of an unconditional null model in order to estimate the total systematic variance in the dependent variables [73]. This analysis clarifies how much variance resides within and between units within a medical or service group, and also serves as a foundation for later analyses. Using MIXED models, we regressed quality of care on units within the medical and service groups. The results of this null model indicated that the proportion of the between-group variance to the total variance (that is, the ICC(1) value for the dependent variables) was .42, $\chi^2(30, N = 31) = 52.69$, $p < .01$ for quality. These results justify modeling units within the medical and service groups as cross-level effects.

To test the hypotheses, we regressed quality of care on the control variable of the extent to which the unit is required to work with other units, the four main effects of *formal integrative practices*, *informal integrative practices*, *understanding of integration* and *belief in integration*, and the four two-way interactions hypothesized earlier. Since the control variable was not significant and had a near-zero-magnitude effect, we regressed the models again without the control variable (B= -.02, SD = .14, P-value=.89). [75].

Table 4 presents the results. The two-way interaction between *formal integrative practices* and *understanding of integration* was significant. Therefore, we focus on this in our discussion as opposed to the direct effect, as per Johnson and Wichern [76]. To understand the nature of the

significant interactions between *formal integrative practices* and *understanding of integration*, in this model we followed the graphing method outlined by Aiken and West [77] (See Fig. 1).

INSERT TABLE 4 & FIGURE 1 ABOUT HERE

Fig. 1 shows that formal integrative practices are associated with higher quality of care when understanding of integration is high rather than low, supporting Hypothesis 3a.

5. DISCUSSION

Two main contributions are at the core of this study. First, integration of both the technical and human components of a system is positively associated with quality of care. Specifically, increased use of formal integrative practices is associated with improved quality of care among units with high rather than low understanding of integration. This is contrary to the current view of integration that focuses solely on the technical component of integration, e.g., [28], [63].

This result suggests that hospitals reap the full benefits of formal integrative practices, such as performance measures and routines, when a unit's staff has a deeper understanding of how their work is interrelated. The lowest quality of care was found when both formal integrative practices and understanding of integration were low. This seems intuitive: if rules are not in place, then staff cannot follow them to achieve improved quality of care. This supports much of the early literature on quality of care such as Crossing the Quality Chasm [1] and key studies of hospitals like Tucker's [20] that called for more medical guidelines and the design of work systems to facilitate coordination in order to improve quality. When *formal integrative practices* is high and an *understanding of integration* is low, the wrong rule or integrative practice may be chosen due to the misperception of a situation or the misapplication of a rule that seemed to fit [78]. The best scenario is when both *formal integrative practices* and *understanding of integration* are high.

Having an understanding of integrative practices, e.g., routines or procedures, allows healthcare employees to use, adapt, and appropriately fit the said practice to their specific situation and context, maintaining quality of care. This finding is at the heart of HSI: a symbiotic use of technical and human components yields the highest level of performance [19]. Moreover, these results hold for both medical and service units, suggesting the results may be more generalizable.

The study's second contribution is the fact that we refer to specific factors of system integration, i.e., the technical component factors of *formal* and *informal integrative practices* and the human component factors of *belief* and *understanding of integration*. We believe that this is a more accurate approach because both the technical and human components are complex concepts; the use of the four factors better captures the meaning and intention of said components. This approach also resulted in an unexpected contribution: our findings suggest that not all technical or human factors influence quality similarly.

Here we discuss the factors that had no significant impact on quality of care. *Belief in integration* did not significantly influence *formal integrative practices'* impact on quality of care. Also, both interactions of *informal integrative practices* with *belief in integration* and with *understanding of integration* were not significant. Thus, regarding the achievement of quality of care, the interaction between *formal integrative practices* and *understanding of integration* has more influence than the other interactions we tested in this study. This unexpected finding requires explanation. The quality literature traditionally emphasizes formal activities over and above informal ones, for example, the ISO 9001 standard [63], [79]. Informal practices may be insufficient in a healthcare setting that may require more procedures to ensure quality of care. Naveh and Katz-Navon [59] suggest that if there is no contradiction between formal and informal

activities, the influence of the former will be significant. Thus, there may be limited contradiction between formal and informal integrative practices in healthcare.

According to the literature on learning, *understanding of integration* is about possessing knowledge while *belief in integration* is more about motivation. Which is more influential, knowledge or motivation, especially in a hospital where staff members may be highly motivated because of the kind of work they are doing? Our study suggests that knowledge is more important.

