AHRQ Grant Final Progress Report

Contextual Factors Associated with Implementation Effectiveness within a Quality Improvement Collaborative

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Structured Abstract

Purpose

To explore sources of variation in implementation of recommended clinical practices within a hospital-based Quality Improvement Collaborative (QIC) and to evaluate its impact on changes in hospital complication and risk-adjusted mortality rates.

Scope

QICs are a common method for organizing improvement efforts at hospitals, yet there is a critical need to understand the value of QICs and why some hospitals are more successful than others at reaping their benefits.

Methods

Surveys were administered to key hospital personnel to assess how perceptions of collaborative-recommended clinical practices, together with hospital implementation climate and strategies, influence implementation of these practices.

Results

Results indicate that using data to guide implementation and the perception of clinical practices as easily piloted contribute to higher implementation of recommended practices within a QI collaborative.

In models comparing trends in risk-standardized mortality among QIC participant hospitals versus nonparticipants, we found that participant hospitals tended to show a greater rate of decrease in the period leading up to the start of the collaborative but that their rate of decrease slowed, though the rate picked up among nonparticipants. By the end of the study period, there was no significant difference in overall risk-standardized mortality.

Key Words: Quality improvement, collaboratives, hospital mortality, complications

Purpose

The primary aim of this study was to investigate the sources of variation in the implementation of recommended clinical practices within Premier's QUEST collaborative, a large collaborative that aims to improve hospital performance across multiple domains of quality, and to better understand the contextual factors and strategies that enable some hospitals to excel within such collaboratives. The study also aimed to examine the association between the implementation of recommended clinical practices and the hospital's change in complication and risk-adjusted mortality rates and to evaluate the impact of the QUEST collaborative on changes in hospital complication and risk-adjusted mortality rates. Ultimately the study aimed to provide actionable information to current and future collaborative participants and organizers and to increase the effectiveness of quality improvement efforts.

Scope

Background and Context

The need to improve the quality and safety of hospital care in the United States is well recognized. Quality Improvement Collaboratives (QICs), in which multidisciplinary teams from different hospitals unite around a common improvement goal, are a popular method for accelerating improvement efforts, both in the United States and abroad. Working collaboratively, hospitals share knowledge about methods to translate clinical innovations into routine practice. Although collaboratives make intuitive sense, they are costly to carry out, and evidence of their benefit is limited. Most significantly, little is known about the sources of performance variation among hospitals participating in the same collaborative or about the strategies that participants can engage in to increase the likelihood that they will be successful. More than simply knowing whether, on average, hospitals that participate in a QIC achieve greater improvements in care than those who do not, there is a critical need to understand why some hospitals are more successful than others at implementing recommended practices and reaping their benefits.

The primary aim of this study was to investigate the sources of variation in the implementation of recommended clinical practices by collaborative participants. To accomplish this we surveyed clinical and administrative leaders at QUEST hospitals in order to assess how perceptions of collaborative-recommended clinical practices, together with the hospital implementation climate and strategies, influence the chances of successful implementation of collaborative recommended practices. We then examined the association between the implementation of recommended clinical practices and change in complication and mortality rates at participating hospitals. Finally, we conducted a rigorous evaluation of the overall impact of the collaborative by examining changes in complication and risk-adjusted mortality rates over time at participating and nonparticipating hospitals.

Settings

In 2008, The Premier healthcare alliance launched *QUEST*, a 3-year collaborative that enrolled

more than 160 hospitals from a network of more than 550 hospitals nationwide. QUEST aimed to improve hospital performance across multiple domains of quality, including increasing adherence to evidence based care, reducing costs, improving patient satisfaction, and decreasing rates of complications. One of the most ambitious goals of the QUEST collaborative was to reduce risk-adjusted hospital mortality rates. To accomplish this, collaborative participants attempted to implement more than a dozen clinical practices, ranging from "sepsis bundles" to rapid response teams, intended to improve survival for patients with high-risk clinical conditions like sepsis and respiratory failure.

