Individual QI projects from single institutions

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Reducing Interdisciplinary Communication Failures Through Secure Text Messaging: A Quality Improvement Project

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Abstract

Introduction: Interdisciplinary communication failures contribute to medical mistakes and adverse events. At our institution, provider communication previously occurred through unidirectional pager systems. We utilized quality improvement methodology to (1) implement a secure text messaging system for providers on a pediatric ward and (2) evaluate its impact on communication failures. We aimed to reduce potential communication failures between providers by > 25% within 1 month. **Methods:** Implementation of secure text messaging occurred via Plan-Do-Study-Act cycles focused on education, feedback, and electronic health record interventions. We collected pager data before implementation and both pager and secure text messaging data after intervention. Potential communication failures were identified a priori through manual review of the messaging data to capture lack of closed-loop communication. A run chart was used to track daily potential communication failures and total communication volumes. **Results:** Before implementation of secure text messaging, the median daily potential communication failure rate was 5.5%. Usage of secure text messaging increased after implementation, representing 3.5 of 7.2 communications per patient-day. Paging communications decreased from 4.2 to 3.7 per patient-day. Potential communication failures decreased to a median daily rate of 2.2%, representing a 59% reduction in communication failures. **Conclusion:** Implementation of secure text messaging using quality improvement methods resulted in a significant reduction in potential communication failures between residents and nurses. Future interventions will be aimed at maintaining and augmenting providers' use of secure text messaging to ensure the potential for communication failure remains low. *(Pediatr Qual Saf 2018;3:e053; doi: 10.1097/pq9.0000000000000053; Published online February 6, 2018.)*

INTRODUCTION

Interdisciplinary communication failures are a key driver of medical mistakes and adverse events in the inpatient hospital setting.[1] Legacy communication systems involving 1-way alphanumeric pagers can be unreliable,[2] a source of frequent interruption to clinical care workflows,[3,4] and lack the rapid, bidirectional structure necessary for effective communication in urgent patient-care situations.[5,6]

A majority of health care providers now carry personal mobile devices with advanced communication capabilities and frequently use non-HIPAA (Health Insurance Portability and Accountability Act) compliant functionalities, such as carrier-based text messaging, for clinical care.[7,8] Previous studies have evaluated the effect of using bidirectional electronic communication methods across many settings including home health care, primary care clinics, inpatient medical units, subspecialty hospitals, trauma services, and operating rooms.[5,6,9–11] Health care providers report perceptions of improved efficiency, satisfaction, and ease of use.[5,9,11–14] Studies looking at technical reliability and speed of smartphone-based communication platforms have demonstrated decreased latency and satisfactory reliability compared with unidirectional alphanumeric paging systems.[6,15]

In response to anecdotal reports of unanswered pages from nurses to residents at our institution, 1 inpatient unit chartered a quality improvement (QI) project focused on evaluating and improving our current pager-based system. Data from this project were presented locally but never published. Based on voluntary reporting, the data

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showed that a median of ~15% of pages from nursing staff to residents went unanswered.[16] Failure modes identified during this project included silent page transmission failure, prolonged answering time due to high-acuity clinical situations, and paging device malfunctions. Based on the findings of this project, we developed a follow-up QI project with systematic data collection and objective quality measures.

With the goal of improving communication reliability between providers, we utilized QI methodology to implement and evaluate bidirectional, secure text messaging on personal mobile phones for residents staffing the pediatric hospital medicine service. Our objective during the study period was to reduce potential communication failures between residents and nurses by > 25% within 1 month of system implementation.

METHODS

Technical Setting and Context

Cincinnati Children's Hospital Medical Center (CCHMC) is a large academic pediatric medical center with 628 beds. General pediatric patients are admitted primarily to two 24-bed units staffed by pediatric nurses, with direct care provided by 4 teams of pediatric residents under the supervision of pediatric hospitalist attendings. The main workflow interventions of this project took place on these 2 units, but the secure text messaging system changes were enterprise-wide as we could not isolate these changes by unit.

