1. Title Page

Title of Project: Understanding the implementation of new practices in healthcare organizations

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2. Structured Abstract

Purpose: This research aimed to increase implementation of evidence-based practices by advancing knowledge on contributors to implementation success. Specific aims were to characterize implementation leaders' behaviors that facilitate implementation and examine the effect of workforce (relative to others') engagement and learning activities.

Scope: We focused on implementation of practices to improve treatment time for patients with ST-segment elevation myocardial infarction, a common type of heart attack; less than 50% of U.S. hospitals had median treatment times compliant with the national guideline at the time, and most had not implemented recommended practices. We studied a sample of hospitals that joined the D2B Alliance campaign to improve.

Methods: A mixed-methods study, using qualitative data from interviews with staff at 12 hospitals, quantitative survey data from more than 500 hospitals, and treatment times from HospitalCompare.

Results: Much of implementation leaders' behavior focuses on addressing implementation challenges. We found consistency in strategies identified as effective. Whether staff voiced their improvement ideas was influenced by characteristics of individuals, work, organizational context, data, and the external environment. These factors shaped staff's sense of safety, efficacy, opportunity, and/or legitimacy, all of which affected their willingness to voice. The benefit of accessing different organizational groups for implementing practices depended on whether the practice was role changing or time changing for staff. Implementing imported practices helped hospitals achieve initial-phase but not later-phase improvement. Once hospitals entered the later phase, significant improvement required creative problem solving.

Key Words: implementation, organizational learning, quality improvement, leadership, teams, staff, voice, networks

3. Purpose (Objectives of Study)

Despite an abundance of scientific evidence on quality-improving clinical and organizational practices, national performance on many quality measures remains poor. Prior research suggests that this is because many healthcare organizations struggle, and ultimately fail, to implement new practices. As a result, millions of patients suffer negative consequences, including higher mortality and morbidity. The objective of this research was to increase the successful implementation of existing and future practices by advancing the evidence base on how three aspects of organizations contribute to the implementation success of new practices: implementation leaders' behaviors, workforce engagement, and use of learning activities. The specific aims were:

AIM 1: To characterize implementation leaders' behaviors and to develop hypotheses about the relationship between implementation leaders' behaviors and implementation success

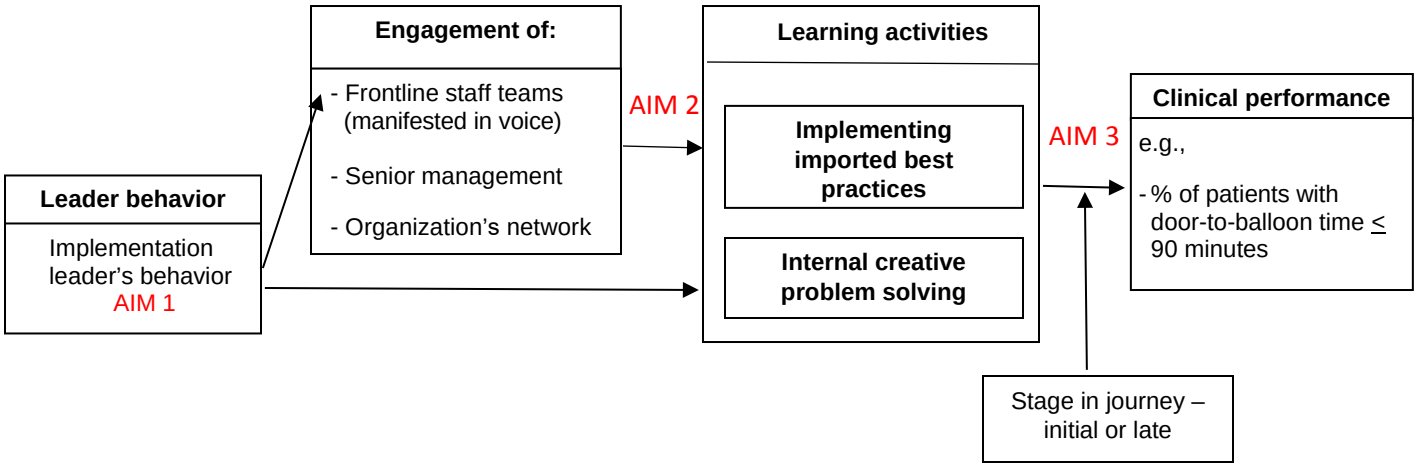
** In the course of this project, realizing that much of implementation leaders' behavior is directed at addressing implementation challenges, and a key challenge is eliciting staff voice (i.e., staff speaking up about concerns and suggestions), we expanded this aim to include identifying what factors influence staff voice, why these factors are influential, and the purposes for which staff use their voice.

AIM 2: To examine the relationship between workforce engagement (for different segments of the hospital workforce) and implementation success and to assess whether implementation success mediates the relationship between their engagement and clinical performance (i.e., door-to-balloon time)

AIM 3: To examine the association between hospitals' use of various national quality campaign-sponsored learning activities and implementation success as well as clinical performance

Although our aims were not substantively modified since the original application, as explained in previous progress reports, having found no association between hospitals' use of various national quality campaign-sponsored learning activities and implementation success or clinical performance for Aim 3, we decided to study two broad learning strategies that hospitals have been encouraged for use to improve clinical performance, one of which is implementing imported best practices (learning by imitating). The other strategy is internal creative problem solving (learning by experimenting). Aim 3 changed to examine the effect of these learning strategies on performance improvement at different points in the improvement journey - initial push versus later phase. In pursuing this aim, we also addressed the association between implementation and clinical performance, as planned in Aim 2. Together, the aims led to an objective of evaluating the concept. model in Figure 1.

Figure 1. Conceptual Model of the Implementation of New Practices in Hospitals, Derived from Project



4. Scope (Background, Context, Settings, Participants, Incidence, Prevalence)

Background

Despite an abundance of evidence on quality-improving clinical practices, national performance on many quality measures remains poor. To help healthcare organizations (HCOs) improve the quality of care they deliver to patients, many professional associations, care networks, improvement experts, and government agencies have launched or sponsored improvement initiatives (i.e., collaboratives, campaigns, etc.) in which HCOs work together to implement evidence-based practices in their organizations.[1-7] Studies of these initiatives show that their effectiveness is mixed.[8-10] The implementation of recommended practices occurs for some, but not all, participating organizations. By some estimates, two thirds of organizations' implementation efforts fail.[11,12] This finding raises the question: Why are some HCOs better able to implement new practices?

Implementation refers to the process of gaining targeted organizational members' skillful, consistent, and committed use of a new practice.[13] It is the means by which a practice is assimilated into an organization such that the practice is routinely used.[14-16] When targeted organizational members use a practice as frequently, consistently, and assiduously as needed to realize its intended benefits, the organization is said to have experienced implementation success. In contrast, when targeted organizational members use a practice less frequently, less consistently, or less assiduously than required for the potential benefits to be realized, implementation failure is said to have occurred.[13(p. 1055)] This research was intended to provide an better understanding of implementation in HCOs and how HCOs may increase their implementation success. The limited understanding of this subject is regarded as "the most serious gap" by diffusion (of practice) scholars.[16]

Organizational theory suggests that at least two sets of characteristics influence implementation success: organizational structure and organizational behavior.[16-18] Organizational structure refers the set of situational features that may influence patient care, such as geographic location, teaching status, and staffing levels.[19] Organizational behavior refers to the actions and interactions that occur in work settings.[20] It is shaped by, for example, leader behavior (e.g., provision of resources), groups that are engaged (e.g., the frontline staff/workforce and senior management), and the climate that they create as well as the choice of learning activities.[18,21-25] Empirical research has demonstrated that the association between organizational structure and implementation success or clinical performance is significant but modest in magnitude.[26,27] This work has also suggested that organizational behavior may play the more instrumental role in implementation success.