Participants

Premier enrolled 150 charter member hospitals into QUEST from across its network. For the purpose of this study, Premier sent Letters of Participation to all charter members asking for their participation in this study. Of these charter members, signed letters of participation were obtained from 74 hospitals. QI Directors from all 74 participating hospitals, as well as 402 clinical and administrative leaders at these hospitals, participated in the study by completing an online survey. One survey was intended for the QI Directors, and the other was intended for clinical and administrative leaders. Surveys were sent to 590 clinical leaders at the 74 participating hospitals, with all 74 QI Directors completing the study (100%) and 402 (68%) completing the survey; at least one clinical leader survey was returned from 64 (86%) of the 74 hospitals.

Methods

Study Design

A repeated measures design was used to assess impact of hospital characteristics and practices on change over time in hospital-level risk-adjusted mortality and complication rates among collaborative participants as well as to compare change over time among participants relative to nonparticipating hospitals.

Data Sources/Collection

Self-administered online surveys were sent to selected employees at hospitals participating in the collaborative. There were 74 participating hospitals. Of the 150 hospitals in the QUEST charter group, we were able to get letters of participation from 74 hospitals. These letters of participation were necessary before we at Baystate were able to contact anyone at the hospital regarding the study. Surveys were sent to all 74 QI Directors at these participating hospitals, with all 74 completing the survey. Clinical and administrative leaders were identified at these 74 hospitals, and up to 10 at each hospital were sent the clinical and administrative survey. Ultimately, 590 surveys were set to clinical and administrative leaders. Of these, 402 completed the survey.

One survey was intended for Quality Improvement Directors at QUEST-participating hospitals; the other survey was intended for key clinical and administrative personnel. The QI Directors survey consisted of 11 sections with answers on 4-point Likert scales and "Agree" or "Disagree" answers. The survey included a section asking questions on the hospital's participation the QUEST collaborative activities; a section asking about the hospital's focus on mortality and harm reduction; and nine sections, each a specific clinical practice, with questions on the level of implementation of that practice and questions concerning implementation of these specific clinical practices. Each section asked about the level of implementation of the practice, and six questions were on a 4-point Likert scale.

De-identified patient-level data on observed and risk-adjusted mortality and complications were obtained from Premier for the QUEST hospitals, along with other hospitals participating in the Premier database but not participating in the QUEST collaborative (non-QUEST hospitals). These data spanned the 2 years prior to the initiation of QUEST (2006-07) and continued through the initial QUEST period (2008-11). In addition, Premier provided data from their Performance Excellence Assessment Tool (PEAT), along with data from the American Hospital Association annual survey for 2008 (start of collaborative), on hospital characteristics, including bed size, urban/rural location, teaching status, FTE staffing of nurses, hospitalists and intensivists, electronic medical record status, palliative care programs, and financial measures.

Measures

Data **on implementation strategies**, **degree of implementation**, and **perceptions of clinical practices** were developed from the surveys. To create and evaluate summary scales from the survey items, we first defined sets of questions that were directed at key items in our conceptual models. We then evaluated each set of items to determine the appropriate subset aimed at the desired concept via examination of:

1. Distribution of responses – Is there variability in responses across hospitals? Is this item useful?
2. Pairwise association: evaluate % agreement – Do two questions provide the same information, or additional information?
3. Correlation within set of items – Kendall's tau-b – Are the set of responses in general agreement?
4. Cronbach's alpha – measure of internal consistency – Are questions aimed at same concept?
5. Principal Components Analysis – evaluate inclusion and relative weighting of items – e.g., Is a simple sum (or mean) appropriate, or should there be different weighting of the items?

Using this process, we created the following scales from our survey items:

Implementation strategies (from QI director survey) for overall mortality reduction

- setting goals
- champions/sponsors
- institutional support
- appropriate documentation/coding
- using data to guide improvement
- QUEST specific:
    - Participation in collaborative activities
    - Use of online performance data
    - Mentoring one on one

Similar summary scales were developed for each of the nine specific clinical practices.

Implementation of Clinical Practices (from the QI director survey)

- Progress toward implementation
- % of eligible patients served

Perceptions/Innovations Value Fit of recommended clinical practice (from the Hospital Leaders survey). For overall mortality reduction, we developed a summary scale for each aspect across the nine clinical practices. We also developed a summary score for each clinical practice.