Before our intervention, the only form of nursing-initiated communication to residents required sending an alphanumeric page to a permanent team pager; although residents also carried personal pagers, floor nurses were essentially blind to the names of individual residents responsible for any given patient. Instead, unit whiteboards only indicated the hospital medicine team to which a given patient belonged. The team pagers, assigned 1 per general inpatient team, were passed from resident to resident at shift change and served as the team's fixed point of contact. The "on-call" resident would answer all pages received on this device and, as able, resolve the patient care issue. If unable to adequately resolve the issue themselves, the on-call resident would then seek out the primary resident responsible for the patient in question. Residents initiated communication to nurses by placing a call to the unit coordinator, who would then transfer the call to the nurse's mobile phone. Nurse-to-nurse communication took place through directory-based calling and text messaging on hospital-supplied mobile devices using the Voalte platform (Voalte Inc, Sarasota, Fla.). Before this study, the hospital had provided all nurses with mobile devices equipped with the Voalte platform to facilitate secure text messaging and voice calls between nursing staff.

Our main intervention was the installation of a secure text messaging application on residents' mobile devices (VoalteMe, Voalte Inc, Sarasota, Fla.). This application allowed for secure text messaging and calls to traverse the gap between personal mobile devices carried by residents and hospital-supplied mobile devices carried by nursing staff. At the time of implementation, this system did not allow for voice communication between nursing staff and resident providers.

Stakeholders involved in the development and execution of interventions included resident physicians, bedside nurses, hospital medicine attendings, and members of the information technology (IT) team. The institutional review board of CCHMC granted a waiver of consent for this research, determining it to be not human subjects related.

Interventions

We implemented a new communication system by enrolling general pediatric residents in a secure text messaging system that unified communication platforms for nurses and residents. The methodology included Plan-Do-Study-Act (PDSA) cycles focused on system enrollment, education, feedback, and changes to the electronic health record [EHR (Epic Systems, Verona, Wis.)]. The new system created visible physician/patient assignments, thereby allowing nurses to identify individual residents caring for each patient. The structure and function of the implemented messaging workflow were focused on failure modes identified in the previous project, including difficulty identifying the primary resident to contact for each patient, lack of message delivery and read status, and failures due to unidirectional communication methods. We developed subsequent interventions through feedback from residents and nurses to mitigate new failure modes and address key drivers as we observed provider messaging patterns in real clinical settings.

Based on resident preference, the enrollment phase involved installation of a secure text messaging application on each resident's smartphone rather than providing an additional hospital-based device. We provided in-person education and standardized educational materials for the new clinical workflow to both residents and nursing staff on the study units. Nursing staff champions volunteered to encourage workflow transition during the study period. We also developed an e-mail-based reminder curriculum to provide ongoing feedback and tips on the efficient use of the new workflow. Individual residents and resident teams were provided with feedback regarding their availability on the secure text messaging application and appropriate self-assignment as a patient's primary physician provider in the patient's treatment team workflow within our EHR. In-person feedback was gathered through structured feedback sessions as well as ad hoc feedback to implementation team members at a participant's discretion. Table 1 describes our PDSA interventions.

Measures

We collected baseline paging data for all resident teams staffing the pediatric hospital medicine service at our

Table 1. Description of Improvement Interventions

Date	Intervention	Description
April 11, 2016	Initial participant contact	Survey of participating nurses and residents to determine workflow format and enrollment strategies
May 1, 2016	Participant education begins	Individual contact with residents and nurses introducing them to the quality improvement project
May 2, 2016	Baseline data collection begins	Systematic collection of numeric and text pager content and metadata begins
May 16, 2016	Messaging platform enrollment	Residents are provided standardized educational materials for messaging platform enrollment and workflow changes
May 30, 2016	Resident education session	Hands on teaching for residents with messaging application and EHR modifications
May 31, 2016	Nursing education session	Physical presence on clinical units to provide real time assistance for nursing
June 1, 2016	Messaging platform go-live	Nurses and residents on participating units start using messaging platform as initial contact
June 3, 2016	Electronic reminder campaign begins	Scheduled e-mails sent to remind residents of workflow changes and present tips to simplify use of new system
June 6, 2016	In-person feedback sessions	Study staff present on clinical units to elicit real time feedback at regular intervals
June 15, 2016	Unit whiteboard modification	Electronic tracking whiteboards on each unit modified to display name of resident currently assigned to each patient
June 28, 2016	Change of service date	Study group of residents debriefed, postintervention feedback elicited through anonymous surveys and in-person meetings