Despite the hypothesized importance of organizational behavior, there had been relatively little empirical research in healthcare that examined how various aspects of organizational behavior work together to influence implementation and clinical performance.[28] Prior research shows the individual importance of staff and management engagement,[29,30] but, with notable exceptions,[31-33] it does not examine empirically whether and how such factors combine with other factors to affect implementation success and clinical performance.[16,18,28] The difficulty in achieving implementation success and improved clinical performance suggests that the relationships among variables are as important, if not more important, than the main effect of individual variables for understanding implementation as a complex organizational process. The lack of research on the relationships historically likely reflected two issues: first, the challenge of studying organizational behavior, because this form of research requires expertise in mixed methods (the integration of qualitative and quantitative methods) to draw meaningful inferences.[16] Second, generalizable research on this subject requires access to a large sample of organizations willing to allow study of their behavior. Access to such samples is difficult to acquire. We were able to access such a sample and employ mixed-methods research.

Context, Setting, and Prevalence

The context for this research was the D2B Alliance for Quality. In November 2006, the American College of Cardiology and 38 partner organizations launched the D2B Alliance (www.d2balliance.org), a national campaign to promote (1) the implementation of evidence-based practices for improving door-to-balloon time for patients with STEMI,[4] a common type of heart attack, and (2) door-to-balloon times $\leq$ 90 minutes for at least 75% of non-transfer patients treated with primary PCI. The campaign was a response to the findings that less than 50% of U.S. hospitals had median door-to-balloon times compliant with the national guideline

of 90 minutes or less[34] and that many U.S. hospitals had not implemented evidence-based practices to reduce door-to-balloon time,[35] despite ample studies showing the importance of implementing these practices on door-to-balloon time and, ultimately, on patient mortality.[36-43] At the launch of the D2B Alliance, only 30.4% of D2B Alliance hospitals had implemented at least four of the five recommended practices for improving door-to-balloon time.[35] This implementation gap suggested a substantial opportunity to improve patient care, and the D2B Alliance provided a convenient sample for investigation of efforts to close the gap.

About 1,000 of the 1,400 U.S. hospitals with primary PCI capability enrolled in the D2B Alliance,[4] which offered a variety of learning activities to help hospitals implement five evidence-based practices for improving door-to-balloon time. Studies of D2B Alliance hospitals had focused on their structural characteristics,[35,44] reasons for joining the D2B Alliance,[44] perceived impact of the D2B Alliance on the hospital,[45] and whether enrollment was associated with significant improvement in door-to-balloon times.[46] Little attention had been devoted to examining whether and how hospitals' organizational behaviors contributed to the implementation of the evidence-based practices recommended by the Alliance and, ultimately, door-to balloon time. We used qualitative data (for Aim 1) and quantitative data (for Aims 2 and 3) collected on D2B Alliance hospitals' behaviors.

Participants in Qualitative Study for Aim 1

As recommended by experts in qualitative research,[47,48] we selected hospitals sites using purposeful sampling to ensure adequate diversity among sites. We began with all hospitals (n=975) that enrolled with the D2B Alliance by June 2007 and had reported door-to-balloon time for at least 10 cases of STEMI to Health Quality Alliance (HQA) during the most recent 6 months (July–December 2006). From this sample, we chose hospitals that reported that they had implemented none or only one of four recommended strategies at enrollment (n=190). Of these 190, we excluded hospitals (n=32) that already had achieved the D2B Alliance goal of 75% of door-to-balloon times within 90 minutes, because we were interested in hospitals that had a performance gap and therefore were more likely to have pursued the implementation of the recommended practices. We stratified the remaining 158 hospitals into those with lower baseline performance (i.e., below median performance in percent of cases having door-to-balloon time within 90 minutes) and those with above-median baseline performance. We then randomized the stratified lists. Proceeding in order of randomization, we conducted telephone interviews to identify hospitals in each baseline performance stratum that reported the D2B Alliance as having low impact versus high impact on their practices. Our classifications were based on a qualitative evaluation of the extent to which respondents attributed changes at the hospital to the D2B Alliance. We purposefully sampled hospitals that reported low and high impact, because the goal of the first phase of research on the D2B Alliance (completed prior to this project) was to understand the impact of a national campaign in promoting the implementation of evidence-based practices. The characteristics of the hospitals selected for site visits and inclusion in the qualitative studies are presented in Table 1.

Table 1. Characteristics of Hospitals in the Qualitative Study

ID	Location	Number of Beds	Teaching Hospital	Practices Implemented at		% of cases ≤ 90 min		Perceived D2B Alliance Impact
				Baseline	Follow-up	Baseline	Follow-up	
1	West	>700	No	1	2	0-45%	70-74%	Low
2	Northeast	400-700	Yes	1	2	45-59%	> 75%	Low
3	South	400-700	Yes	1	2	45-59%	> 75%	Low
4	Northeast	>700	Yes	1	0	45-59%	70-74%	Low
5	West	400-700	No	1	2	60-75%	> 75%	Low
6	Northeast	<400	No	1	1	60-75%	> 75%	Low
7	South	>700	Yes	1	3	0-45%	> 75%	High
8	Midwest	400-700	No	0	3	0-45%	> 75%	High
9	South	400-700	No	1	3	0-45%	70-74%	High
10	South	<400	No	1	2	45-59%	> 75%	High
11	Northeast	400-700	Yes	1	1	60-75%	> 75%	High
12	Midwest	400-700	Yes	1	4	60-75%	> 75%	High

Baseline performance based on Hospital Quality Alliance data from July 1, 2006, to December 31, 2006
Follow-up performance based on Hospital Quality Alliance data from July 1, 2007, to June 30, 2008

Although we present information on hospitals' implementation of recommended practices and door-to-balloon times approximately 1 year after their enrollment in the D2B Alliance in the table, hospitals were not selected based on these characteristics. Hospitals were added to the sample until no new concepts emerged from our visits and interviews (i.e., until theoretical saturation occurred).[47,49] This occurred after 12 visits and 99 interviews.

The 99 interviewees included clinical and administrative staff identified by the D2B Alliance hospital contact person as relevant to the hospital's door-to-balloon improvement efforts, including:

- cardiologists (N=15)
- emergency medicine physicians (N=10)
- nurse/technicians in the catheterization laboratory (N=15)
- cardiology department staff (N=12)
- emergency department staff (N=11)
- quality improvement staff (N=9)
- emergency medical services paramedics and team members (N=8)
- middle- and senior-level administrators (N=19).

Participants in Quantitative Studies for Aims 2 and 3

We conducted longitudinal, cohort studies of 517 hospitals that enrolled in the D2B Alliance to assess support for our hypotheses developed in relation to Aims 2 and 3. The 517 hospitals were a subset of the 915 hospitals that enrolled in the network during its first 6 months (November 2006–May 2007) for which we were able to obtain complete information about our variables of interest. The sample for analyses related to implementation (Aim 2) consisted of hospitals that provided data on their implementation of practices recommended by D2B Alliance via two surveys described in the Methods section below. Of the 715 hospitals that completed both surveys, we excluded hospitals that did not meet the volume criterion of at least 12 cases of STEMI annually during the study period (N=174), resulting in 541 eligible hospitals. Of these, we dropped 24 hospitals that were missing either data on key hospital characteristics (e.g., teaching status) (N=8) from the American Hospital Association Annual Hospital Survey or annual volume data in the HospitalCompare dataset compiled by the Hospital Quality Alliance (N=16). We applied the minimum volume criterion to capture hospitals with sufficient volume to be motivated to pursue implementation of the recommended practices.

With inclusion criteria satisfied, the final sample for our quantitative study related to Aim 2 was 517 hospitals (96% of hospitals eligible for our study and 72% of 715 hospitals that completed the surveys).

The final sample for the quantitative study related to Aim 3 was 504 hospitals, 13 hospitals fewer than the sample for Aim 2. Thirteen hospitals were excluded because longitudinal data (2006-2010) on their clinical performance improvement, required for Aim 3's analysis, was missing.