- Good evidence to support practice: relative advantage
- Fit well into work flow: compatibility
- Complex to implement: complexity
- Benefits easy to determine: observability
- Easily piloted: trialability

Data on **hospital climate** were obtained from Premier.

Hospital Climate

- Region (South/Northeast/Midwest/West)
- Bed size (small/med/large)
- Teaching status
- Urban/rural location
- Electronic medical record score for start of QUEST period – EMRAM0608
- Staffing:
    - FTE hospitalists, intensivists, RN-to-bed ratios
    - Hospitalist employment model (y/n)
- Performance Excellence Assessment Tool (PEAT)
- Palliative care program (PALHOS) and inpatient palliative care (IPALHOS) from AHA survey data

Outcomes

Hospital-observed and risk-standardized mortality and complication rates for each quarter from were created from aggregating patient-level data for Q1 2006 through Q4 2011. These data were used in analysis of trends overtime, comparing the pre-QUEST to QUEST period and comparing QUEST participants to non-QUEST hospitals. In addition, we aggregated data to the annual level for the QUEST period for assessing the impact of implementation strategies and degree of implementation on mortality and complication rates.

1. **Mortality Reduction – Change in Mortality measured as**
   - Absolute difference in observed rates 2011 – 2008
   - Absolute difference in risk-adjusted rates 2011 – 2008
   - Relative change in observed rates
   - Relative change in risk-adjusted rates (***primary***)
   - 2011 observed rate
   - 2011 risk-adjusted rate
   - Residual – unexpected change in observed rate
   - Residual – unexpected change in adjusted rate (***primary***)

2. **Mortality Reduction** (using measures as above) restricted to high-risk diagnoses:
   - Sepsis
   - Respiratory Failure
   - AMI

3. **Risk-adjusted complication rate** using the AHRQ
   - composite Patient Safety Indicator (PSI)
   - PSI #07: Selected Infection due to Medical Care

We considered hospital climate to be composed of four main components: (1) a set of general hospital characteristics, (2) information technology, (3) nurse and physician staffing patterns, and (4) the hospital's quality improvement structures and systems. General hospital characteristics that were assessed included bed size; teaching status; location; whether the hospital serves an urban or rural population; and several measures of financial status available within the AHA annual survey, including both operating margin and 2-year average cash flow margin, as well as the level of adoption of health information technology (IT). Several aspects of hospital staffing patterns were also assessed. Hospitals will be categorized according to the penetration of the hospitalist model, the availability of intensivists in the ICU, nursing staffing and the number of registered nurses, licensed practical nurses, and nursing assistive personnel. We have already measured the strength of each hospital's quality improvement structures and systems using the results of the Performance Excellence Assessment Tool (PEAT). Annual risk-adjusted mortality and complication rates, along with observed rates for each hospital, will be provided by Premier.

Limitations

Despite the high survey response rate among hospitals signing the letter of participation, only half the QUEST hospitals were included, leading to much reduced power to evaluate sources of variation among participating hospitals. Implementation of the clinical practices was determined by self-assessment of the QI director, because it was not feasible to visit or audit all the sites. In addition, surveys of hospital leaders assessing perceptions of the practices may be subject to desirability bias. Also, participation in QUEST was not determined randomly, and hospitals we have identified as controls differ from QUEST hospitals in several ways. However, within the context of hypothesis 3A, in which we examine changes over time in mortality among QUEST participants, we note that virtually all quality collaboratives rely on voluntary participation. For this reason, our estimates of the collaboratives benefits should be generalizable to other hospitals considering joining a similar collaborative. Moreover, within the context of hypothesis 3B, in which we compare changes in mortality among QUEST and non-QUEST hospitals, we have adjusted for differences between the hospitals using multivariable adjustment methods, including the propensity to participate. Last, our mortality outcome was limited to inpatient mortality, which can be biased by variation in discharge practices, but it was not possible to obtain data on 30-day outcomes.

Results

Principal Findings

Specific Aim 1: To explore sources of variation in the implementation of recommended clinical practices within a large, hospital-based quality improvement collaborative aimed at reducing hospital complication and mortality rates through the application of the implementation effectiveness framework.
Hypothesis 1: The hospital's implementation climate and strategies, together with perceptions of the collaborative-recommended clinical practices, will be associated with the implementation of recommended clinical practices.