institution from May 1 through May 31, 2016. Collected data included timestamped numeric and text pages sent to team pagers. Starting June 1, we collected both pager and secure text messaging data for all residents staffing the pediatric hospital medicine service at our institution for 30 days. The secure text messaging data included sender, receiver, timestamp, and message content.

Data for paging and secure text messaging-based communications were collected every 72 hours due to rolling log access restrictions for historical paging data. We collected data for numeric paging, text paging, and secure text messaging in different systems resulting in multiple raw data files with different content and formats. We aggregated these disparate data streams into a standardized format and file using automated scripts to ensure data consistency (**see Supplemental Digital Content,** *http://links.lww.com/PQ9/A20*).

Our primary outcome measure was the incidence of potential communication failures defined a priori as 1 of 3 variants likely capturing broken communication loops (Fig. 1). Variant 1 included any numeric page sent from the same extension to the same team pager within 30 minutes. Variant 2 included any text-based communication (paging or secure text messaging) with contextual evidence of broken loop communication. Variant 3 included any communication sent to a team 15 minutes before or after a rapid medical response team activation on 1 of the team's patients. These definitions were created by a team of residents, attendings, and nurses based on prior experience and anecdote. One member of the team performed a manual review of the messaging data, comparing patterns and content to predetermined failure definitions. Liminal cases were adjudicated by all 3 members of the study team. As a balancing measure, we followed per-patient communication volumes.

Our secondary outcome measure was resident and nursing perception of communication quality and efficacy. Preintervention surveys were collected from nursing staff and residents to assess perceptions of the communication environment and workflow effectiveness using a previously validated tool (Teamwork Effectiveness Assessment Module).[17] We also collected baseline data from residents detailing anticipated concerns about using personal smartphones for professional obligations. Follow-up postintervention perceptions were collected using an open-ended questionnaire to elicit resident and nursing feedback for further PDSA cycles.

Analysis
Run charts were used to track ongoing progress in near–real time during each PDSA cycle. Charts tracked median potential communication failures, communication volumes, and unit census. Statistical process control rules were used to determine significant shifts in the data and shift the median line.[18,19] Descriptive statistics were compiled at the conclusion of the intervention study period.

RESULTS
During the month before implementation of secure text messaging, the median daily potential communication failure rate was 5.5% or approximately 18 potential communication failures on average of 226 daily pages. Following our intervention, combined potential communication failures across both secure text message and paging systems decreased to a median daily rate of 2.2%, which represents a 59% reduction in communication failures (Table 2; Fig. 2). This reduction in potential communication failures, including both pager and secure text messaging communications in the analysis, was significant (chi-square, 270.81 on 1 df; $P < 0.001$). Similarly, analysis of the pager system alone also demonstrates a significant difference in the incidence of failures before and after intervention (chi-square, 102.73 on 1 df; $P < 0.001$).