5. Methods (Study Design, Data Sources/Collection, Interventions, Measures, Limitations)

Methods for Aim 1: Qualitative Study of Implementation Leaders' Behaviors

Study Design

We chose a qualitative study design to accomplish Aim 1 for two reasons. First, although research had suggested that leader behavior influences a hospital's ability to implement new practices successfully, few studies had sought to identify the specific behaviors of implementation leaders that contribute to implementation and the mechanisms by which their behaviors contribute to implementation. Qualitative research is an ideal approach to investigation when existing research is limited.[48,50] It often generates hypotheses that can be tested subsequently in quantitative studies.[48,50] Second, we selected qualitative methods because we suspected that some relevant attributes of leader behavior and their relationship to other attributes would be complex and therefore difficult to measure. Qualitative research enables the investigator to develop characterizations of complex attributes and relationships through descriptive analysis of events in the environment.[51]

Data Collection

Data was collected via in-depth interviews with clinical and administrative staff (N=99) during 12 hospital site visits from December 2007 to October 2008. Teams of two to three interviewers visited each hospital and conducted interviews using a standardized interview guide. Interviewees were asked to share their hospital's implementation story for one of the evidence-based practices for which he or she was familiar via a global question: "How has the hospital approached the implementation of [named practice]?" Following their response, if not addressed, interviewees were asked to discuss the implementation leader's management style and strategies; who was involved in the effort as well as when and why; how the rollout to all staff occurred; challenges and obstacles encountered; and how, if at all, obstacles were overcome. We also asked questions about improvement efforts related to door-to-balloon performance generally. Sample questions included "Can you tell us more about the efforts here to reduce door-to-balloon time and how they came about?" and "Tell us what it is like to work in this hospital in general. How would you characterize the organizational culture, the way people interact, what it feels like to be in this organization?" We probed for information on communication patterns and challenges and facilitators to change. Although the questions in the guide did not ask explicitly about voice, they were such that interviewees readily spoke about voice as they responded and described hospitals' quality improvement efforts, allowing us to add a voice analysis to Aim 1, as described above.

Interviews with staff lasted 30-60 minutes. We use the term "staff" to capture individuals who worked at the hospitals, including managers, nurses, quality improvement specialists, physicians, and others, including physicians employed and not employed by the hospitals. Although individual interviews were most common, when requested by hospitals, interviews were conducted with groups of staff as organized by the hospital contact. Group interviews (median group size=2) occurred for 30% of interviews. The same interview guide was used for all interviews. To foster open conversation, the confidentiality and anonymity of participants beyond the room were assured at the start of each interview. Interviews were then recorded or handwritten based on the interviewee's preference. A transcriptionist transcribed all digital files. To ensure the accuracy of transcription, a sample of transcripts was checked against the recordings prior to data analysis. These transcripts were accurate.

Data Analysis

We used the constant comparative method[47] to code the transcribed interviews, conducting iterative comparison of the data from each site to data from other sites and to our code list in order to identify recurrent themes in the transcripts. In the first step of this analysis, two authors (the P.I. and a research assistant) independently reviewed 10 transcripts. They then met to discuss our understanding of the data and develop a preliminary set of codes for application to the transcripts. The coding framework was developed inductively, based on concepts that emerged from reviewing the transcripts. We then read the transcripts again and coded them using the framework. In the process, the code list was refined and definitions for codes were revised for greater precision. Transcripts were then re-reviewed with the most current code framework until no new concepts were apparent and the code list was considered final.

Once our code list was finalized, we sought to develop high coding reliability early by having three

authors (the P.I. and two research assistants) code 15 transcripts (five transcripts from three hospitals), compare their coding, and discuss the coding in-depth to reach common understanding. We then divided all remaining transcripts between all three authors for coding. Each transcript was coded by two authors (A and B or B and C). Differences in coding were few (9%, dividing the number of disagreements by total number of coded texts); they were resolved through discussion, as recommend by experts.[52] During analysis, we remained blind to hospitals' door-to-balloon performances.

All the coded transcripts were entered in ATLAS.ti (version 7) for additional analysis, at which point we also coded the profession of interviewees in order to facilitate subsequent analysis of data patterns by profession. We used the software to identify themes across sites (i.e., the concepts unifying the recurrent answers to our questions, as reflected by our codes and relationships between codes). ATLAS.ti allowed us to explore relationships between codes using the "Networks" functions in the software to identify co-occurring codes (e.g., factor coded with reason). Examining co-occurring codes allowed us to observe the inter-relatedness of codes/themes and derive the models that we present in our findings. We also used ATLAS.ti to identify exemplifying quotes for presented themes. Our findings did not vary markedly by hospital characteristics (e.g., baseline door-to-balloon performance, number of hospital beds, teaching status). Therefore, we present results across sites.

Limitations for Aim 1

We interviewed staff at hospitals that had a need for quality improvement and that had recently committed to improvement through their participation in the D2B Alliance at a time when there was national attention to improving door-to-balloon times. Although this sample and timing provided a rich context for our study (we knew that there were issues to voice due to the need for improvement, that there were clear evidence-based practices to be implemented, and that staff were primed to reflect on their voice in this context), these attributes raise questions about the generalizability of our findings to professionals working in hospitals with greater ambiguity about the need for improvement, with a more limited (group) improvement orientation, not in the midst of national efforts to improve, or focused on implementing practices on improving care for conditions other than STEMI. Conducting this research in other contexts is an important next step for understanding the extent to which our findings are broadly applicable.

Additionally, our study should be replicated because, although we used interview data collected during implementation to capture information about leader behavior without relying on memory, our data are still subject to recall bias. Additional behaviors may have been missed. As recall is driven by salience, our data reflect those events that most affected implementation, from the participants' perspective, which was our concern. Still, future research should document leader behavior using real-time observation.

Methods for Aim 2: Study of Engaging Different Segments of the Workforce/Organizational Groups and Implementation Outcome

Study Design

We conducted a longitudinal (3-year; 2006-2008) study of 517 hospitals that enrolled in the D2B Alliance to assess support for four hypotheses about the extent to which (access to) three organizational groups–frontline staff, management, and network–facilitate the implementation of evidence-based practices. In our study, we introduce the distinction between role-changing practices (innovations), altering what workers do, and time-changing practices (innovations), altering when tasks are performed or for how long. Our study was designed to test hypotheses about the (relative) effect of factors that grant access to our focal groups on implementation of these two innovation types. We focus on organizations' access because access is the foundation for leveraging groups' potential contribution via their engagement. We specifically focus on access as indicated by improvement team representativeness (i.e., team consists of affected staff groups), senior management engagement, and network membership. Each has been promoted as important for implementation, but past work has produced mixed results for them, suggesting the need for greater analysis of each group's role in implementation. Our tested hypotheses about their effects were:

Hypothesis 1: Team representativeness (of affected staff) has a more positive association with the implementation of role-changing innovations than senior management engagement does.

Hypothesis 2: Senior management engagement has a more positive association with the implementation of time-changing innovations than improvement team representativeness does.

Hypothesis 3a. Network membership and implementation team representativeness interact positively with respect to implementation of role-changing innovations.

Hypothesis 3b. Network membership is more (or less) positively associated with implementation of time-changing innovations when there is less (or more) senior management engagement.