After assessing associations among the implementation strategies and hospital climate factors, we evaluated univariate associations with our primary outcome for each hospital factor implementation strategy and a perception score. Our initial models focused on mean implementation score and mean perception scores across the nine clinical practices included in the survey. Multivariable models were developed for the outcome defined as the percent of eligible patients that received the recommend treatment, and factors associated with outcome had a $p<0.20$. Additional models will address progress toward implementation and a combined outcome.

Controlling for hospital characteristics, we found "use of data to guide improvement" and a perception of the clinical practices as easily piloted (trialability) to be significantly predictive of the mean percent of eligible patients treated. Additional analyses that are focused on specific clinical practices are in progress.

Parameter		Estimate	Standard Error	t Value	Pr > |t|
Intercept		0.718	0.741	0.97	0.337
Region	**1. Midwest**	-0.277	0.135	-2.05	0.045
	2. Northeast	0.006	0.137	0.04	0.965
	3. West	0.367	0.214	1.71	0.093
	4. South		.	.	.
Bed size	**1. <200**	0.145	0.132	1.10	0.277
	2. 200-399	0.040	0.122	0.33	0.745
	3. ≥400		.	.	.
Performance Excellence Assessment Tool		0.238	0.179	1.33	0.191
Champions/sponsors		0.003	0.016	0.22	0.830
Institutional Support		-0.039	0.019	-1.99	0.052
Use of data to guide		0.036	0.010	3.55	0.0009
Perception: Trialability		0.460	0.201	2.29	0.027

Specific Aim 2: To examine the association between the implementation of recommended clinical practices and change in complication and risk-adjusted hospital mortality rates.
Hypothesis 2: Hospitals that report successful implementation of clinical practices will have larger reductions in complication and risk-adjusted mortality rates than those who fail to, or only partially, implement such practices.

After preliminary analyses comparing survey participants versus nonparticipants, we evaluated associations among predictors to assess for collinearity. We then evaluated association of each predictor with the outcome and included those associated with $p<0.20$ as candidates for multivariable modeling. Because of our small sample size (n=74 hospitals), the large number of predictors, and strong associations among the predictors, we applied a forward selection strategy, beginning with the implementation strategy most strongly associated with the outcome, and sequentially added and removed additional factors, retaining those with $p<.20$. We began with the implementation strategies; hospital characteristics were added last. After adjusting for other strategies and hospital characteristics in the model, the implementation strategy of "setting goals for implementing practices" was associated with a greater decrease in overall risk-standardized mortality, measured as a relative change from baseline or as unexpected change from baseline.

Outcome Y is relative change in risk-standardized mortality (2011- 2008)/2008

Parameter	Estimate	Std Error	Pr > |t|
Intercept	-0.127	0.277	0.6475
Using data to guide improvement	0.039	0.027	0.1407
Participation in QUEST activities	0.041	0.030	0.1653
Setting goals	**-0.140**	**0.061**	**0.0238**
Institutional support	0.036	0.028	0.1985
FTE Hospitalists	**0.006**	**0.002**	**0.0053**
Rural (vs. Urban)	**0.208**	**0.081**	**0.0101**