Overall communication volumes increased throughout the month of implementation, with secure text messages ultimately representing 49% of total communications (3.5 of 7.2 communications per patient-day, Fig. 3). Conversely, pager communications decreased from 4.2 to 3.7 per patient-day (Table 2).
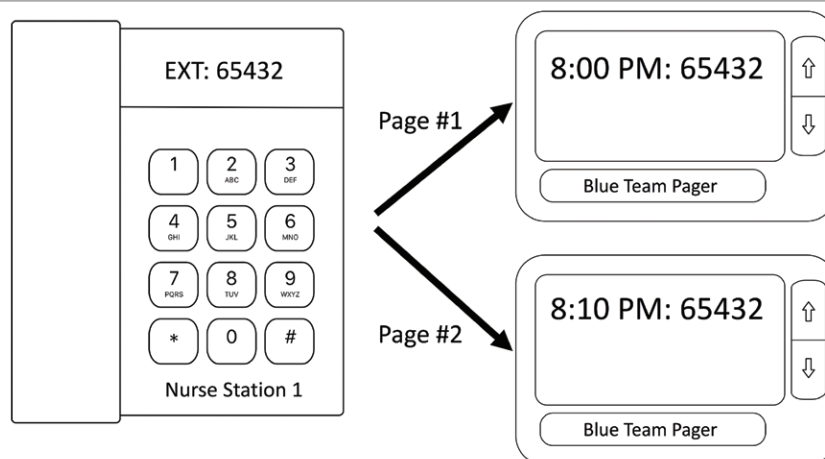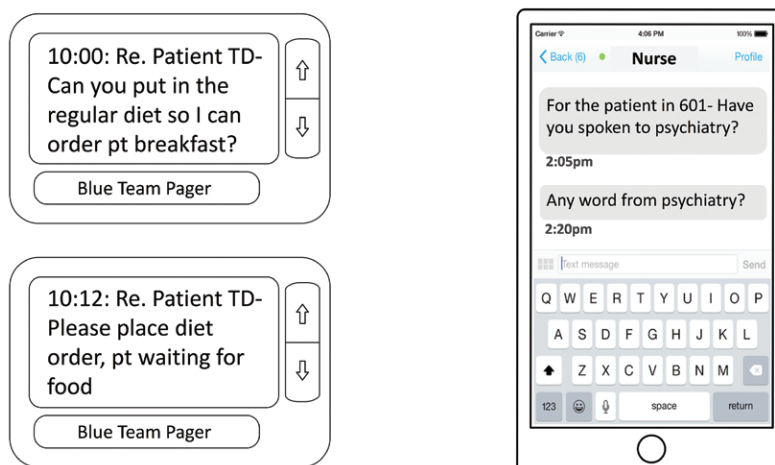
Fig. 1. Definition and examples of 3 variant potential communication failures.

Twenty-two residents (100% of participating residents) utilized the secure text messaging application. All except one were able to download and login to the application on their personal phones. This one failure was due to a personal phone that was incompatible with the application (Windows phone Operating System (OS)); this resident was instead provided with a hospital-supplied phone, through which they were able to utilize the secure text messaging application.

The baseline Teamwork Effectiveness Assessment Module surveys, collected from 21 bedside nurses and 26 residents, revealed an overall satisfactory communication environment. There were differing perceptions of the efficacy of communicating urgent changes in patient care, with nurses reporting that urgent changes were less effectively communicated compared with residents' perceptions. In total, 53% of residents had concerns about using their personal smartphones before the intervention. The most common areas of concern included the appearance of using a personal device during team discussions or while in a patient room as well as being able to keep personal and professional communications separate. Residents were also concerned about battery life and network reliability inside the hospital. Fifteen participating residents provided postintervention feedback to the implementation team, and 14 of 15 residents (93%) preferred using secure text messaging over the traditional paging system. Residents did not report the perception of increased workflow interruption with increasing total communication volume or increased battery usage. Concerns were voiced regarding the incomplete transition from pagers to secure text messaging and the potential for further fragmentation of communication across multiple platforms.

System Performance

Our data also showed that implementation of secure text messaging was associated with decreased communication failures when compared with the pager system alone. There was a single report of delayed message delivery on

Table 2. Communication Volumes

Measure	Preintervention	Postintervention
Total messages (pager, text)	6,984	7,831 (4,012, 3,819)
Total failures (pager, text)	554	171 (130, 41)
Pager failures/d (mean, median)	17.9, 11	5.2, 5
Secure text message failures/d (mean, median)		1.64, 1
Total failures, variant 1 (repeat numeric page sent from the same extension within 30 min)	466	108
Total failures, variant 2 (contextual evidence of broken loop communication; pager, text)	49	65 (26, 39)
Total failures, variant 3 (communication sent 15 minutes before or after a rapid medical response team activation; pager, text)	33	5 (3, 2)
Total communications per patient-day	4.2	7.2

Chi-square analysis on total messages and failures indicates significant difference between pre- and postintervention groups. Chi-square = 270.81 on 1 df; $P < 0.05$.

the secure text messaging system related to loss of network access. The affected resident was unable to provide a time or location of the system failure, eliminating the possibility to perform an additional technical evaluation of the issue.

