AHRQ Grant Final Progress Report

Title of Project:

REdesigning SystEms to Improve Teamwork and Quality for Hospitalized Patients (RESET)

Principal Investigator

Kevin J. O'Leary, MD, MS – Northwestern University Feinberg School of Medicine

Team Members

Jenna Goldstein, MA – Society of Hospital Medicine
Julie K. Johnson, MSPH, PhD – Northwestern University Feinberg School of Medicine
Jane Kim, MD, Med – Northwestern University Feinberg School of Medicine
Julia Lee, PhD, MPH – Northwestern University Feinberg School of Medicine
Milisa Manojlovich, PhD, RN – University of Michigan
Iva Terwilliger, PhD, RN – Northwestern University Feinberg School of Medicine
Jing Song, MS – Northwestern University Feinberg School of Medicine
Mark V. Williams, MD – Washington University

Organization: Northwestern University Feinberg School of Medicine

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Federal Project Officer: David Rodrick, PhD

Structured Abstract

Purpose: Systemic challenges impede the provision of high-quality care to hospitalized patients. We conducted a multi-site mentored implementation study in which each site implemented interventions to redesign hospital care delivery, evaluating the effect on teamwork climate and patient outcomes.

Scope: The study involved professionals and patients on two medicine units at each of four hospitals.

Methods: Sites implemented the Advanced and Integrated MicroSystems (AIMS) interventions: (1) Unit-based Physician Teams, (2) Unit Nurse-Physician Co-leadership, (3) Enhanced Interprofessional Rounds, (4) Unit-level Performance Reports, and (5) Patient Engagement Activities. Primary outcomes included teamwork climate and adverse events. We collected qualitative data and used cross-case comparisons to determine how contextual factors influenced fidelity of implementation.

Results: The median teamwork climate score was higher post versus pre intervention (85.0 [IQR 73.0-91.0] vs. 80.0 [IQR 70.0-89.0]; p<0.01). A greater percentage of patients on control units experienced ≥1 adverse event post versus pre intervention (3.8% vs. 2.2%; adjusted OR=1.87 [1.07-3.27]). A similar percentage of intervention patients experienced ≥1 adverse event post versus pre intervention (3.7% vs. 3.3%; adjusted OR=1.12 [0.67-1.85]). Difference-in-differences analysis of adverse events did not show a significant effect (p=0.18). There were no differences in length of stay, 30-day readmission, or patient experience.

Fidelity of implementation varied across sites and over time. Qualitative analysis identified four factors associated with implementation success: (1) senior hospital leader involvement and organizational support; (2) organization, hospital, and professional group priority alignment; (3) site leaders' engagement and relationship with one another; and (4) professionals' perceptions of need and intervention benefits.

Key Words: teamwork, patient safety, interprofessional care, implementation science, healthcare systems

Purpose

Despite major investments to improve the quality of care for hospitalized patients, the evidence suggests that we are still a long way from consistently delivering high-quality care to hospitalized patients.[1-4] Most adults requiring hospitalization are admitted for medical conditions,[5] but the optimal model of care for these patients is yet to be established.[6] Teams caring for medical patients are large, with membership that continually evolves and is seldom in the same place at the same time.[7] Physicians are often spread across multiple units and floors, giving them little opportunity to develop relationships with nurses and other professionals who work on designated units.[8] Nurse and physician leaders commonly operate in silos, limiting their ability to address challenges collaboratively.[9] Patients and family members are generally poorly informed and lack opportunities to engage in decision making and co-production of their care.[10,11] As a result, medical services lack the structure and professionals lack the shared accountability necessary to optimally coordinate care on a daily basis and improve performance over time.[12]

A growing body of research has tested interventions to redesign aspects of the care delivery system for hospitalized medical patients. These interventions include localization of physicians, unit nurse-physician co-leadership, interdisciplinary rounds, performance dashboards, and patient engagement strategies.[13-20] Importantly, the overwhelming majority of prior research studies have evaluated the effect of a single intervention (e.g., physician localization without unit-based nurse-physician co-leadership or interdisciplinary rounds). These interventions are better conceptualized as complementary and mutually reinforcing components of a redesigned clinical microsystem and should be implemented and evaluated as such. Furthermore, the influence of contextual factors has not been determined, nor have we identified strategies associated with successful implementation.

Our objective for this proposal was to implement a set of evidence-based complementary interventions across a range of clinical microsystems, identify factors and strategies associated with successful implementation, and evaluate the impact on quality. Our hypothesis was that uptake of the complementary components of the intervention set would result in improvements in teamwork climate and patient outcomes.

The Specific Aims of the <u>RE</u>designing <u>S</u>yst<u>E</u>ms to Improve <u>T</u>eamwork and Quality for Hospitalized Patients (RESET) study were to:

AIM 1. **Conduct a multi-site mentored implementation study in which each site adapts and implements complementary interventions to improve care for medical patients.**
H1: Hospitals adapt and implement interventions in different ways and to different degrees based on local, hospital, and unit-specific contextual factors.

AIM 2. **Evaluate the effect of the intervention set on teamwork climate and patient outcomes related to safety, patient experience, and efficiency of care for hospitalized medical patients.**
H2: Implementation of interventions result in significant improvements in teamwork climate and patient outcomes related to safety, patient experience, and efficiency.

AIM 3. **Assess how site-specific contextual factors interact with the variation in the intensity and fidelity of implementation to affect teamwork and patient outcomes.**
H3: Certain contextual factors within sites and implementation units, as well as different approaches to implementing the components of the intervention, lead to greater improvement.