6. LIMITATIONS

The study has four limitations that we would like to point out. First, though acceptable in similar research designs [55], it has a relatively small sample size. Thus, the sample size and the number of responses by unit may still be insufficient to generalize the findings. Given that some of the results were surprising, this study needs to be replicated to include more organizations and units in order to establish common conclusions. There is also possibility that only certain (e.g., biased) individuals took the survey in the short time that we conducted the study. Second, the study is a cross-sectional research that was conducted over a short period, not a longitudinal study that would examine causality. Third, although we used acceptable methodology in developing the data collection questionnaires and all measures of agreements were satisfactory, as always, there may be concerns of potential misinterpretation and bias by respondents. For example, it is possible that the unit heads or senior doctors that assessed the quality of care could be biased, though the inter-unit homogeneity and intra-unit variance of the respondents were high. We eliminated common source bias by separating between the responders to the dependent and independent variables. However, we used questionnaire and did not use objective hospital measures to assess aspects of quality of care. Thus, there are potential temporal factors that could have influenced our results. For example, *belief in integration* may be influenced by the temporal nature of the success of

results, cooperation, and problem solving, e.g., at the time of the study, poor objective quality of care outcomes could influence the respondents. Other limitations might be the influence of cultural, regional, gender, professional roles, and hierarchy, on the respondents' understanding of integrative strategies (based on involvement). Fourth, the control variable, extent to which unit is required to work with other units, was asked in regards to all other department and not specifically in regards to each department. These limitations suggest interesting future research directions as we lay out in the following section.

7. FUTURE RESEARCH

Our study has two main contributions. First, we find that integration of both the technical and human components of a system is positively associated with quality performance. Secondly, we identify specific factors of integration, i.e., the technical component factors of formal and informal integrative practices and the human component factors of belief and understanding of integration, that can be used to understand system performance. This identification leads us to areas where future research is needed. We suggest five highly promising directions for future research. First, there are few studies that refer to several performance dimensions simultaneously. In this study, we referred to quality. The fact that some of the factors were not significant, yet still appear in the literature as important for performance, suggests that they may be significant for other dimensions of performance. This is an interesting direction, since tensions between the integration factors may create a situation in which improving one performance dimension may harm another [6]. While organizations today are expected to embrace a paradox, it is unclear how system integration simultaneously influences several performance dimensions. Second, an intervention-based longitudinal research design, based on our cross-sectional model, would strengthen the ability to infer causality. It could lead to fascinating studies currently inexistent in the field of engineering

or operations management. Third, since the term “system” can refer to individuals within teams within organizations, more attention should be given to the level-of-analysis aspect of integration. For example, it would be beneficial for future studies to test our theory not only at the inter-unit level but also the inter-organizational level. Also, factors that were not significant at the inter-unit level may have a different influence at the inter-organizational level. Fourth, while we believe this study’s contributions are general and do not refer only to healthcare delivery, the study was done in a hospital and its generalization to other fields needs to be demonstrated.

Finally, this study exhibits methodological fit, i.e., internal consistency among elements of the research: the research question, prior work, research design, and theoretical contribution [80]. The state of the literature is such that there are existing theoretical and empirical research papers that pertain to the topic of the current study. The type of data we collected, data collection tools and procedures, and the type of analysis align well with a hypotheses testing study. Future research can continue this line of hypotheses testing study, for example by using existing objective measures to assess aspects quality of care and efficiency together with subjective measures in different sectors. However, future research can also initiate exploratory research to further explore basic and hidden mechanisms of integration and quality of care. One such direction may explore specific to quality of care integration mechanisms giving that in current study the integration factors were not specifically related to quality of care but general (e.g., such that may be related to efficiency as well) in accord with the theory presented in this study.

8. PRACTICAL IMPLICATIONS

Healthcare organizations find integrative practices difficult to incorporate because providers are not necessarily incentivized to implement these cross-unit practices [25], perhaps perceiving them as yet another non-clinical task that takes away from patient-provider interactions.

Our study shows that integrative practices are important since they influence quality of care. This can be a good motivation for their implementation.

Moreover, our study suggests practical implications for the design and implementation of formal integrative practices by hospital leadership. Regarding design, hospital leadership should not create formal integrative practices without having in mind how current levels of understanding of integration may impact the implementation of those practices. For example, as a hospital implements a centralized pharmacological decision-making process for patients with multiple co-morbidities who interact with multiple specialists, the process designers should take into consideration how varying levels of the understanding of integration may impact implementation. If understanding of integration is generally high, then such formal integrative practices should make it possible to use that understanding so that professionals can adapt practices to varying situations (e.g., a patient that has 2 versus 10 co-morbidities, or various specialist physicians working with the same patient). If understanding of integration is generally low, then formal integrative practices may need to be as explicit as possible until understanding increases through training or opportunities for cross-unit interaction and discovery.