DISCUSSION
Summary
Our study demonstrates that introduction of secure, bidirectional communications to our inpatient general pediatrics teams resulted in more reliable communication between team members. The legacy paging system used exclusively before this intervention suffered from shortcomings noted in the introduction, most notably the inability to acknowledge receipt, triage a numeric-only page, or directly contact a patient's primary resident consistently. The resulting communication atmosphere led to frequent work interruptions, constant handoff of pagers, phones, and messages, and avoidable confusion between nurses and residents. After our intervention, we saw a significant decrease in the rate of pager-associated potential communication failures.

Although this could be spurious considering our limited study period, it could also reflect changing behavior among providers, shifting more failure-prone communications to a platform they deemed more reliable, in this case, secure text messaging. It could also represent changes in behavior during the study period based on education and observation that would otherwise not be so pervasive in a clinical communication system.

Although overall messaging rates did increase after our implementation, it is important to consider the fundamentally different workflow burden between answering a page or sending a page and waiting for the answering phone call versus communicating via text message (which residents reported was quicker and more efficient). This difference is likely reflected in the fact that providers in the postintervention survey did not identify increased messaging volumes as a problem. Instead, they were overwhelmingly positive about the implemented software and workflow. It is important to note, however, that this assessment is incomplete without a more thorough assessment of nursing workflow and impact.
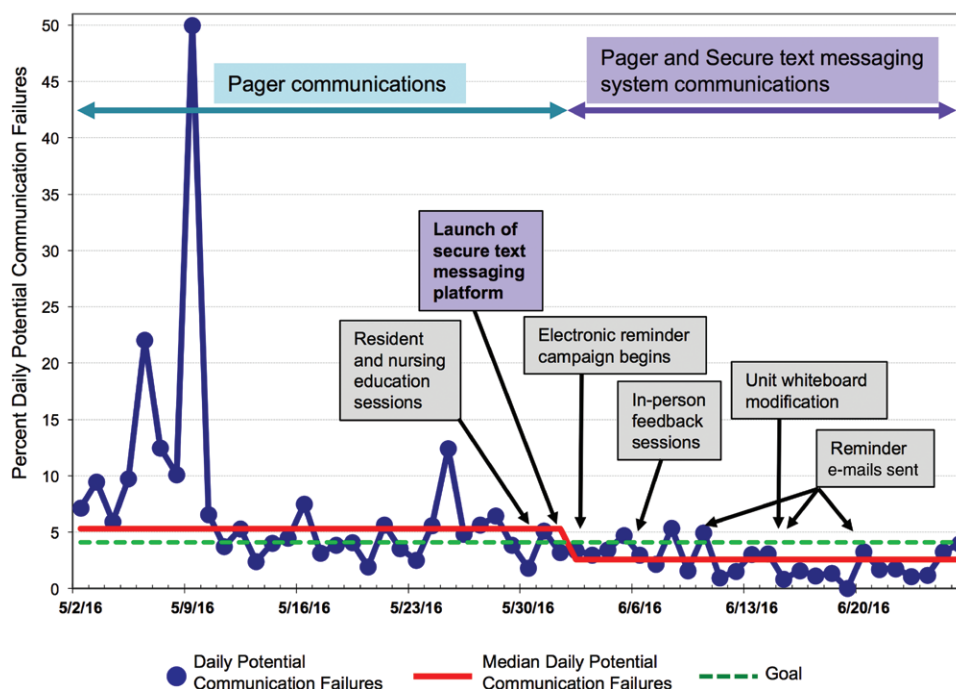