Data Sources/Collection

D2B Alliance Follow-up Survey. Upon enrollment in the D2B Alliance (November 2006-May 2007), sample hospitals were invited to complete the D2B Alliance baseline survey. Approximately 10-12 months after answering the baseline survey (February 2008-June 2008), they were sent the D2B Alliance follow-up survey. Both surveys assessed implementation of the five evidence-based practices for timely treatment of STEMI, allowing us to examine change in (implementation of) practices; the follow-up survey also assessed access to key segments of the workgroup/organizational groups (i.e., frontline staff via team representativeness and senior management via their engagement) and use of learning activities. Surveys were submitted electronically by the hospitals' contacts for the D2B Alliance, most often the director of quality improvement or his/her designee. Contacts were instructed to consult knowledgeable coworkers for information to complete survey questions accurately. Thus, the survey completion process was expected to involve multiple knowledgeable respondents even though a single survey was received from each hospital, which is a study design that has been used in high-impact, theory-generating organizational research to obtain organizational-level data from the most informed people across the organization.[53]

Hospital Quality Alliance (HQA)

The Hospital Quality Alliance (HQA), a collaboration of CMS and The Joint Commission, collects door-to-balloon time as one of its measures of quality care for patients with myocardial infarction from all U.S. hospitals participating in the Reporting Hospital Quality Data for Annual Payment Update and other HQA initiatives. For each hospital and each quarter, it calculates and publicly reports the percentage of door-to-balloon times that were within 90 minutes and the number of patients treated. HQA reports this data on the *HospitalCompare* website (www.HospitalCompare.hhs.gov) to "help consumers assess hospital quality and value and make informed decisions about their care." It also makes this data available for research. The advantage of this data is that it is nationally standardized and verified. Data are audited by the CMS Clinical Data Abstraction Centers, which abstracts and reanalyzes data from five charts per hospital per quarter.[54]

American Hospital Association Annual Survey of Hospitals

Data on hospital characteristics will be obtained from the American Hospital Association Annual Survey of Hospitals. This survey collects information on numerous structural characteristics for nearly 6,000 hospitals in the United States. For this research, we acquired information on each D2B Alliance hospital's geographic location, setting (urban/rural), size (number of staffed beds), teaching status (teaching hospital will be defined as one with a graduate medical training program according to the Council of Teaching Hospitals), ownership type (nonprofit, for-profit, governmental), and multi-hospital system affiliation.

Measures

Implementation of role-changing and time-changing innovations. In the D2B Alliance surveys, hospitals were asked whether they used each of five evidence-based practices for STEMI care: (1) emergency room physicians assume responsibility for ECG interpretation and activation of the cardiac catheterization laboratory (example used earlier); (2) paging staff notify the catheterization team of a new case via single call, shifting from multiple, individual pages; (3) emergency medical (ambulance) staff perform electrocardiograms and activate the catheterization laboratory while the patient travels to hospital; (4) catheterization team arrives at the laboratory within 30 minutes (time example used earlier); and (5) feedback is provided about delays in care within 1 week, reduced from longer (to prompt ongoing improvement). Each practice was presented as one option in multiple-choice questions about an issue in STEMI care (e.g., who activates the catheterization lab), with respondents instructed to select the option that "best describes" the protocol for handling the issue. To assess our belief that these practices separate into two groups (role versus time changing), based on observation and conversation with staff, we conducted an exploratory principal component (factor) analysis of the five practices at follow-up, using a promax rotation. Table 2 presents the results of our factor analysis. Two factors with eigenvalues greater than one emerged, explaining 46.93% of the variance. Using a cutoff of 0.50 for the loadings in the pattern matrix, three practices loaded uniquely on the first factor (eigenvalue=1.30), and two loaded uniquely on the second factor (eigenvalue=1.05). The three practices in the first factor–practices (1), (2), and (3) above–all involved a change in role for workers. Therefore, we labeled these three "role-changing innovations." The two practices in the second factor–practices (4) and (5)–had in common that they did not change workers' roles but changed the timing of their tasks. For both practices, tasks–arrival and use of data feedback–were to occur sooner. Thus, we labeled them "time-changing innovations." We measured hospitals' implementation of each type of innovation as the sum of the practices that each hospital had implemented in each category (range for role-changing innovations= 0-3; for time-changing ones=0-2). For completeness, we also calculated total innovations implemented by taking the sum of role- and time-changing innovations implemented (range=0-5), which allowed us to examine the effect of our independent variables on implementation of process innovations overall. By calculating sums, we follow previous studies of multiple innovations.[55-57] Practices were not weighted, as none was deemed more important than another; rather, all were recommended to achieve the guideline.

Table 2. Results of Factor Analysis of Process Innovations for Treatment of Heart Attack

Evidence-based practice	Role changing	Time changing	% of hospitals with practice at follow-up
Practice 1: shift responsibility for activating the cardiac catheterization laboratory/team from cardiologists to emergency physicians	**.675**	.163	62%
Practice 2: have paging staff notify the catheterization laboratory/team of new cases using a single call (vs. multiple individual pages)	**.645**	.071	37%
Practice 3: have emergency medical (ambulance) staff perform electrocardiograms and activate the catheterization laboratory/team while the patient is en route to the hospital	**.623**	-.259	46%
Practice 4: reduce the required arrival time to the catheterization laboratory for the catheterization team to within 30 minutes of being paged	-.029	**.699**	90%
Practice 5: reduce the time expectation for providing feedback about delays in care to within 1 week (to prompt continuous improvement efforts)	.053	**.695**	78%

Improvement team representativeness. The extent to which the project team's composition reflected all roles that would be affected by implementation was assessed by the diversity of relevant professional roles present on the hospital's improvement team. We assessed the presence of hospital staff serving in at least 11 roles that can affect door-to-balloon time: interventional cardiologist, non-interventional cardiologist, emergency medicine physician, emergency medicine nurse manager, emergency medicine nurse, catheterization lab nurse manager, catheterization lab nurse, catheterization lab technologist, quality management, data management staff, and emergency medical services personnel. In the D2B Alliance follow-up survey, hospitals indicated whether their improvement team included individuals from each of the 11 roles (for each role: 1=yes; 0=no). Using these data, we created a count variable to indicate the total number of roles represented on each hospital's team (scale: 0-11). This variable captured the extent to which affected professions had a representative involved in discussions about implementation.

Senior management engagement. This factor was assessed using survey respondents' reported level of agreement with three survey items adapted from Klein et al.'s [58] management support scale: "Hospital senior management has pushed to make efforts to improve door-to-balloon time a success," "Hospital senior management takes an active interest in the problems and successes of the D2B efforts," and "Hospital senior management is strongly committed to the implementation of D2B Alliance strategies." Agreement was reported on a five-point scale (1=strongly disagree; 5=strongly agree) for each item in the D2B follow-up survey. Cronbach's alpha for this scale was 0.82.

Network membership. A central network for hospitals seeking to implement the focal practices was the D2B Alliance. As hospitals in our sample were all members, we used a measure that captured length of membership: hospitals' tenure in the D2B Alliance, calculated as the number of days between hospital enrollment and the last date that a hospital in our sample enrolled (June 11, 2007). The more days enrolled, the longer the hospital's access to the influence of this national network.

Covariates. We included two categories of covariates in our analyses. The first consisted of hospital characteristics obtained from the American Hospital Association Annual Survey of Hospitals, including hospital size, teaching status, ownership type, and geographic location. As is common in studies, we used a series of dummy variables to indicate hospital size based on number of beds (< 300, 300-499, or > 500 beds), teaching status (does or does not have a residency program according to the Accreditation Commission for Graduate Medical Education), ownership type (public/government, for-profit, or not-for-profit), and geographic location based on the U.S. Census Bureau's state-region classification system (region 1=Northeast, 2=Midwest, 3=South, 4=West).

The second category of covariates related to hospitals' baseline/learned performance, with respect to practice implementation and treatment time. To address change in implementation and prior learning, we adjusted for the total number of role- and time-changing practices at baseline and the hospitals' door-to-balloon time performances in 2006, the year before the D2BAlliance/network began. Additionally, because hospitals with greater patient volume may have more chances to learn and incentive to implement, we included the number of patients with STEMI that the hospital treated in the year preceding the Alliance's launch, as reported on HospitalCompare; this baseline number was highly correlated with volume in later years ($p<0.001$), so we only included the starting year.