Scope

Background and Context. Despite equivocal evidence to support their use, many hospitals have begun to implement models of combined interventions to redesign care.[21] Better evidence is needed to allow leaders to make informed decisions about the use of these novel models of care. We conducted the **RE**designing **S**yst**E**ms to Improve **T**eamwork and Quality for Hospitalized Patients (**RESET**) study to evaluate the effect of complementary interventions to redesign care on interprofessional teamwork and patient outcomes and to identify factors associated with successful implementation.[22]

Settings and Study Sites. In collaboration with the Society of Hospital Medicine (SHM) and the American Nurses Association (ANA), we issued a national call for applications for the RESET project. We received 14 applications from hospitals throughout the U.S., each of which was independently assessed by two members of the research team for need (i.e., similar interventions had not already been implemented), commitment, and potential for success. Four hospital sites were selected, with two hospitals located in the Southeast U.S., one in the Midwest, and one in the West. All hospitals were nonprofit and had between 200 and 350 beds. Two were nonteaching hospitals and two were teaching hospitals, though neither was a major affiliate of a medical school.

Participants. The RESET study involved professionals and patients on two general medicine units at each of four study hospitals. The qualitative portion of the study also involved RESET mentors.

Methods

Study Design. RESET was a pragmatic controlled trial using a parallel group study design and two group pretest-posttest analyses for patient outcomes. Site leaders at each hospital selected one unit for initial implementation of interventions (Phase I) and a second unit for later implementation (Phase II) (Figure 1). We used a multi-method approach to collect and triangulate qualitative data collected during visits to study sites and semi-structured interviews. We conducted cross-case comparisons to consider how site-specific contextual factors influenced the fidelity of implementation.

Figure 1. Overview of RESET Study Design and Data Collection
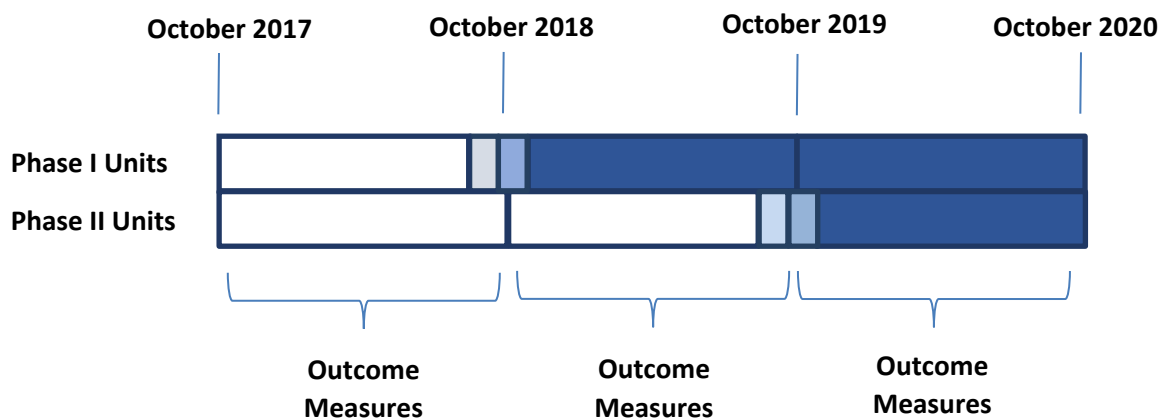
Shaded areas show implementation of AIMS intervention on Phase I and Phase II study units.

The Advanced and Integrated MicroSystems (AIMS) Interventions. RESET sites implemented the Advanced and Integrated MicroSystems (AIMS) interventions, which our research team developed from available evidence, a detailed needs assessment, and our experience implementing similar interventions.[6,23-27] The AIMS interventions address common challenges to teamwork and the provision of high-quality care to hospitalized medical patients and include (1) Unit-based Physician Teams, (2) Unit Nurse-Physician Co-leadership, (3) Enhanced Interprofessional Rounds, (4) Unit-level Performance Reports, and (5) Patient Engagement Activities (Table 1).

Table 1. Advanced and Integrated MicroSystems (AIMS) Interventions

Component	Description
Unit-based Physician Teams	Localization of physician to a minimum number of units on which they provide care while on service
Unit Nurse-Physician Co-leadership	Collaborative model in which a nurse leader and physician leader are jointly responsible for quality on their unit
Enhanced Interprofessional Rounds	Interprofessional rounds, redesigned with input from front-line professionals to optimize collaboration and patient engagement
Unit-level Performance Reports	Performance reports designed to give unit leaders and front-line professionals relevant, interpretable, actionable data
Patient Engagement Activities	Methods to continually inform and engage patients and families as partners in care

Mentored Implementation, Site Leaders, and Site Project Teams. RESET used SHM's mentored implementation model, which involves coaching provided by external professionals who are practicing experts in the area of focus.[28] RESET involved two mentorship teams, each consisting of a physician and nurse with experience leading the redesign of clinical microsystems. Mentors received 6 hours of SHM Mentor University training for their role, which occurred during an in-person meeting at SHM headquarters and included an overview of the study aims, scope, and methods, fundamentals of mentoring, and mentor expectations.[28]

The research team provided sites with a RESET Implementation Guide, which included descriptions of each AIMS intervention, recommended strategies for implementation, milestones, and tools.[29] Each study site assembled a local leadership team, including a physician leader, a nurse leader, and a research nurse. Site physician and nurse leaders dedicated sufficient time for the study with support from their hospital. The research nurse received funding from the grant to support effort for data collection and local project management activities. Mentors coached sites during monthly video conferences with site leadership teams. The research team hosted monthly video conferences with all mentors, during which each mentor team provided updates on sites' progress. Each site also received guidance from their mentor team through an initial 2-day site visit to assess relationships with key stakeholders, site infrastructure, and readiness for change. Mentor teams provided a written report with observations from site visits and recommendation to site leaders.

We also convened all site leaders in a video conference thrice in year one and twice annually thereafter. During the video conferences, sites shared their progress, adaptations, and lessons to date. Site leaders received feedback from one another and from the research team.