Hospital administrators should provide cross-unit training focused on systems thinking and aimed at gaining an external perspective of inter-unit relations for new hires and existing members of a unit. While understanding of integration may allow the adaptation of formal integrative practices over time, hospital leadership should be wary when such adaptation becomes burdensome. For example, if a new unit is added to the hospital, formal integrative practices should be updated to reflect the different integration needs, instead of depending solely on the professionals' understanding of integration to bridge the gap left by the absence of an integrative

practice. By coupling technical and human integration practices, we expect that healthcare organizations' performance may improve in this age of integrated care.

9. CONCLUSION

Organizational practitioners often emphasize the importance of integration for achieving quality of care. However, while many studies suggest that integration is positively associated with improved quality of care, others assert that this may not necessarily be the case. The inconsistent success of integration to improve performance is not limited to healthcare operations, but is seen in operations and engineering management as well. Thus, our study has both theoretical and practical contributions, mainly the explanation of this inconsistency and the suggestion of conditions under which integration improves performance. We suggest that the inconsistency is due to the predominant view that does not consider both technical and human components. We use recent works on the theory of HSI, a lens that is attracting considerable attention, and contrary to the current view of systemic integration that focuses solely on the technical aspect, we show how both the technical and the human components of a system interact to influence quality of care.

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Table 1: Studies examined the role of integration on healthcare operations to achieve improved performance.

Author, Year	Entity being Integrated	Formal Integration Mechanism Studied and Findings	Informal Integration Mechanism Studied and Findings	Unit of Analysis	Performance Variable of Interest	Measurement Approach
Provan and Milward (1995) [22]	Service links between mental health-related organizations in four cities	Density and centralization of referrals, case coordination, joint programs, and service contracts were negatively associated with quality of mental healthcare provision	Not included	Mental health provider network	Client quality of life satisfaction and medical status	Quantitative--medical record data and survey instrument
Tucker (2004) [20]	Observations of operational failures, i.e., disruptions or errors in the supply of necessary materials or information, among 26 nurses in 9 hospitals	Formal and informal integration mechanisms not explicitly reported; based on operational failures tracked, findings suggest that "(1) designing work systems that facilitate coordination and communication between dependent groups, and (2) developing problem solving procedures that enable employees to effectively address failures that stem from other groups"		Hospital	Operational failures resulting in rework, additional time, interruptions, delays, risk, or losses in materials or confidence in the hospital	Qualitative--interviews
Mitchell (2006) [21]	IT exchanges across 114 health networks (where each network included multiple hospitals, clinics, etc.) via Enterprise Application Integration (EAI) projects	Integrative capability (measured as access to external knowledge through journals and workshops and internal knowledge integration through shared clinician/IT EAI design) was associated in a decrease in project time overrun	Not included	Health network (a multi-organizational conglomerate, typically comprised of 20 or more health care facilities)	Project time overrun: amount of time the actual completion date exceeded the target completion date	Quantitative--survey instrument

Gittell, Seidner, and Wimbush (2010) [6]	Knee replacement care across functions within 9 orthopedics units	Selection for Cross-Functional teamwork, conflict resolution, performance measurement, rewards, meetings, and boundary spanners is associated with an increase in patient-perceived quality of care and a decrease in patient length of stay	Accurate, frequent, and timely communication increases patient-perceived quality of care and decreases patient length of stay	Department (e.g., coordination between physician, resident, physical therapist, and social worker within an orthopedic department)	Patient-perceived quality of care & Patient length of stay	Quantitative--survey instrument and hospital discharge data
Tucker et al. (2012) [81]	Turnover of hospital patient rooms in two hospitals, including equipment, supply, and information exchanges across 14 medical and support departments (internal supply chain)	The perception of interconnectedness of system performance metrics, departmental routines, and daily management and continuous improvement infrastructure was lower than deemed necessary for decreasing room turnaround times	The perception of interconnectedness of deliberate knowledge translation across departmental boundaries to enable efficient response was lower than deemed necessary for decreasing room turnaround times	Department (i.e., Physician, Nursing, Engineering, Central Supplies, Dietary, Sterile Processing, Biomedical Equipment, Environmental Services, IT)	Decreasing the time required to make a just vacated patient room ready to receive the next patient admitted to the unit	Qualitative--interviews
Goldstein and Iossifova (2012) [82]	TQM practices across units in 814 acute care hospitals	Formal and informal integration mechanisms not explicitly reported; TQM depth measure included items such as supplier involvement in new services and cooperative labor/management relations and this TQM depth measure was positively associated with process performance		Hospital	Process performance: treatment for heart attacks, heart failure, pneumonia, and surgical care	Quantitative--public archival data and survey instrument
Chen, Preston, and Xia (2013) [83]	Hospital/supply chain management interactions from 117 hospital supply chain executives	Hospital-supplier integration (e.g., Inter-organizational logistics activities between hospital and major key vendors/suppliers are closely coordinated) is positively associated with hospital supply chain performance	Not included	Hospital (i.e., the supply chain executive)	Hospital supply chain performance: quality, speed, cost, and flexibility of order fulfillment process	Quantitative--survey instrument