Data Analysis

We tested our hypotheses using a series of ordinal logistic regression models estimated with robust standard errors, which were calculated using the Huber/White/sandwich estimator of variance in Stata/SE 11.0. We used this type of regression because our dependent variables (implementation of role-changing practices or implementation of time-changing practices) were ordinal (i.e., categorical and ordered; practice is fewer than two practices, etc.). We considered Poisson and negative binomial models as well, because our dependent variables were also count variables, but we did not pursue these models as our primary approach, because the means of our dependent variables did not equal their variances and because our data were not overdispersed, the basis for Poisson and negative binomial models, respectively.[59] We used these models to examine the consistency of our results, however, and found that results were consistent across approaches, which provided reassurance.

We created two sets of models for each of the two dependent variables (implementation of role-changing practices and implementation of time-changing practices). In the first model, we included our measures for

independent variables (team representativeness and senior management engagement) to assess the main and relative effects of these factors and support for Hypotheses 1 and 2. We began with these main effects models because we wished to show the effects of the two groups internal to the organization (staff and management), per Hypotheses 1 and 2, before introducing external group (network) effects. Presuming significant, positive effects for both factors, we planned to compare their effect sizes (relative benefit) using the lincom command in Stata.

In the second model for each dependent variable, we entered our measure for network membership and the hypothesized interaction term, which we computed as the product of network membership and either team representativeness (for Hypothesis 3a) or senior management engagement (for Hypothesis 3b). To reduce multicollinearity between the interaction term and its components and to facilitate interpretation of results, we standardized our variables before entering them in the models.[59] We examined the significance and direction of the coefficient for the interaction term to determine whether our hypotheses were supported. When the interaction was significant, we compared the effect of network membership on innovation implementation for hospitals that were high versus low (i.e., one standard deviation above versus below mean) on the relevant internal factor (e.g., senior management engagement).

For completeness and to examine the effect of our variables on implementation of process innovations overall, we then constructed a model that included all independent variables and interaction terms and "total practices implemented" as the dependent variable. In all models, we used standardized versions of our measures to facilitate comparison of effects originally measured on different scales and included covariates. To assess effects, we examined the proportional odds ratios (ORs) derived from our ordinal models. In our context, the interpretation of these ORs is that, for a one-unit change in the independent variable, the odds of being in the hospital group that implemented greater than *k* practices (e.g., more than 1 practice) versus the group that implemented less than or equal to *k* practices (e.g., hospitals with less than or equal to 1 practice) are the proportional odds times larger. ORs greater than 1 indicate greater odds of being in the higher implementation group, whereas ORs less than 1 indicate lower odds of being in that group.

Our analysis captures change in implementation, as we included the baseline number of practices as a covariate and the number of practices implemented at follow-up as the dependent variable. We included the baseline number for the focal practice type in the model (role or time changing) as well as the baseline number for the alternate type, summed to create "total practices at baseline." Our results were consistent when we did not adjust for the baseline number of the alternate practice type and when we included change in alternate type. We present results from models including number of both baseline practices (the total) as a covariate, because the starting point across practices logically affects implementation (via momentum, for example). We also wanted to keep variables consistent across models, allowing for direct comparison of associations with role- and time-changing practices.

Limitations

All study hospitals were members of the D2B Alliance, which was convenient given our interest in network membership. However, research has found that hospitals in learning networks differ from nonenrolled hospitals by being nonprofit, larger, and teaching institutions,[44] and senior management engagement was high in our sample (M=4.4/5), raising the question of whether our results generalize to hospitals not in an alliance. Comparison of covariates of sample hospitals to the larger population in HospitalCompare showed similarity ($p>0.10$); we included covariates in models to account for possible differences, and past work showed no difference in practice implementation between groups.[60] Still, we cannot claim generalizability. Our sample may have been more motivated than a random sample. Our study should be replicated using other samples, as results may differ. Ideally, replications of this work will use a verifiable multiple-informant/multiple-source approach to validate implementation (and depth of), team representativeness, and senior management engagement. Our single-survey approach with multiple-choice questions to assess implementation allowed for data collection from a large number of hospitals while minimizing social desirability bias[61]; the multi-item scale used for management engagement was reliable in this sample (Cronbach's alpha=0.82), and we found effects using this approach. Thus, our methods are acceptable, particularly for a first test of new theory (Huselid & Becker 2000). Still, lack of additional informants and objective data prevents us from confirming the validity of the assessment.

Methods for Aim 3: Longitudinal Study of the Relationship Between Learning Activities and Clinical Performance Improvement

Study Design

We conducted a longitudinal study (5-year study; 2006-2010) of the effect on clinical quality improvement of two common but distinct approaches to organizational learning: importing best practices (an externally oriented approach rooted in learning by imitating others' best practices) and internal creative problem solving (an internally oriented approach rooted in learning by experimenting with self-generated solutions). This study was designed to test our proposition that independent and interaction effects of these approaches depend on where organizations are in their improvement journey—initial push or later phase. The initial push is when organizations are launching (or renewing) their improvement effort with the intent of achieving significant improvement relative to current performance, and the later phase is when organizations are nearing the performance goal and/or improving past it.

Data Sources/Collection

The data sources for this study were the same as those used to achieve Aim 2, with one addition. We added data on hospital financial health from the American Hospital Directory (AHD)®, which provides data for more than 6,000 hospitals nationwide via its profiles of U.S. hospitals. AHD derives its information from both public and private sources, such as Medicare claims data, hospital cost reports, and commercial licensors.

Measures

Importing best practices. For each hospital, we calculated the sum of the D2B-recommended practices that the hospitals reported using at baseline and follow-up (i.e., the sum of role-and time-changing practices studied in Aim 2). We then subtracted the baseline from the follow-up sum and used this number as our measure of importing best practices.

Internal creative problem solving. We assessed whether hospitals utilized creative problem solving to develop new practices internally by their responses to four questions in the D2B Alliance follow-up survey. The questions asked whether hospitals engaged in each step of the process during their project and emphasized the use of the process for internally generated solutions–as opposed to adapting imported practices. Specifically, the survey asked whether the hospital (1) used root cause analysis or some similar approach to investigate delays in door-to-balloon times when they occur (problem identification and root cause analysis); (2) came up with new ideas about how to reduce door-to-balloon time that were not part of the D2B Alliance recommendations (solution development); (3) experimented with ways to reduce door-to-balloon time that were not suggested by the D2B Alliance or its member hospitals (solution evaluation); and (4) worked on implementing strategies for reducing door-to-balloon time that were not recommended by the D2B Alliance (solution implementation). We summed positive responses across questions to create a score ranging from 0 (completed no steps in the process) to 4 (completed all steps). Because we and prior research conceptualize the process as requiring all four steps, we created an indicator variable to differentiate hospitals that fully adopted creative problem solving (1=hospital completed all steps; 0=otherwise). We used this measure in our analyses and used the continuous measure (0-4) in sensitivity analysis.

Initial-phase improvement. As noted above, the HQA database reports the percentage of each hospital's patients for whom door-to-balloon time satisfied the national guideline (i.e., within 90 minutes). For our measure of initial improvement, we used hospitals' changes in door-to-balloon time performance (i.e., change in percentage of patients that received treatment within the national guideline of 90 minutes between hospital arrival and opening of the coronary artery) between our baseline and initial follow-up periods (2006 and 2008). We selected 2008 (July 2008-June 2009),as our initial follow-up period, because (1) prior research has shown that more than a year is required to detect the effects of interventions on core measures in hospitals[62]; (2) the D2B Alliance (which began in earnest in 2007) ended in 2008, making 2008 a natural period for first evaluation after the initial push (organizers expected sizable improvement by then); and (3) the use of earlier time periods would have resulted in the loss of 400 hospitals (43%) from our survey sample due to missing performance data from HQA.