Outcome Y is unexpected change in risk-standardized mortality

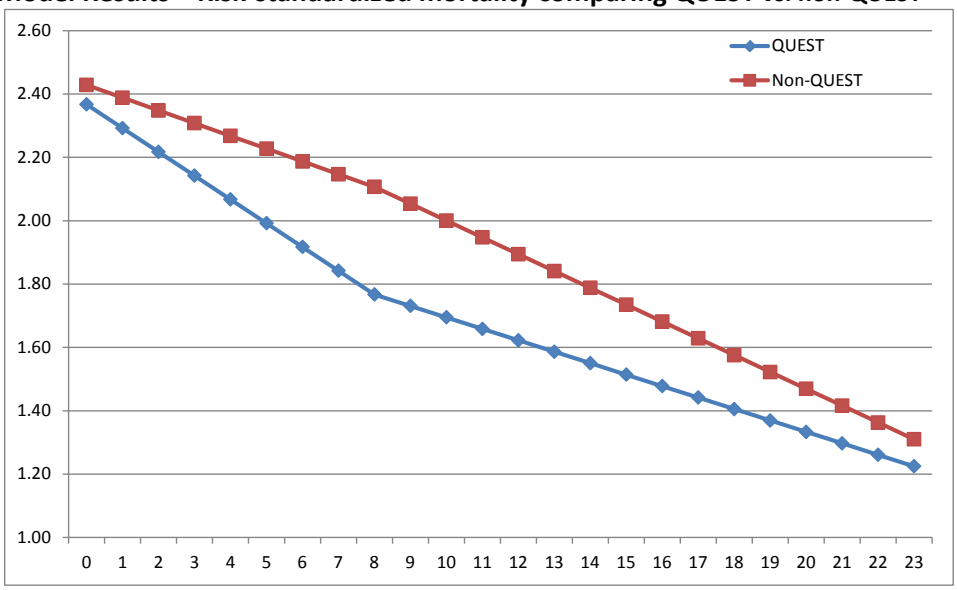
Label	Estimate	Std Error	Pr > |t|
intercept	-0.071	0.538	0.895
Participation in QUEST activities	0.125	0.072	0.082
Setting goals	**-0.350**	**0.125**	**0.005**
Institutional support	0.097	0.053	0.067
Using data to guide improvement	0.106	0.061	0.085
Rural (vs. Urban)	**0.509**	**0.162**	**0.002**

Specific Aim 3: To evaluate the impact of the QUEST collaborative on changes in hospital complication and risk-adjusted mortality rates.
Hypothesis 3a: Hospitals enrolled in QUEST will have a greater reduction in complication and risk-adjusted mortality rates than would be expected on the basis of pre-enrollment or secular trends.
Hypothesis 3b: After controlling for differences in hospital characteristics and other potential confounders, hospitals enrolled in QUEST will have a greater reduction in complication and risk-adjusted mortality compared with nonparticipating institutions.

Preliminary analysis was focused on evaluating linear versus negative binomial models for trend over time; evaluating inclusion of a change in level as well as slope at the start of the QUEST period; and evaluating appropriate quarter (Q1-Q4 of 2008) to define the start of the QUEST period. We focused on linear models with a change in slope at Q1 2008 as our primary models.

Using interrupted time series analysis incorporating hospital-level random effect, we evaluated linear models for trends in mortality over time, comparing pre-QUEST to QUEST period and comparing QUEST participant to nonparticipant hospitals. Models included an effect for season, and trends were assessed using the average season effect.

Linear Model Results – Risk-standardized mortality comparing QUEST vs. non-QUEST



Note: Modeled risk-standardized mortality decreased from ~2.4% at the start of 2006 to ~1.2% at the end of 2011. On the x-axis, 0 refers to Q1 2006, and 8 refers to the start of QUEST, Q1 2008.

Effect	Estimate	Error	LL	UL	t Value	Pr > |t|
Intercept	2.428	0.047	2.335	2.521	51.17	<.0001
QUEST_hospg (0=Q)	-0.062	0.077	-0.212	0.089	-0.80	0.423
QUEST_hospg (1=nQ)	0.000	.	.	.	.	.
Yr06qtrnew	-0.040	0.004	-0.049	-0.032	-9.09	<.0001
Yr08qtrnew	-0.013	0.005	-0.023	-0.003	-2.53	0.011
Season	0.132	0.016	0.102	0.163	8.45	<.0001
Season	-0.164	0.016	-0.194	-0.134	-10.56	<.0001
Season	-0.215	0.015	-0.245	-0.184	-13.90	<.0001
Season	0.000	.	.	.	.	.
Yr06qtrnew*QUEST_hospg	-0.035	0.007	-0.048	-0.021	-5.06	<.0001
Yr06qtrnew*QUEST_hospg	0.000	.	.	.	.	.
Yr08qtrnew*QUEST_hospg	0.052	0.008	0.036	0.067	6.49	<.0001
Yr08qtrnew*QUEST_hospg	0.000	.	.	.	.	.