Data Sources and Collection
Quantitative Data – Research nurses at each site administered surveys, conducted observations and medical record abstractions, and assembled data from administrative databases. Research nurses provided data using tools created by the research team in the Research Electronic Data Capture (REDCap) platform.[30] The research team met with research nurses in video conferences every 3 months to review data, confirm consistency, and address any challenges with data collection.

Qualitative Data – We conducted 2-day visits at each site. During the visits, the research team toured medical units, met with various stakeholder groups (e.g., hospitalists, nurses, leaders), and conducted observations of physician and nurse work activities and interprofessional rounds. Each team member completed individual handwritten field notes of their observations and conversations. After each site visit, the handwritten notes were transcribed and combined into typed team field notes.[31] We also conducted semi-structured interviews via Zoom with professionals at each site and RESET mentors. Interviews were conducted using a pre-tested interview guide, designed to ask participants about contextual factors influencing implementation efforts.

Measures
Fidelity of Implementation Measures – For each AIMS intervention, research nurses collected data for two to seven measures to assess the degree to which interventions were implemented as intended (i.e., fidelity of implementation). Research nurses collected fidelity of implementation data during interviews with physicians, surveys of hospital leaders, and direct observations of interprofessional rounds.

Teamwork Climate (primary outcome) – We assessed teamwork climate using the Safety Attitudes Questionnaire (SAQ) developed by Sexton et al.[32] The SAQ teamwork climate domain includes 14 questions and generates a score from 0 to 100.[17,27] Similar to prior studies, we also asked respondents to rate the quality of collaboration experienced with each professional type.[8,16] We administered the survey using a REDCap link delivered by email at baseline and at the end of Phase I to all nurses, nurse assistants, physicians, pharmacists, social workers, and case managers on study units. Nonresponders received up to five reminder emails.

Adverse Events (primary outcome) – We used the Medicare Patient Safety Monitoring System (MPSMS) methodology to detect adverse events. MPSMS is a medical record-based national patient safety surveillance system that provides rates for specific inpatient adverse event measures.[33,34] MPSMS data have been used in Agency for Healthcare Research and Quality National Health Care Quality and Disparities Reports and currently serve as the major national-level patient safety data source for the U.S. Department of Health and Human Services.[35] We collected data for nine types of adverse events that commonly occur among hospitalized general medical patients, including adverse drug events, hospital acquired infections, pressure ulcers, and falls.

Hospital Length of Stay and Readmissions (secondary outcomes) – We assessed efficiency of care using hospital length of stay (LOS) and 30-day readmissions. The research nurse at each site obtained data on a yearly basis for patients admitted to study units, excluding those transferred from other hospitals and those initially admitted to other units. Data included information on patient age, sex, race, payer, admission source, primary diagnosis, type of admission (i.e., observation vs. inpatient), and discharge destination (i.e., home vs. other).

Patient Experience (secondary outcome) – We used Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) global ratings of hospital care.[36] The research nurse obtained data for patients admitted to study units, excluding those transferred from other hospitals and those initially admitted to other units.

Quantitative Analysis

Teamwork Climate and Ratings of Collaboration – We calculated the median and interquartile range (IQR) for teamwork climate scores and compared baseline versus post-implementation scores using Wilcoxon rank-sum tests. We compared the percentage of professionals rating the quality of collaboration with other professional categories as high or very high using Chi-square tests.[16,17,37] We included all professionals who worked on Phase I units during the study and conducted pre-post analyses rather than difference-in-differences analyses for teamwork and collaboration, because physicians in all hospitals and nonphysician staff in one hospital worked on both study units over time.

Difference-in-differences Analyses of Patient Outcomes – We conducted difference-in-differences analyses (DID) to evaluate the association of the interventions on adverse events. We used this approach because hospitals have continuous efforts to reduce adverse events. This approach accounts for potential differences in the adverse event rates occurring on study units over periods of time due to these ongoing efforts. The first model used mixed-effects multiple Poisson regression and the number of adverse events as the dependent variable. The model compared the change in the number of adverse events from baseline to post-implementation in intervention-unit patients (i.e., Phase I unit) versus the change in control-unit patients (i.e., Phase II unit) using an interaction term defined as unit type multiplied by the intervention period. Covariates included patient age, sex, race, payer, and primary diagnosis. The model used the number of days on the study unit as the exposure variable and the study site as a random effect to control for clustering of data (patients nested in hospitals). The second model used mixed-effects multiple logistic regression and the occurrence of one or more adverse events as the dependent variable. The model used an interaction term and covariates similar to the first model. We calculated estimated proportions of occurrence of adverse events. The pre-post effect (95% confidence interval) was estimated as the difference in estimated proportions; DID was estimated by the difference between the pre-post effects in the intervention and the control cohorts. We also created mixed-effects multiple regression models to compare length of stay, 30-day readmission, and patient experience. The models used an interaction term and covariates identical to the adverse event models.

Analysis of Patient Outcomes by Fidelity of Implementation – Because implementation varied across sites and over time, we also conducted analyses based on fidelity of implementation. We created a composite fidelity of implementation score by assigning a score of 1 to 5 for adherence to measures of each AIMS intervention component.[38] The composite score was calculated as the mean of intervention component scores. We then performed mixed-effects multiple regression models using the composite fidelity of implementation score as the independent variable and adverse events, length of stay, and 30-day readmissions as dependent variables, with covariates as described above. For patient experience, a logistic regression model was performed due to the reduced sample size.