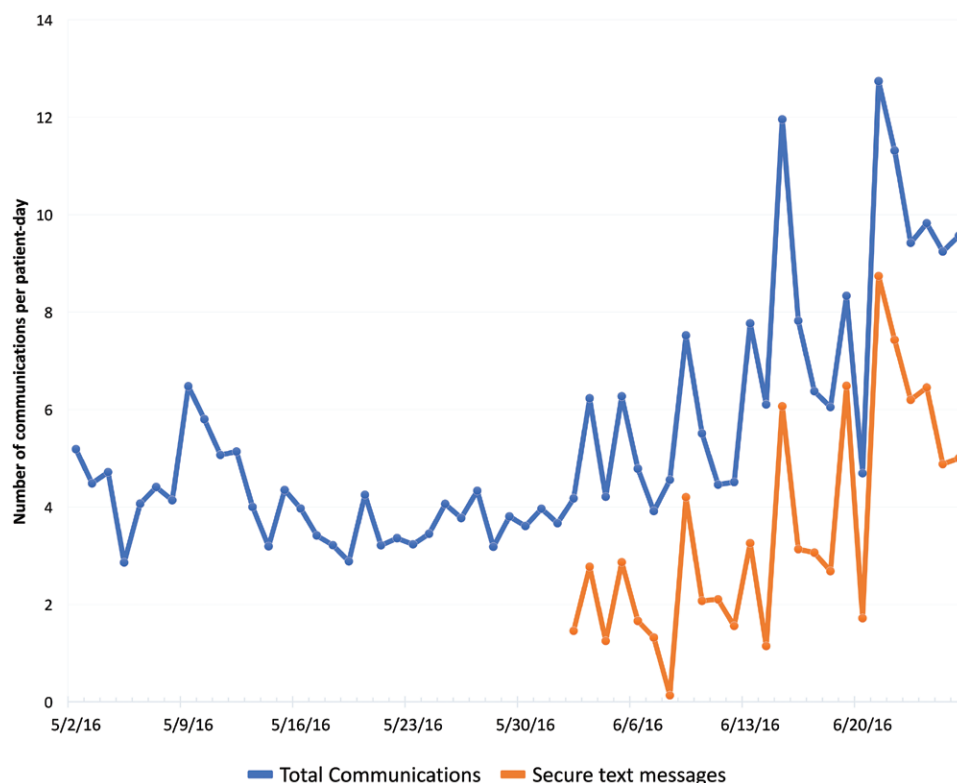**Fig. 2.** Run chart of daily potential communication failures.

Fig. 3. Census-adjusted communication volumes.

Strengths of Intervention

Our intervention workflow introduced bidirectional, closed-loop communication methods. With the ability to respond directly to communication requests in the same medium, there were fewer workflow interruptions and fewer "moving parts" in the communication environment. Secure text messaging also benefitted from transparent failure modes that allowed nurses and residents to see when their messages had been delivered and read. These cues were not available in the legacy pager system.

One unanticipated strength of our intervention's novel monitoring system was the inadvertent discovery of previously silent failure modes inherent in the legacy paging system. In near real time, we identified a spike in potential communication failures between May 8 and 10 (Fig. 2). We discovered that a team pager had been removed from service as it was not able to receive pages. Treatment team contact information had been updated in the hospital-wide directory to a new temporary team pager with a different phone number, but pages continued to be sent to the nonfunctioning number. We felt this was likely due to many bedside caregivers having team pager numbers memorized and not referencing the pager directory.

Limitations of Intervention

Our project was limited by the introduction of multiple workflow changes at 1 time. The transition from pager to secure text messaging-based communication occurred at the same time as the transition from team-based to individually identified resident contacts in the EHR. Initially, the study team observed that residents frequently failed to assign the individual primary physician provider in the EHR. Although this improved with feedback to individual residents, it highlighted the fact that increasingly complex clinical systems would rely even more on proper provider-patient assignment. Currently, there is no solution that we are aware of to automate this assignment without changing or complicating provider workflows. In response to assignment failures, nursing staff frequently defaulted to using the legacy paging system when they were unable to identify the appropriate resident for a given patient. Technical limitations in our version of the secure text messaging software did not allow residents to assume team roles directly within the messaging environment; however, a newer version of the software allows for this team-based assignment option, which may simplify the problem.