Linear Model Results – Risk-standardized mortality comparing trends for QUEST vs. non-QUEST

Parameter Estimates	Estimate	Standard Error	DF	t Value	Pr > |t|
Non-QUEST intercept 2006, Q1	2.428	0.047	8158	51.17	<.0001
QUEST intercept 2006, Q1	2.367	0.063	8158	37.86	<.0001
Non-QUEST slope 2006-2007	-0.040	0.004	8158	-9.09	<.0001

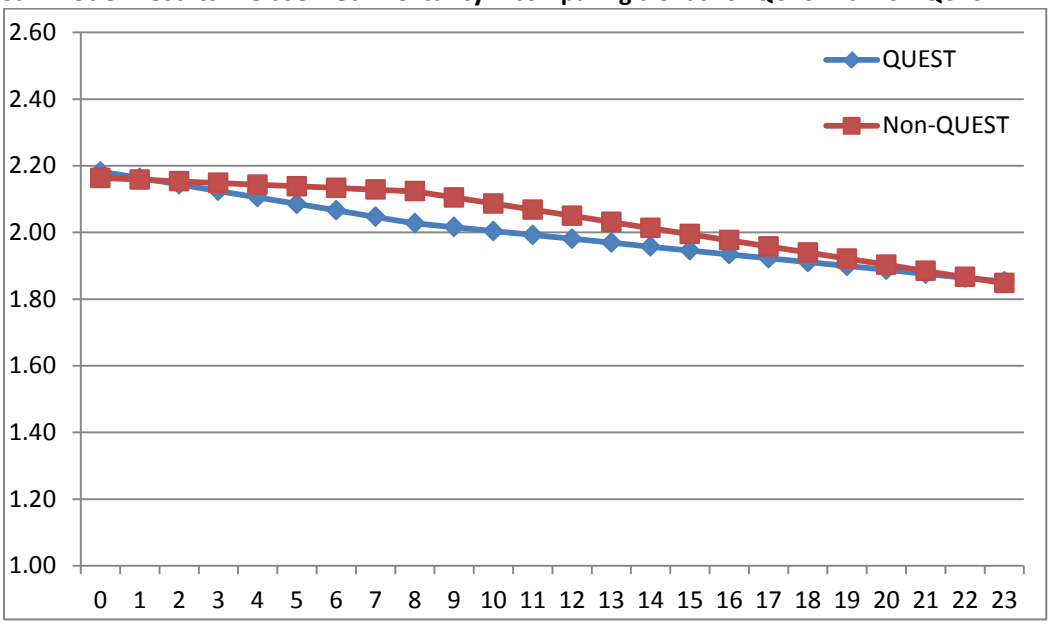
QUEST slope 2006-2007	-0.075	0.005	8158	-14.24	<.0001
Non-QUEST intercept 2008, Q1	2.107	0.042	8158	49.89	<.0001
QUEST intercept 2008, Q1	1.767	0.062	8158	28.61	<.0001
Non-QUEST slope 2008-2011	-0.053	0.002	8158	-21.93	<.0001
QUEST slope 2008-2011	-0.036	0.003	8158	10.92	<.0001
Non-QUEST change in slope	-0.013	0.005	8158	-2.53	0.0114
QUEST change in slope	0.039	0.006	8158	6.33	<.0001
Non-QUEST 2011, Q4	1.310	0.054	8158	24.48	<.0001
QUEST 2011, Q4	1.225	0.082	8158	14.96	<.0001

Contrasts: Tests comparing slopes and Intercepts	Num DF	Den DF	F Value	Pr > F
Non-QUEST and QUEST intercepts same Period 1 (2006,Q1)	1	8158	0.64	0.423
Non-QUEST and QUEST slopes same 2006-2007	1	8158	25.58	<.0001
Non-QUEST and QUEST intercepts same Period 2 (2008,Q1)	1	8158	21.37	<.0001
Non-QUEST and QUEST slopes same 2008-2011	1	8158	17.12	<.0001
Non-QUEST no change in slope starting 2008,Q1	1	8158	6.40	0.011
QUEST no change in slope starting with 2008,Q1	1	8158	40.09	<.0001
Non-QUEST and QUEST changes in slope the same	1	8158	42.06	<.0001
Non-QUEST and QUEST same at 2011,Q4	1	8158	0.77	0.38

Outcomes

QUEST and non-QUEST hospitals started at similar risk-adjusted mortality in 2006 (intercept), but, during the pre-collaborative period, the hospitals that joined QUEST showed a greater decrease in mortality, with the QUEST hospitals rate decreasing a mean of .075% compared with non-QUEST hopsitals' mean of .040% (p=.0001). Both QUEST and non-QUEST hospitals rate of decline changed significantly from the baseline period; non-QUEST hospitals started to show faster decrease over the period, while QUEST hospitals rate of decline slowed. By 2011, QUEST and non-QUEST hospitals had similar risk-adjusted mortality (p=.38, test for difference).