Qualitative Analysis

Interviews were transcribed by an independent, professional transcriptionist service. All data (transcripts and field notes) were imported into MAXQDA® 2020, a software program to support qualitative coding and analysis.[39] We used an inductive approach and conducted conventional content analysis to identify contextual factors and their influence on the implementation of the

interventions.[40,41] In our first cycle coding, a team of coders independently reviewed and coded the first eight healthcare professional transcripts and collectively built a codebook. One researcher coded all remaining transcripts using the codebook, and three other research team members each received a portion of the remaining transcripts, which they independently coded so that each transcript was coded by two individuals. A second coding team followed the same process for the field notes and mentor transcripts. The team compared coding, resolved disagreements through iterative discussion, and refined the codebook. Our second cycle coding used pattern coding to compare, synthesize, and map relationships between findings and generated interpretive insights about the data. As part of our second coding cycle, we reviewed trends in the composite fidelity of implementation score for each site and used memos and data displays as outlined in the work of Miles, Huberman, and Saldaña.[41] We constructed a cross-case data display matrix to help see patterns amongst the sites.[41] Both code saturation (codebook is stable) and meaning saturation (understanding of the issue with no additional insights arising) were met.[42] Participant member checking occurred during the final RESET study call in March 2022.

Limitations
Our study had several limitations. First, we included only four hospitals. It is possible that a larger multi-site study would have greater statistical power to detect improved outcomes. Second, as described below, implementation varied and was never optimal in any site at any time. We conducted patient outcome analyses based on fidelity of implementation to explore the association with patient outcomes. Third, some important constructs (e.g., quality of teamwork in interprofessional rounds) were not captured and incorporated into our analyses. Fourth, we were unable to complete implementation of the interventions on Phase II units due to the COVID-19 pandemic. We restricted our analyses to data collected before the pandemic affected the study sites to eliminate any effect on our results. Fifth, we excluded patients transferred from other hospitals and nonstudy units from our analyses, which may have reduced our ability to detect significant differences in outcomes.

Results
Principal Findings
Implementation – Sites A, C, and D began implementing the AIMS interventions in Fall 2018 (October or November) as planned. Site B had to postpone implementation until May 2019 due to high patient volumes, staffing challenges, and the effects of a nearby natural disaster. Fidelity of implementation varied, with some sites showing improved fidelity over time and others showing little improvement (Figure 2). No site achieved a fidelity of implementation score greater than 4.3 of 5 at any point. Phase I was slightly shorter than the initially planned 12 months for each site (range, 8-11 months), because sites elected to begin implementing AIMS interventions on the Phase II units before a full year had elapsed.

Figure 2. Composite Fidelity of Implementation Score for Each Site by Month
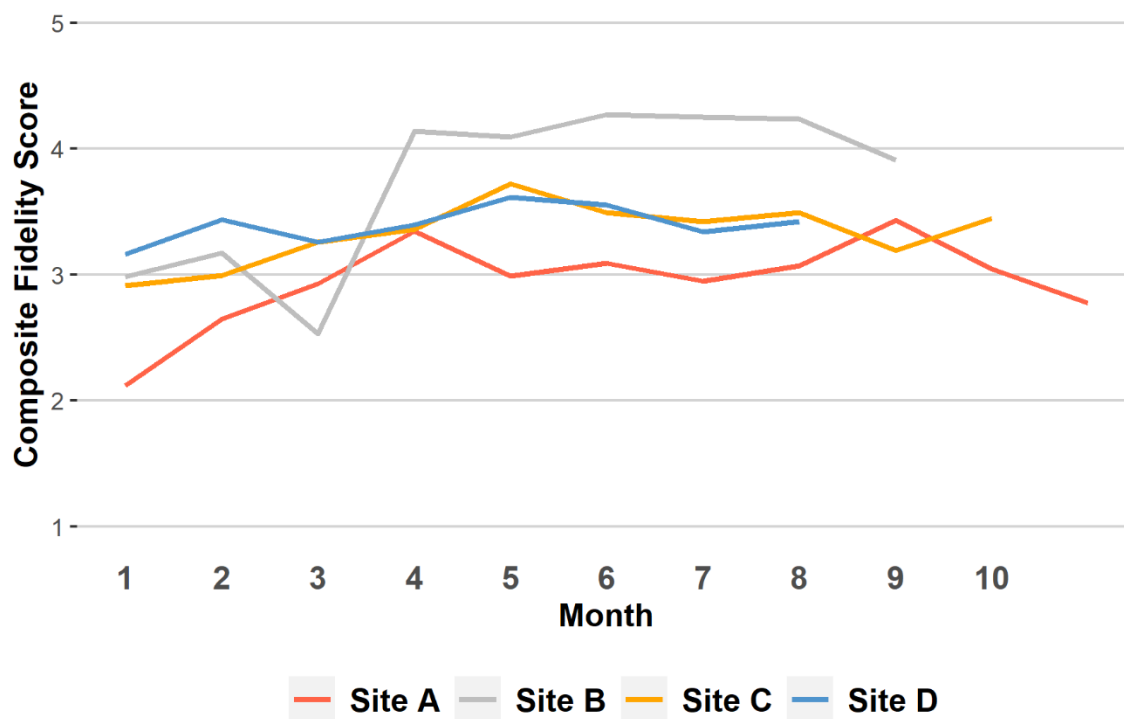
The figure shows the composite fidelity of implementation score over time, starting with the first month of implementation at each site, irrespective of the calendar month in which implementation began.

Outcomes

Teamwork Climate – Overall, 263 of 318 professionals (82.7%) completed the baseline survey, and 221 of 307 (72.0%) completed the survey at the end of Phase I. The median teamwork climate score was significantly higher at the end of Phase I versus baseline (85.0 [IQR 73.0-91.0] vs. 80.0 [IQR 70.0-89.0]; p<0.01) (Table 2). Though the median teamwork climate score was higher for nurses, hospitalist physicians, and nurse assistants at the end of Phase I, only the nurse score showed a statistically significant difference (87.0 [IQR 77.0-93.0] vs. 79.5 [70.0-88.0]; p<0.01). The percentage of hospitalist physicians rating the quality of collaboration with nurses as high or very high was similar at the end of Phase I versus baseline (67.3% vs. 63.2%; p=0.64) (Figure 3). The percentage of nurses rating the quality of collaboration with hospitalist physicians as high or very high was significantly higher at the end of Phase I versus baseline (72.5% vs. 47.3%; p<0.01).