Later-phase improvement. To compute this measure, we again calculated hospitals' changes in door-to-balloon time performance but defined the focal period as 2008 to 2010. We used 2010 as the later-phase follow-up period, because we desired a meaningful endpoint for the improvement phase. By 2010, the U.S. hospital average percent of patients treated within guideline was 92%, up from 44% in 2006,[63] suggesting that 2010 was an appropriate final year. After 2010, virtually all U.S. hospitals had shifted from improving to sustaining their gains.

Covariates. We adjusted for the same hospital characteristics used for analysis for Aim 2 (teaching status, hospital size, geographic location, and ownership type) and added financial health. Financial health was measured by net income at baseline, which we normalized by taking the natural log of values once positively transformed; the original distribution suffered from excess peakedness (kurtosis=28). Because statistical research on performance changes indicates that change correlates with initial status,[64] and because we wished to assess added effects of our focal approaches, we adjusted for hospitals' baseline (2006 for 2008 analysis and 2008 for 2010 analysis) door-to-balloon performances. We also adjusted for hospitals' 2006 use of best practices and the number of patients with STEMI that the hospital treated in the follow-up periods, because research shows that higher patient volume is associated with better performance.[65] Last, we included performance review by management as a covariate, because managers' vigilance can motivate workers to achieve performance goals.[66] Hospitals reported the frequency with which management reviewed door-to-balloon times in the follow-up survey using the following response scale: monthly, quarterly, annually, not at all, and other. We coded "not at all" responses as 0 and other responses, which indicated that review occurred at some regular interval, as 1.

Data Analysis

We tested our hypotheses using linear regression models estimated with robust standard errors. In our first model for each dependent variable (i.e., initial-phase improvement and later-phase improvement), we included our measure for importing best practices and our measure of creative problem solving to assess the main effects of these two approaches. In the second model for each dependent variable, we entered the interaction term, which we computed as the product of our two focal variables. Following Aiken and West's [67] recommendation, we first mean-centered our measure for importing best practices to reduce the potential for multicollinearity between the interaction term and its components and to facilitate interpretation of results.[59] We examined the significance and direction of the coefficient for the interaction term to determine whether our hypotheses were supported. When the interaction term coefficient was significant, we examined the effect of importing best practices in the subgroup of hospitals that used creative problem solving and the subgroup that did not using separate models. To assess the robustness of our results, we examined whether results remained the same if we used the continuous measure of creative problem solving. All models included the covariates.

Limitations

The limitations of this research (i.e., inclusion of only D2B Alliance hospitals raising concern about generalizability to other hospitals and reliance on hospitals' own reports about their behavior submitted via a single survey/respondent) are the same as those for the study used to achieve Aim 2, as both studies relied on the same data set.

6. Results (Principal Findings, Outcomes, Discussion, Conclusions, Significance, Implications)

Principal findings related to Aim 1: Qualitative Study of Implementation Leaders' Behaviors
Much of implementation leaders' behaviors aim to address implementation challenges. In the first study from this research, we found that all implementation leaders experienced four challenges during practice implementation: interprofessional tensions, lack of staff engagement, competing demands, and dwindling momentum. The studied leaders, all of whose hospitals' ultimately experienced significant performance improvement, used multiple strategies to address each challenge. Three strategies per challenge were consistently identified as effective by leaders and staff (see Table 3). For each challenge, leaders used a combination of relational and structural strategies or used structural strategies alone. As beneficial as all the identified strategies were, our data suggested that some strategies came with risk. First, there is risk of overutilization. A second risk is relationship threat. A core decision in selecting strategies was whether to pursue a positive versus negative approach. Some strategies (e.g., recognizing effort to counter dwindling momentum) were seen as facilitating challenge management through positive mechanisms, whereas others facilitated through negative mechanisms (e.g., enforcing policy). Although both approaches were deemed effective, interviewees noted that negative approaches could undermine long-term relationships. Thus, implementation leaders need to be mindful of the short and long term and, relatedly, the project versus personal consequences, of strategies. Future research might examine handling of such tradeoffs.

Table 3. Implementation Challenges and Strategies Leaders Used to Overcome Them

Challenge	Strategies Leaders Used to Overcome Challenge*	Why Strategies Are Effective (elements creating a supportive context)
Interprofessional tensions	▪ Shared leadership (ST) ▪ Created integrative project teams (ST) ▪ Convened team meetings regularly (ST)	▪ Promoted understanding, respectful relationships and equality between groups
Lack of staff engagement	▪ Communicated purposefully and frequently (RE) ▪ Invited and appreciated staff feedback (RE) ▪ Created learning opportunities (ST)	▪ Increased belief in the value of the new practices and ability to implement them ▪ Provided an opportunity for shaping the implementation, creating a sense of ownership
Competing demands	▪ Prioritized tasks (ST) ▪ Specified and divided core functions within the team (ST) ▪ Used reminders (ST)	▪ Minimized individual demands and promoted implementation efficiency via divide-and-conquer approach ▪ Diminished effects of limited attention span
Dwindling momentum	▪ Utilized internal competition spurred by data-based feedback (ST) ▪ Enforced policy (ST) ▪ Recognized effort (RE)	▪ Fostered interest in continuous learning and improvement, and motivation overall ▪ Facilitated identification and removal of problems that stall implementation

* Strategies are listed with the challenge to which interviewees most strongly associated them. Some strategies were also mentioned as helping to overcome other challenges; for example, strategies for managing interprofessional tension also helped address staff engagement indirectly. ^ST indicates a strategy that instituted a structure, whereas RE indicates a strategy that instituted leader-staff relations or interpersonal interactions. Whether the strategy emphasized primarily structure or relations is noted; a strategy might leverage the other as well to a lesser degree.

Discussion and conclusions: How to overcome challenges to innovation implementation is a critical issue facing healthcare organizations and their implementation leaders, as many of their attempts to overcome challenges have failed, causing the quality-improving and/or cost-reducing benefits of many innovations to go realized. Use of the identified strategies may help implementation leaders to surmount common challenges to implementation of new practices. In selecting strategies, leaders should consider the challenge as challenges can require different strategies and some strategies carry risks. Although relational strategies can be helpful, strategies that involve structures may be foundational for overcoming the four challenges identified here.

Significance and implications: In our study, we attend not only to what implementation leaders did that worked but also why identified strategies were effective, from the perspective of leaders and staff. Beyond providing practical insight to help future implementation leaders achieve implementation goals, our results contribute to health services research on implementation by demonstrating the ability of implementation leaders' strategies/processes to serve as a challenge management strategy, not just a source of challenge.

Outcomes: This paper was presented at the 2014 AcademyHealth and Academy of Management meetings and is currently under review.

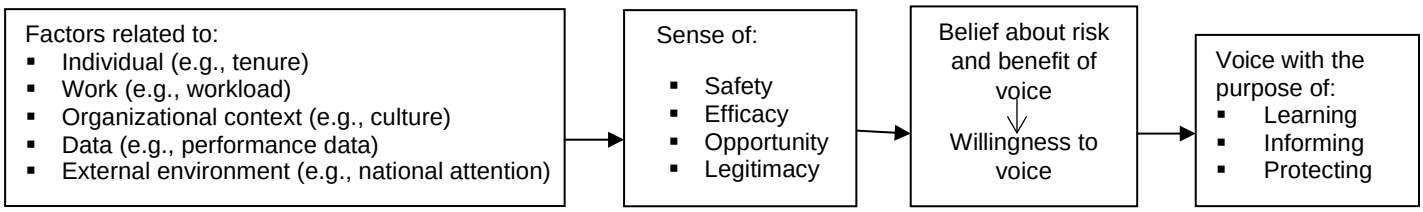
Principal findings related to Addition to Aim 1: Qualitative Study of Voice for Quality Improvement

A determinant of implementation project success that is often missing in healthcare organizations is staff voice (i.e., discretionary communication of ideas, suggestions, concerns, or opinions about work-related issues with the intent to improve organizational or unit functioning). In this study, we identified what factors influence staff voice, why these factors are influential, and the purposes for which staff use their voice. Specifically, we found that factors related to individuals (e.g., tenure), work (e.g., work configuration), organizational context (e.g., culture), data (e.g., benchmarking), and the external environment (e.g., attention) influenced health professionals' voices (see Table 4). These factors shaped heath professionals' sense of safety, efficacy, opportunity, and/or legitimacy, all of which affected their belief about the risk and benefit of voice and willingness to voice. They voiced for three purposes: to learn for themselves, inform others, and protect patients. Collectively, these findings result in a model of health professionals' voices depicted in Figure 2.