Linear Model Results – Observed mortality – comparing trends for QUEST vs. non-QUEST



Note: Modeled observed mortality decreased from ~2.2% at the start of 2006 to ~1.8% at the end of 2011. On the x-axis, 0 refers to Q1 2006, and 8 refers to the start of QUEST, Q1 2008.

Contrasts	Num DF	Den DF	F Value	Pr > F
Non-QUEST and QUEST intercepts same Period 1 (2006,Q1)	1	8158	0.05	0.818
Non-QUEST and QUEST slopes same 2006-2007	1	8158	5.31	0.021
Non-QUEST and QUEST intercepts same Period 2 (2008,Q1)	1	8158	1.38	0.241
Non-QUEST and QUEST slopes same 2008-2011	1	8158	3.08	0.079
Non-QUEST no change in slope starting 2008,Q1	1	8158	8.53	0.0035
QUEST no change in slope starting with 2008,Q1	1	8158	2.01	0.156
Non-QUEST and QUEST changes in slope the same	1	8158	8.78	0.0031
Non-QUEST and QUEST same at 2011,Q4	1	8158	0.00	0.964

QUEST and non-QUEST hospitals started at similar observed mortality in 2006 (intercept), but, during the pre-collaborative period, the hospitals that joined QUEST showed a greater decrease in mortality (p=.0001), with QUEST hospitals rate decreasing a mean of .019% per quarter decrease compared with non-QUEST hopsitals' mean decrease of .005% per quarter (a nonsignificant slope). The QUEST hospitals' rate of change in observed mortality did not change during the QUEST period relative to baseline (p=0.156); non-QUEST hospitals rate of decline changed significantly from the baseline period; non-QUEST hospitals started to show faster decrease over the period. By 2011, QUEST and non-QUEST hospitals had similar observed mortality (p=.96, test for difference in level).

Discussion

To date, we have completed preliminary analyses for all three specific aims, in particular focusing on strategies for overall mortality reduction and the outcome of overall mortality reduction. Our results are generally negative (no association) or surprising in direction. The negative results may be due to the small sample size (n=74 hospitals of 150 participating), or it may be that overall mortality reduction is less sensitive to the factors we measured and that we will see meaningful differences when focusing on complication rates and mortality among specific high-risk diagnoses.

Our next steps will be to focus on evaluating implementation strategies, perceptions, and level of implementation of specific clinical practices, such as sepsis bundles or ventilator bundles and mortality reduction among specific high-mortality diagnoses – sepsis, respiratory failure and AMI – along with change in complication rates.

Conclusions

Although we observed significant decrease in risk-standardized mortality over the course of the collaborative, we identified few implementation strategies that predicted greater levels of improvement over time. Similarly, we found that the strategy of using data to guide implementation and the perception of practices as easily piloted were associated with greater implementation of the clinical practices. In addition, although hospitals participating in QUEST showed an initial period of rapid improvement in mortality measures compared with non-QUEST participants, by the end of the collaborative period, we saw little difference in mortality rates.

Significance / Implications

Additional research is needed to identify the factors and strategies that enable some institutions to be more successful than others within the context of quality improvement collaboratives.

Planned Publications and Products

1. Sources of variation in the implementation of recommended clinical practices within a large, hospital-based quality improvement collaborative
2. Association of the implementation of recommended clinical practices and change in complication and risk-adjusted hospital mortality rates
3. Impact of the QUEST collaborative on changes in hospital complication and risk-adjusted mortality rates

Additional manuscripts focused on implementation of specific clinical practices (e.g., sepsis bundles or rapid response teams) and sepsis, respiratory failure, and AMI mortality reduction are also planned.