Table 2. Pre-Post Teamwork Climate for Healthcare Professionals

Respondents	Pre-Intervention	Post-Intervention	P value *
All respondents †	n=263	n=221	
Median Teamwork Climate Score (IQR)	80.0 (70.0-89.0)	85.0 (73.0-91.0)	<0.01
Hospitalists	n=68	n=56	
Median Teamwork Climate Score (IQR)	81.5 (72.0-90.0)	86.0 (69.5-92.0)	0.70
Nurses	n=110	n=91	
Median Teamwork Climate Score (IQR)	79.5 (70.0-88.0)	87.0 (77.0-93.0)	<0.01
Nursing Assistants	n=36	n=31	
Median Teamwork Climate Score (IQR)	79.0 (68.0-90.0)	84.0 (62.0-92.0)	0.92

* Comparisons performed using Wilcoxon rank-sum tests.
† All respondents included nurses, nursing assistants, hospitalists, residents (only one site involved residents), advanced practice providers, pharmacists, social workers, and case managers.

Figure 3. Comparison of Ratings of the Quality of Collaboration by Professions Pre and PostIntervention
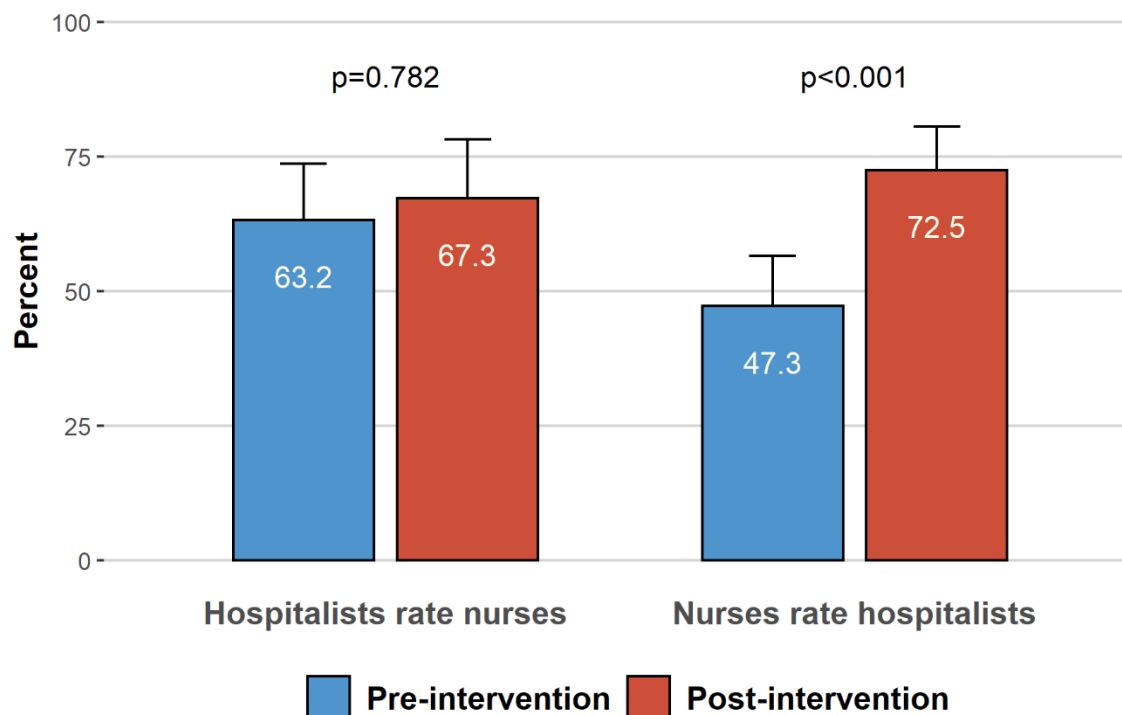

Figure shows percent of respondents in one professional category rating the quality of collaboration with the other profession as high or very high.

Adverse Events – Overall, 3,773 patients were included in the adverse event analysis, including 1,886 control and 1,887 intervention unit patients. The overall rate of adverse events was 0.78 per 100 patient days, and 3.2% (120/3,773 patients) experienced one or more adverse events. Patients on control units experienced a significantly higher rate of adverse events (change, 0.45 [95% CI, 0.05-0.86]), and a greater percentage experienced one or more adverse events (change, 1.61% [95% CI, 0.01-3.22]), in the Phase I period versus the baseline period (Table 3 [not shown]). Patients on the intervention units experienced a similar rate of adverse events
(change, 0.04 [-0.36, 0.43]), and a similar percentage experienced one or more adverse events (change, 0.43% [95% CI, -1.25, 2.12]), in the Phase I period versus the baseline period. The DID analyses did not show statistically significant differences for either the rate of adverse events (adjusted DID, -0.40 [95% CI, -0.97, 0.16]; p=0.16) or percentage of patients experiencing them (adjusted DID, -0.92 percentage points [95% CI, -2.29, 0.64]; p = 0.25) (Table 4).

Length of Stay, Readmissions, and Patient Experience – Overall, 24,473 patients were included in the length of stay, readmissions, and patient experience analyses. Patients on control units had a similar length of stay, 30-day readmission rate, and patient experience in Phase I versus the baseline period (Table 5). Patients on intervention units also had similar length of stay, 30-day readmission rate, and patient experience in Phase I versus the baseline period. The DID analyses did not show statistically significant differences for length of stay, 30-day readmission rate, or patient experience.