Table 4. Factors Influencing Health Professionals' Voice

Factors related to				
Individual	**Work**	**Organizational context**	**Data**	**External environment**
Tenure in profession or organization Profession Position (e.g., manager) Personality	Work configuration Workload	Leadership support Culture Structures supporting voice (e.g., policies)	Existence of: Own performance data Benchmarking data Guidelines based on data	National/external attention to topic

Figure 2. Derived Model of Health Professionals' Voices. Note that each construct, including the specific factors listed in Table 4, was a code in our analysis.



Discussion and conclusions: Our results indicate that hospitals and their leaders must attend to multiple factors if they wish to increase staff voice in service of quality improvement. The presence of many influential factors suggests that there are several levers that leaders can use to elicit voice, noting that voice can be used in multiple ways to facilitate improvement. One approach to increase voice is to attend to the factors identified in this study that are within leaders' domain–those related to work design, the organizational context, and data. A second approach, which can be combined with the first, is to target the motivations of health professionals (e.g., protecting patients).

Significance and implications: Our findings contribute to the literature on healthcare management in several ways. First, they advance research on what influences health professionals' decisions to voice. Prior work showed that individual attributes and leader behavior play a significant role[e.g., 68,69] and proposed that other factors are likely to be important in the decision-making process about voice, given the large unexplained variance in prior analytic models.[70] However, a more complete set of factors had yet to be identified empirically. Our study revealed not only that a multitude of factors are relevant but also that factors operate at multiple levels (individual, workgroup, organizational, and environmental) and simultaneously. Thus, future research should increase the number of factors (and levels) included to better reflect the complexity of the decision-making process related to voice.

Outcomes: A manuscript based on this work was published in *Health Care Management Review.* The findings were also presented at an annual meeting of AcademyHealth and the Academy of Management.

Principal findings related to Aim 2: Longitudinal Study of Engaging Different Segments of the Workforce/Organizational Groups and Implementation Outcome

We found that the benefit of accessing different organizational groups for implementing evidence-based practices depends on whether the practice is role changing or time changing for staff. Although team representativeness and network membership, which facilitated access to frontline staff and other organizations, respectively, were positively associated with implementing role-changing practices, senior management engagement, which opened access to senior managers, was not. In contrast, senior management engagement was positively associated with implementing time-changing practices, whereas team representativeness was not, and network membership was not unless there was limited management engagement. Figure 3 shows the found interaction between management engagement and network membership for time-changing practices.

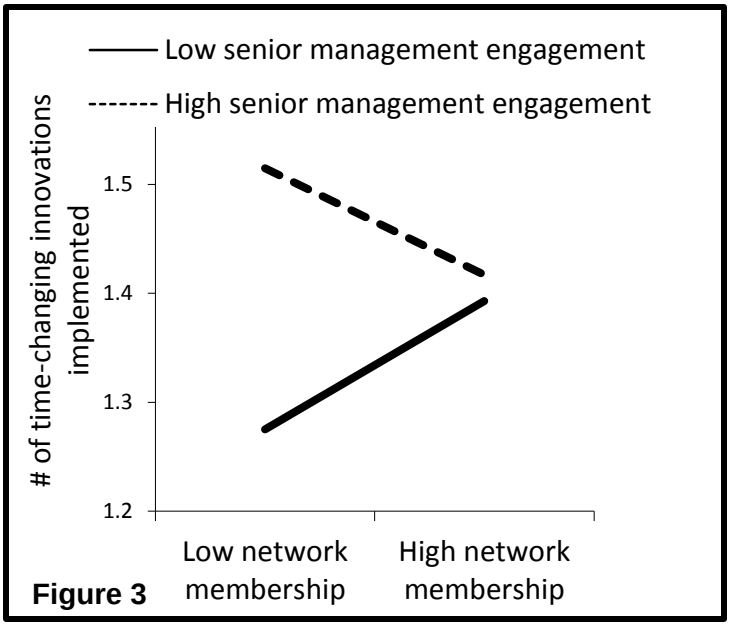


Figure 3

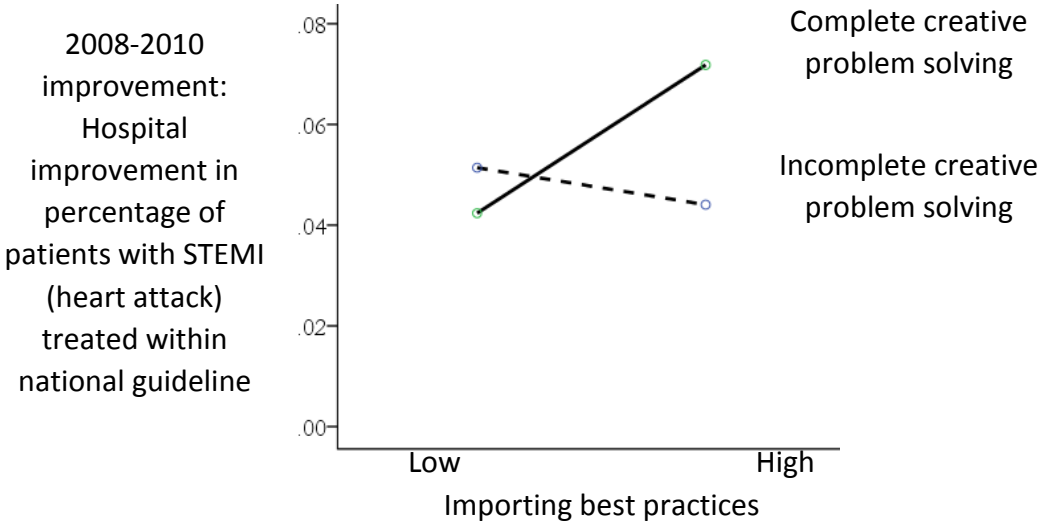
Discussion and conclusions: In this study, the first to differentiate innovations on the basis of their change for workers, we find evidence that supports our proposition that the effectiveness of factors that organizations might leverage for innovation implementation depends on the nature of the change for workers. Although it might be unsurprising that organizations with low management engagement and low network membership had the lowest level of implementation of time-changing innovations, it may be surprising that organizations with high management engagement and low network membership had the greatest implementation success (Figure). An explanation, given that it is also better to have high (versus low) network membership if there is low management engagement, is that these groups are (partial) substitutes: both groups may influence learning through the same mechanisms. That observation, along with our results, implies that implementation leaders do not need to devote effort to leveraging both. To implement time-changing innovations, they can enlist internal support (management) or external support (network), although our data indicate that cultivating managers' engagement should receive priority, because it is associated with greater implementation (likely because it is internal). Still, we advise against presuming that network membership has no value for those with highly engaged management that would join late. Later-joining organizations may benefit from the network's cumulative learning. Although we found no significant benefit of senior management engagement for role-changing innovations, we caution against assuming that it is unhelpful. It may be that engaged management supports the creation of a representative team. This is an important possibility, as it points to a way in which managers can support implementation of role-changing innovations: create a representative improvement team.

Significance and implications: In healthcare, innovations such as evidence-based practices are constantly being developed due to rapid advances in scientific and operational knowledge. In the past three decades, with the rising emphasis on reducing cost and improving quality of care, healthcare organizations and their workers have challenged themselves to implement various process innovations. Many have struggled, and studies indicated mixed value of leveraging various organizational factors. In this work, we provided an explanation for the mixed results in studies and practice: the nature of change for workers, whether the change is role changing or time changing for them, alters factors' effects on implementation. Given this finding with respect to three prominent organizational factors, both implementation research and practice would benefit from considering innovations' change for workers in selecting factors to study and leverage, respectively.