Perols, Zimmermann, and Kortmann (2013) [84]	Supplier product and process integration for multiple industries, including 26 healthcare organizations	Supplier involvement in product development was positively associated with time to market. Suppliers developing technology for the healthcare organization was negatively associated with time to market	Not included	Organization	Time to market compared to major competitors	Quantitative--survey instrument
de Blok et al., (2014) [85]	Interfaces between modular components and providers in 4 elderly care organizations	Established lines of communication and customer meetings were found to be interfaces between providers	Not included	Organization	Not included	Qualitative--interviews

Table 2: Independent and Dependent Variables—Factor Items

Measurement Scales: Responses ranged from 1, "not at all or to a very slight extent," to 5, "to a very large extent."

Independent Variables
Formal integrative practices (Adapted from [6]) To what extent does your unit:
1. Use formal routines and procedures to coordinate efforts
2. Have cross-unit performance measures
3. Formally coordinate in order to conduct cross-unit activities
Informal integrative practices (Adapted from [64]) To what extent does your unit:
1. Freely exchange information with other units
2. Bypass formal communication channels as needed
3. Use informal relationships to do the work
Understanding of Integration (Adapted from [65]) To what extent does your unit:
1. Try to think about how the different units fit together
2. Understand how our work relates to other units
3. Familiarize itself with what is going on in other units
Belief in Integration with other units (Adapted from [86]) To what extent does your unit believe:
1. Work with other units is necessary for achieving successful results
2. Work that is based on cooperation with other units leads to the best performance
3. In general, working with other units helps in solving problems
Dependent Variable
Quality of Care (adapted from [5], [87]) To what extent does this unit:
1. Provide quality medical care/service[a]
2. Have a low rate of errors
3. Deliver care/service accurately[a]
4. Follow medical guidelines/standard procedures[a]
5. Have a low rate of readmission within a week after discharge/unnecessary rework [a]

[a] – service unit version

Table 3. Means, Standard Deviation, and Correlation [a,b]

	Mean	SD	1	2	3	4	5	6	7
Technical integration factors of a system									
1. Formal integrative practices	2.72	.56	[.81]						
2. Informal integrative practices	2.5	.58	.66**	[.81]					
Human integration factors of a system									
3. Understanding of Integration	3.76	.45	.44*	.35	[.85]				
4. Belief in Integration	4.13	.4	.26	-.03	.48**	[.84]			
Control variable									
5. Work with other units	4.0	.76	.22	.25	.35*	.33			
6. Medical vs. service	1.45	.50	-.42*	-33	.16	-.17	.19		
Performance									
7. Quality of Care	4.2	.4	-.23	-.25	-.01	-.08	-.18	.24	[.78]

[a] These statistics are at the unit level of analysis
[b] Cronbach's alpha (α) coefficients appear in square brackets
$n = 31$
* $p < 0.05$
** $p < 0.01$

Table 4. Results of Hierarchical Linear Regression

	Quality of care (SE)	
Intercept	5.48*	(3.37)
Formal integrative practices	-3.33†	(1.97)
Informal integrative practices	3.20	(2.54)
Understanding of Integration	-2.13	(1.32)
Belief in Integration	1.65	(1.51)
Formal integrative practices * Belief in Integration	-0.35	(0.56)
Informal integrative practices * Belief in Integration	-0.27	(0.46)
Formal integrative practices * Understanding of Integration	1.29*	(0.48)
Informal integrative practices * Understanding of Integration	-0.57	(0.41)

$n = 31$
† $p < 0.1$
* $p < 0.05$

Figure 1

Hierarchical Linear Regression lines of quality as a function of Formal Integrative Practices and Understanding of Integration