Analyses based on Fidelity of Implementation – The composite fidelity score was not associated with the presence of one or more adverse events (adjusted OR=1.06 [0.64, 1.76] for 1-unit increase in composite fidelity scores) (Table 6). Similarly, the composite fidelity score was not associated with length of stay, 30-day readmissions, or overall patient experience.

Qualitative Findings
Four contextual factors were associated with implementation success: (1) senior hospital leader involvement and organizational support; (2) alignment of RESET with organization, hospital, and professional group priorities; (3) site leaders' engagement in RESET and relationship with one another; and (4) perceptions of need and intervention benefits among professionals. The manner and degree to which each factor affected implementation differed across study sites and over time.

Cross-Case Analysis – Our cross-case analysis revealed differing trends in fidelity of implementation and how each factor affected implementation for sites over time (Table 7). Site A struggled with implementation throughout the study, because the site physician leader was not committed and the physician group's payment model incentivized productivity over partnership with the hospital to improve quality. Site B initially struggled with implementation because the site physician leader was ambivalent, the physician payment model incentivized productivity over partnership, and nurse leadership was not committed to change. Site B experienced significantly improved implementation as the physician leader later became more supportive and the physician payment model changed to one with a lower productivity incentive. Site C was able to overcome physician resistance over time, because site leaders were committed and worked well together, and because the organization provided tangible support for implementation efforts. Site D had early success because of engaged site and senior leaders but later was unable to overcome staff resistance and logistical challenges, in part due to senior leadership turnover.

Table 4. Difference-in-Differences (DID) Analyses of Adverse Events by Study Period and Unit Type (n=3,773)

Outcome	Model	Control unit			Intervention unit			DID in adjusted pre-post effects (95% CI), p value
		Pre-intervention mean or % (95% CI) n=1,097	Post-intervention mean or % (95% CI) n=789	Pre-post effect difference in mean or % (95% CI)	Pre-intervention mean or % (95% CI) n=1,084	Post-intervention mean or % (95% CI) n=803	Pre-post effect difference in mean or % (95% CI)	
Adverse Events per 100 days, mean *	Unadjusted	0.52 (0.28, 0.76)	0.97 (0.57, 1.37)	0.45 (0.05, 0.86)	0.80 (0.49, 1.12)	0.84 (0.49, 1.19)	0.04 (-0.36, 0.43)	-0.42 (-0.98, 0.14), 0.15
	Adjusted	0.47 (0.13, 0.81)	0. 93 (0.29, 1.58)	0.46 (-0.00, 0.93)	0.70 (0.23, 1.18)	0.69 (0.23, 1.29)	0.06 (-0.29, 0.41)	-0.40 (-0.97, 0.16), 0.16
Presence of one or more AE, % †	Unadjusted	2.17 (1.22, 3.12)	3.78 (2.28, 5.28)	1.61 (0.01, 3.22)	3.29 (2.07, 4.51)	3.72 (2.24, 5.19)	0.43 (-1.25, 2.12)	-1.18 (-3.50, 1.13), 0.32
	Adjusted	1.23 (0.31, 2.14)	2.27 (0.63, 3.90)	1.04 (-0.12, 2.21)	1.93 (0.57, 3.30)	2.16 (0.59, 3.73)	0.22 (-0.81, 1.25)	-0.92 (-2.49, 0.64), 0.25

* Estimated mean AEs, pre-post effect, DID in pre-post effects and 95% confidence interval (CI) from mixed-effects Poisson regression models, unadjusted and adjusted for age, sex, race, payer, primary diagnosis.
† Estimated % of presence of one or more AE, pre-post effect, and DID in pre-post effect and 95% CI from mixed-effects logistic regression models, unadjusted and adjusted for age, sex, race, payer, primary diagnosis, and days on unit.

Table 5. Difference-in-differences (DID) Analyses of Length of Stay, Readmissions, and Patient Experience by Study Period and Unit Type

Outcome	Models	Control unit			Intervention unit			DID in adjusted pre-post effects (95% CI), p value
		Pre-intervention mean or % (95% CI)	Post-intervention mean or % (95% CI)	Pre-post effect difference in mean or % (95% CI)	Pre-intervention mean or % (95% CI)	Post-intervention mean or % (95% CI)	Pre-post effect difference in mean or % (95% CI)	
Length of stay (unit=log of days), mean * N=24,473	Unadjusted	1.39 (1.17, 1.61)	1.40 (1.26, 1.53)	0.01 (-0.01, 0.03)	1.45 (1.32, 1.59)	1.47 (1.34, 1.61)	0.02 (-0.005, 0.04)	0.01 (-0.02, 0.04), 0.52
	Adjusted	1.40 (1.26, 1.53)	1.40 (1.32, 1.48)	0.003 (-0.01, 0.02)	1.44 (1.35, 1.52)	1.44 (1.36, 1.53)	0.01 (-0.02, 0.03)	0.003 (-0.03, 0.03), 0.85
30-day readmissions (restricted to inpatient cohort), % † N=10,224	Unadjusted	14.24 (11.18, 17.30)	14.06 (10.95, 17.17)	-0.17 (-1.87, 1.5)	15.30 (11.87, 18.73)	15.73 (12.12, 19.35)	0.43 (-2.02, 2.89)	0.61 (-2.36, 3.58), 0.69
	Adjusted	10.76 (7.35, 14.16)	10.58 (7.18, 13.97)	-0.18 (-1.52, 1.16)	11.18 (7.52, 14.84)	11.59 (7.74, 15.45)	0.41 (-1.50, 2.33)	0.59 (-1.74, 2.92), 0.62
Overall rating as top hospital from patient survey, % ‡ N=2,030	Unadjusted	63.38 (58.08, 68.67)	63.55 (58.10, 68.99)	0.17 (-5.56, 5.89)	62.09 (56.39, 67.78)	62.07 (56.15, 67.99)	-0.02 (-6.31, 6.27)	-0.19 (-8.69, 8.32), 0.97
	Adjusted	66.39 (59.51, 73.26)	67.61 (60.47, 74.76)	1.23 (-4.32, 6.78)	67.13 (59.72, 74.53)	67.11 (59.59, 74.63)	-0.01 (-6.04, 6.01)	-1.24 (-9.44, 6.95), 0.77