Outcomes: A manuscript describing this work is forthcoming in *Medical Care Research and Review.* The findings have been disseminated via presentations at the AcademyHealth Annual Meeting, Academy of Management Annual Meeting, Conference on the Science of Dissemination and Implementation (virtually), and several universities.

Principal findings related to Aim 3: Longitudinal Study of the Relationship Between Learning Activities and Clinical Performance Improvement

We found that importing (i.e., implementing) best practices helped hospitals achieve initial-phase but not later-phase improvement. Once hospitals enter the later phase of their efforts, significant improvement required creative problem solving as well. Together, our results suggest that importing best practices delivers greater short-term improvement, but continued improvement depends on creative problem solving. The positive interaction of learning strategies in the later phase of improvement is depicted in the figure below.



Note. When the interaction was examined the opposite way, assessing the effect of creative problem solving in the subgroup high on importing best practices (above mean) versus the low subgroup (below mean), the results were similar.

Discussion and conclusions: This work addressed a perplexing question: are some learning approaches more helpful during the initial push, while others are more helpful during the later phase, and are there tradeoffs or synergies between approaches depending on where organizations are in their improvement effort? These are central questions, because many organizations face resource constraints and the need to optimize learning investments to achieve both immediate and later goals. The benefit of learning approaches and combinations thereof likely varies across phases, because improvement needs change over time. However, research had not assessed the effectiveness of learning approaches at different stages of improvement. Without examination of the potential for different effects and for synergies or antagonisms among approaches, it remaied unknown how best to use learning activities to facilitate organizations' abilities to achieve and sustain high performance. Our results show when each is most helpful.

Significance and implications: The importance of importing best practices for realizing performance gains quickly suggests the value of organized efforts (e.g., D2B Alliance national campaign) to disseminate best practices. Thus, sponsors (government and private) of these efforts are advised to continue honing their dissemination strategies. Additionally, given our findings about the value of creative problem solving for multiplying later-phase improvement, sponsors may wish to broaden their role to include helping organizations to develop the capacity for creative problem solving and an appreciation for starting creative problem solving early, because its benefits are delayed. Only 31% of the hospitals in our sample engaged in every step of the process. The need to strengthen organizations' capacities for creative problem solving and importing best practices suggests that another key role for sponsors is helping organizations' improvement teams to appreciate and manage seemingly conflicting approaches to improvement, such as those we studied here.

Outcomes: A manuscript describing this study was published in *Medical Care Research and Review.* The findings were also disseminated via conference presentations (AcademyHealth Annual Meeting, Academy of Management Annual Meeting, and Industry Studies Association Conference) and presentations at several universities. This work received AcademyHealth's Best Abstract in the Science of Quality Improvement Award in 2012.

7. List of Publications and Products (Bibliography of Published Works and Electronic Resources from Study)

Related to research aims

1. **Nembhard IM**, Labao I, Savage S. Breaking the silence: Promoting voice for quality improvement in hospitals. *Health Care Manage Rev;* in press (e-pub: June 4, 2014).
2. **Nembhard IM,** Cherian P, Bradley EH. Deliberate learning in health care: How importing best practices and internal problem solving affect performance. *Med Care Res Rev* 2014; 71(5): 450-471.
3. **Nembhard IM,** Morrow C, Bradley EH. Implementing role-changing versus time-changing innovations in healthcare: differences in helpfulness of staff improvement teams, management, and network. *Med Care Res Rev*; in press.
4. **Nembhard IM**, Savage S, Labao I. Overcoming implementation challenges in hospitals: a qualitative study of what project leaders do. Under review

Related to implementation of evidence-based practices, organizational learning as an implementation strategy, and quality improvement, completed in collaborations per Career Development Plan

1. Yuan CT,* Bradley EH, **Nembhard IM.** A mixed methods study of how clinician 'super users' influence others during the implementation of electronic health records. *BMC Med Inform Decis Making* 2015; 15(1): 26.
2. Lee Y.,* Stone PW, Pogorzelska-Maziarz M, **Nembhard IM.** Differences in work environment for staff as an explanation for variation in central line bundle compliance in ICUs. Under review.
3. Pogorzelska-Maziarz M, **Nembhard IM,** Schnall R, Nelson S, Stone PW. Psychometric evaluation of an climate for quality instrument in a sample of infection preventionists. *Am J Med Qual* 2015; in press.
4. **Nembhard IM**. All teach, all learn, all improve? The effect of interorganizational learning on performance improvement. *Health Care Manage Rev* 2012; 37(2): 154-164.
5. Lapre MA, **Nembhard IM.** Inside the organizational learning curve: Understanding the organizational learning process*. Found Trends: Tech Inform Oper Manage* 2010, 4(1), 1-103.
6. **Nembhard IM**, Northrup VS,* Shaller D, Cleary PD. Improving organizational climate for quality and quality of care: Does membership in a collaborative help? *Med Care* 2012; 50 (Suppl): S74–S82.
7. **Nembhard IM**, Yuan CT,* Northrup VS,* Cleary PD. The relationship between voice climate and timeliness of care in primary care clinics. *Health Care Manage Rev* 2015; 40(2): 104-115.
8. Valentine MA*, **Nembhard IM**, Edmondson AC. Measuring teamwork in health care settings: A review of survey instruments. *Med Care* 2015; 53(4): e16-e30.

* Indicates a doctoral student

Inclusion of Women and Minorities (AHRQ Priority Populations)

No attempt was made to purposefully sample women and minorities, because the focus of the study was on whether and how aspects of hospitals' organizational behavior work together to influence the implementation success of new practices and clinical performance. Thus, the units of analysis were hospital implementation leaders (Aim 1) and the hospitals themselves (Aims 2 and 3). For Aim 1, we interviewed the hospital's implementation leaders and staff relevant to the implementation of recommended practices for improving door-to-balloon time, irrespective of their gender, race, and ethnicity. No individual was excluded on the basis of gender, race, or ethnicity, and no hospital was excluded on the basis of the demographic composition of its staff or patient population, which was unknown to us. Of the 99 individuals that we interviewed, 51 (52%) were female. As indicated in the enrollment table (Table 5) below, the race and ethnicity of our interviewees are unknown. We did not ask interviewees to disclose their race and ethnicity, because that information was not critical to our understanding of the implementation of new practices. For Aims 2 and 3, the inclusion of women and minorities is not relevant, because the unit of analysis was the hospital.

Table 5. Enrollment for Aim 1

TARGETED/PLANNED ENROLLMENT: Number of Subjects			
Ethnic Category	**Sex/Gender**		
	Females	**Males**	**Total**
Hispanic or Latino	unknown	unknown	unknown
Not Hispanic or Latino	unknown	unknown	unknown
Ethnic Category: Total of All Subjects *	51	48	99
Racial Categories			
American Indian/Alaska Native	unknown	unknown	unknown
Asian	unknown	unknown	unknown
Native Hawaiian or Other Pacific Islander	unknown	unknown	unknown
Black or African American	unknown	unknown	unknown
White	unknown	unknown	unknown
Racial Categories: Total of All Subjects *	51	48	99

* The "Ethnic Category: Total of All Subjects" must be equal to the "Racial Categories: Total of All Subjects."

Inclusion of Children

No children are included in this study, because the clinical performance measure for this research, door-to-balloon time for patients with STEMI treated with primary PCI, is collected only for adult patients by the Hospital Quality Alliance. This is because children with STEMI treated with primary PCI are rare. They were less than 1% of the sample of patients with STEMI treated with primary PCI in American College of Cardiology National Cardiovascular Data Registry for 2005-2006.[71]

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