Our project was also limited by perceptions of optional participation in a resident-driven pilot program. Many residents were unaware of the high failure rate of the pager system as most failures were silent from the resident perspective. As a pilot study, we did not obligate or enforce usage of the new communication workflow, nor deprecate the legacy system.

Limitations of Evaluation

This project was the first study at our institution to attempt systematic collection of pager system metadata.

All previous projects used subjective self-report methods that are vulnerable to multiple biases.[20,21] Although we were able to objectively and systematically define potential communication failures with a novel data collection system, our methods were limited to having 1 primary assessor, preventing any assessment of inter-rater agreement. Further study in this area would benefit from more stringent assessment methodology.

Due to the unidirectional nature of the pager metadata that was available to us, we had to define potential communication failures via patterns that represented repeated or untimely attempts at communication. These prospectively developed patterns were based on our clinical experience of provider workflow and observed paging patterns. These data patterns may not reveal all communication failures and may misidentify some successful communications as potential failures. However, it should be noted that this method is far more likely to have underestimated communication failures. For instance, our data capture mechanism was unable to capture page failures that were due to misdialing pager numbers.

Subjective data collection was limited to a small number of participants due to the limited time frame of the pilot project and the size of our participating teams and, unfortunately, the scope of this project did not allow follow-up collection from nursing staff. We were not able to reach statistical significance in our surveys, though we feel that important trends were identified. The duration of our study period limited data collection to a proof-of-concept time frame. We were unable to track longer term trends, benefits, and complications of the intervention workflow. Although our team was unaware of any safety events that occurred during the study period, there was no formal review of the hospital's reporting system to identify any negative consequences stemming from the introduction of a new communication format and workflow.

Interpretation
This study confirms the findings of other studies reporting that providers prefer bidirectional communication platforms. Effective inter-professional communication is essential to the safe and effective practice of medicine at both the individual and system levels. As clinical environments become more technically complex, we must systematically work to identify failure modes and clinical impacts of health IT interventions. The pace of technological change is far outstripping our ability to implement and study the effects of change on the clinical environment and the potential fragmentation of workflow, safety protocols, and provider knowledge of health IT tools.

CONCLUSIONS
Our implementation of secure text messaging using QI methods was associated with reduced utilization of a dated unidirectional pager-based communication, drove usage of secure text messaging, and reduced the number of potential communication failures between providers.

Resident physicians preferred it over pager-based systems. Behavioral change was the rate-limiting step in technology and workflow uptake across the intervention population.

FUTURE WORK
We have been unable to systematically and objectively confirm improved workflow efficiencies with validated tools at this time. However, as the project moves from proof-of-concept into hospital-wide implementation, we will be able to perform postintervention surveys to assess new perceptions of communication workflow and efficiency on the hospital medicine services. Our pilot project also identified important technical limitations of the product that may benefit from clinician-vendor collaboration.

More work is needed to understand the data underlying communication patterns in hospital systems, workflows involving these communication systems, and implementing best practices in a data-driven manner. Our project required labor-intensive manual extraction of paging and text message data in addition to the algorithm-driven unification of this data. Ideally, an automated solution could be implemented to collect, collate, and identify potential communication failures in real-time based on pattern recognition or other factors. This system would, considering the increasing utilization of secure text messaging, require some form of natural language processing to parse string-based communications.

UNANSWERED AND NEW QUESTIONS
How can we improve behavioral change in complex and ever-changing clinical environments? How can we increase clinician-vendor collaboration to reduce technical limitations that become roadblocks in clinical workflows? What long-term safety and efficiency effects are produced by the unification of hospital communication systems?

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DISCLOSURE
The authors have no financial interest to declare in relation to the content of this article.

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