* Estimated mean, pre-post effect, DID in pre-post effects, and 95% confidence interval (CI) from mixed-effects linear regression models on log of length of stay, controlling for cluster, unadjusted and adjusted for age, sex, race, payer, and primary diagnosis.
† Estimated %, pre-post effect, DID in pre-post effects, and 95% CI from mixed-effects logistic regression models, unadjusted and adjusted for age, sex, race, payer, primary diagnosis, and days on unit.
‡ Estimated %, pre-post effect, DID in pre-post effects, and 95% CI from mixed-effects logistic regression models, unadjusted and adjusted for age, sex, race, and primary diagnosis; payer could not be included as an adjustment factor due to modeling issues.

Table 6. Association of the Composite Fidelity Score with Adverse Events, Length of Stay, Readmissions, and Patient Experience

Outcome	OR (95% CI) or coefficient (95% CI) in 1-unit increase in fidelity score	
	Unadjusted Model	**Adjusted Model**
Presence of one or more adverse events *, n= 1,598	1.05 (0.64, 1.72)	1.06 (0.64, 1.76)
Length of stay (unit=log of days) †, n=10,355	0.01 (-0.02, 0.03)	0.01 (-0.01, 0.03)
30-day readmissions (restricted to inpatient cohort) ‡, n=8,202	1.00 (0.82, 1.22)	1.01 (0.82, 1.23)
Overall rating as top hospital from patient survey §, n=931	1.10 (0.81, 1.50)	1.04 (0.74, 1.45)

* Odds ratio (OR) of 1-unit increase in fidelity score effect and 95% CI estimated from mixed-effects logistic regression models, unadjusted and adjusted for age, sex, race, payer, primary diagnosis, and days on unit.
† Beta coefficient of 1-unit increase in fidelity score effect and 95% confidence interval (CI) estimated from linear mixed-effects regression models on log of length of stay, controlling for cluster, unadjusted and adjusted for age, sex, race, payer, and primary diagnosis.
‡ Odds ratio (OR) of 1-unit increase in fidelity score effect and 95% CI estimated from mixed-effects logistic regression models, unadjusted and adjusted for age, sex, race, payer, and primary diagnosis.
§ Odds ratio (OR) of 1-unit increase in fidelity score effect and 95% CI estimated from logistic regression models, unadjusted and adjusted for age, sex, race, payer, and primary diagnosis.

Table 7. Cross-case Analysis of Contextual Factors Associated with Implementation Success

	Fidelity of Implementation Trend	Factors			
		1. Senior leadership involvement and organizational support	2. Alignment of RESET* with organization, hospital, and professional group priorities	3. Site leaders' engagement in RESET and relationship with one another	4. Perceptions of need and intervention benefits among professionals
Site					
Site A	Low to moderate initial fidelity with minimal improvement over time	The Chief Medical Officer was supportive but retired. Other senior leaders were focused on organizational changes (e.g., planned merger with another health organization) which overshadowed RESET.	Hospitalist physicians were employed by a staffing company with quality goals that differed from the hospital's and a compensation model that prioritized clinical productivity.	The site nurse leader was committed, but the physician leader did not embrace RESET and was reluctant to ask hospitalists to change their workflow.	Though nurses appreciated the need for, and the benefit of improved interprofessional teamwork, physicians did not see a need to improve teamwork. Physicians were unwilling to make changes to workflow.
Site B	Low initial fidelity with significant improvement over time	The Chief Medical Officer was fully engaged, as evidenced by regularly attending RESET meetings. The Chief Nursing Officer was not engaged and had cursory knowledge of RESET.	The hospitalist physician compensation model incentivized clinical productivity over partnership in improving quality of care. The compensation model later changed to one that emphasized quality improvement over productivity.	The nursing site leader changed, but neither nurse site leader was actively engaged. The physician leader was initially ambivalent in his commitment and hesitant to ask physicians to change their workflow. The physician leader became more supportive over time.	Nurse buy-in varied and was dependent on nursing unit leadership commitment. Physicians did not perceive a need to improve interprofessional teamwork and were unwilling to change their workflow.
Site C	Moderate initial fidelity with slow steady improvement	Senior leaders regularly attended RESET meetings and reallocated protected time for existing physician leaders to incorporate the unit medical director role. The organization's quality improvement department provided support for project management.	The site successfully worked to align RESET with a similar unit-based intervention to improve teamwork. Though the internal medicine service was flexible, family medicine remained unwilling to change processes to facilitate localization of physicians.	The site physician and nurse leaders were committed, held regular team meetings, came prepared for monthly mentor meetings, and coordinated well with one another. The physician leader had authority and was well respected within the organization.	Physicians expressed concern about decreased patient variety with localization but remained open to the interventions. Case management and nurses saw the benefit of the interventions in improving clinical decision making and teamwork.
Site D	Moderate initial fidelity with slight improvement over time	Senior leaders were initially supportive, but there was senior leader turnover. New senior leaders did not intervene to resolve disagreement among stakeholders (e.g., physician group, residency program, and bed assignment).	Physicians generally did not collaborate on hospital quality improvement efforts. Regulatory requirements for professional groups (mandated nurse breaks, ACGME work hour rules) made it hard to align priorities.	The site physician and nurse leaders were committed and had a strong working relationship. However, the physician leader did not have formal authority to make workflow changes and struggled to gain physician buy-in.	Physicians did not perceive a problem with teamwork and had concerns that interventions would decrease patient variety and continuity. Social workers felt RESET made it more difficult for them to address patients' social needs.

Discussion

In this pragmatic controlled trial evaluating the effect of complementary interventions to redesign care for patients hospitalized with medical conditions, we found an association with higher ratings of teamwork climate and collaboration but no association with adverse events, length of stay, 30-day readmissions, or patient experience. The improved ratings of teamwork climate were mainly driven by improved ratings among nurses. Notably, hospitalists had higher ratings of teamwork and collaboration at baseline than did nurses, a finding seen in prior research across various settings.[8, 37, 43, 44] The improvement in nurses' perceptions of teamwork climate and collaboration is similar to prior studies of similar interventions.[16, 17]

Communication failures are a common contributing factor to adverse events experienced by hospitalized patients.[45-47] Thus, we theorized that interventions designed to address systemic barriers to communication and teamwork would be associated with fewer adverse events. However, despite the improvement in teamwork climate, we did not find an association of the interventions with adverse events in the DID analyses. Notably, our study's percentage of patients experiencing adverse events was lower than anticipated (i.e., 3.2% versus our initial estimate of 8.9%). National rates of adverse events experienced by hospitalized patients have significantly declined over time,[4] spurred largely by national patient safety campaigns, public reporting, and payment policies.[1,48-50] Study hospitals may have addressed other important contributing factors to adverse events, reducing the potential benefit of an improved teamwork climate. The interventions in our study were also not associated with changes in length of stay, 30-day readmissions, or patient experience.

Anticipating that the effect of the RESET interventions might be influenced by fidelity of implementation, we created a comprehensive RESET Implementation Guide, conducted site visits, prepared monthly fidelity of implementation reports, and had mentors provide guidance during monthly mentor video conferences. Nonetheless, sites struggled with implementation. In light of the implementation challenges, we conducted additional analyses based on fidelity of implementation but did not see an association with patient outcomes.

In our qualitative comparative case analysis, we identified four interrelated contextual factors associated with the successful implementation of interventions to redesign systems providing care to hospitalized patients. These factors are (1) senior hospital leader involvement and organizational support; (2) alignment of the interventions with organization, hospital, and professional group priorities; (3) site leaders' engagement and relationship with one another; and (4) perceptions of need and intervention benefits among professionals. The manner and degree to which contextual factors affected implementation differed across sites and over time. Implementation was optimal when senior leadership was stable and tangibly involved; organizational, hospital, and group goals were aligned; site leaders were committed and collaborated well; and nurses and physicians perceived a need for and benefits from the interventions.

Despite our finding no association with the patient outcomes assessed, leaders may have other reasons to consider implementing similar interventions. Prior research has shown that hospitals with higher teamwork culture ratings have lower nurse resignation rates.[51] Moreover, poor teamwork within hospitals may adversely affect financial performance due to physician and nurse workflow inefficiencies.[52] Given rising concerns over healthcare worker wellness and ongoing nursing staffing shortages, leaders may consider implementing similar models to build cohesion and promote retention. Future research should evaluate whether interventions to improve teamwork are associated with improvements in retention, workflow efficiencies, and financial performance.

Conclusions
In this study of complementary interventions to redesign care for patients hospitalized with medical conditions, we found an association with higher ratings of teamwork climate and collaboration but no association with adverse events, length of stay, 30-day readmissions, or patient experience. Efforts to improve patient safety and efficiency of care, spurred in large part by national campaigns, public reporting, and payment policies, may have resulted in limited opportunities for further improvement related to improvements in teamwork climate. Sites struggled to optimally implement the AIMS interventions, and we identified four interrelated contextual factors associated with the successful implementation of combined interventions.

Significance and Implications
Despite the equivocal evidence to support their use, many hospitals have begun to implement models of combined interventions to redesign care.[21] Our findings allow leaders to make better informed decisions about the use of these novel models of care. Healthcare leaders should consider our findings in the context of their improvement priorities before implementing similar interventions. Additional research is needed to identify optimal implementation strategies and to determine whether interventions to improve teamwork are associated with improvements in other outcomes of interest, such as retention, workflow efficiencies, and financial performance.

List of Publications and Products:
1. Terwilliger IA, Manojlovich M, Johnson JK, Williams MV, O'Leary KJ. Effect of COVID-19 on the implementation of a multifaceted intervention to improve teamwork and quality for hospitalized patients: a qualitative interview study. BMC Health Services Research. 2022;22(1):1379.
2. O'Leary KJ, Manojlovich M, Johnson JK, Estrella R, Hanrahan K, Leykum LK, et al. A Multisite Study of Interprofessional Teamwork and Collaboration on General Medical Services. Joint Commission Journal on Quality and Patient Safety/Joint Commission Resources. 2020;46(12):667-72.
3. O'Leary KJ, Hanrahan K, Cyrus RM. Teamwork Essentials for Hospitalists. Med Clin North Am. 2020;104(4):727-37.
4. O'Leary KJ, Johnson JK, Manojlovich M, Goldstein JD, Lee J, Williams MV. Redesigning systems to improve teamwork and quality for hospitalized patients (RESET): study protocol evaluating the effect of mentored implementation to redesign clinical microsystems. BMC Health Services Research. 2019;19(1):293.
5. O'Leary KJ, Clepp K, Estrella R, Goldstein JD, Hanrahan K, Johnson JK, et al. Redesigning Systems to Improve Teamwork and Quality for Hospitalized Patients: RESET Project Implementation Guide. 2019 September. Available at: Redesigning Systems To Improve Teamwork and Quality for Hospitalized Patients (RESET Project) | Agency for Healthcare Research and Quality (ahrq.gov) and reset-guide.pdf (hospitalmedicine.org)

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