FINAL PROGRESS REPORT

PROJECT TITLE: SAFETY ADVANCEMENT IN THE EMERGENCY DEPARTMENT*

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PROJECT DATES: SEPTMBER 30, 2008 – SEPTEMBER 29, 2009

(ORIGINAL END DATE: SEPTEMBER 29, 2011)

FEDERAL PROJECT OFFICER: KERM HENRIKSEN, PhD

FUNDING AGENCY: AGENCY FOR HEALTHCARE RESEARCH AND QUALITY (AHRQ)

GRANT AWARD NUMBER: R18 HS17904

*PLEASE NOTE THAT THIS GRANT WAS CLOSED AFTER THE FIRST YEAR DUE TO THE PRINICPAL INVESTIGATOR TAKING A POSITION AT AHRQ.

STRUCTURED ABSTRACT

Purpose: The purpose of this study was to develop a tool to reduce gaps in care related to diagnostic study processes and medication delivery in emergency departments.

Scope: The project aimed to develop a checklist-based cognitive tool to reduce the risks of gaps in care related to diagnostic study processes and medication delivery. The intended goal was to implement and evaluate the tool to reduce the risks of information gaps in the ED. A toolkit would be developed and disseminated as part of this work.

Methods: A variety of methods were employed in the conduct of the research portion that was completed prior to the grant ending at the close of Year 1. Participatory design methods were employed for preliminary tool development, and an interrupted time-series quasi-experimental design was to be used to evaluate the ability of the tool to reduce information gaps.

Results: Because the PI relocated to AHRQ, the project was stopped at the end of first year. It was determined that the three processes for improvement shared similar features and failure modes. This information was used to develop a draft cognitive tool for status tracking. Pre-implementation surveillance was conducted to establish baseline process failure rates. Preliminary data indicated that failures were correlated with gaps in processes.

Key Words: emergency department, patient status, healthcare delivery

PURPOSE (Objectives of Study)

The specific aims of this study were to:

(a) Develop a checklist-based cognitive tool to reduce the risks of gaps in care related to diagnostic study processes and medication delivery in the emergency department ***(Specific Aim 1)***;

(b) Implement the cognitive tool in the emergency department ***(Specific Aim 2)***;

(c) Evaluate the ability of the status tracking tool to reduce the risks of information gaps in the emergency department ***(Specific Aim 3)***;

(d) Develop and disseminate a comprehensive "toolkit" to facilitate implementation of a status tracking tool for diagnostic tests and medication ***(Specific Aim 4)***.

SCOPE (Background, Context, Settings, Participants, Incidence, Prevalence)

Background

The emergency department is likely to be the most unsafe ambulatory care setting for patients. By nature, emergency department (ED) care is transitional and more likely than other ambulatory locations to be influenced by multiple factors, such as variable patient acuity, lack of patient information, and interruptions in patient flow. Care within the ED is also complex as a result of the many people, decisions, and overlapping processes of care that must be integrated both within and outside of the ED.

Until recently, knowledge about the number and types of errors and adverse events occurring within the ED has been limited. The majority of studies conducted in the ED have focused on missed diagnoses of high-stakes conditions, with very little data available regarding the epidemiology of errors and adverse events (AEs) within the ED. To bridge this gap in knowledge, a study has been undertaken by our research group to evaluate the nature and number of errors and AEs in the ED. This study, Evaluation of Risk by Active Surveillance in the Emergency Department (ERASED), uses a novel approach of real-time surveillance of the people and processes in the ED, which targets the identification of errors and AE at the point of care.

Data from the ERASED study suggest that gaps in care related to diagnostic study processing and medication delivery are the largest risks to ED patients. For the over 110 million annual ED visits, 71% require at least one diagnostic test and 77% have drugs either given in the ED or prescribed at discharge. Clearly, these processes represent a broad target for intervention, relevant to a large number of ED patients. Several other studies, predominantly found in the Internal Medicine literature, have described similar results. Gaps in care appear to occur in the ED when communication and coordination between clinicians and across disciplines fail and are particularly notable across transitions of care and during periods of high patient volumes. A critical step in translating these findings into safety improvement is to develop an intervention that works within existing ED operations. Research in other high-acuity areas of the hospital indicates that the use of a checklist-based tool can lead to improved coordination in the performance in tasks across disciplines. In this study, we propose to develop, implement, and evaluate a tool that will minimize the risks of gaps in care that arise from diagnostic study processes and medication delivery.

Context and Setting

There were two research sites at which the work was conducted: (1) The University of Maryland Medical Center (UMMC) ED (Site A), which provides care to over 65,000 visits annually; and (2) the Mercy Medical Center (MMC) ED (Site B), with an annual volume of over 52,000 visits. Each hospital had different processes and information technology systems, with the UMMC ED utilizing paper-based nursing and physician charting systems and computerized physician order entry and the MMC ED utilizing paper-based nursing charts and physician orders, a computer-based order processing system, and dictated physician notes. This variation in technology offered a diverse experience on which to base the cognitive tool.

Participants

In addition to the research team, consisting of the Principal Investigator and senior personnel, other participants included human factors experts, information technology specialists, pharmacists, lab personnel, and radiology staff. The nature of their participation is described in the Methods section of this report.

METHODS (Study Design, Data Sources/Collection, Interventions, Measures, Limitations)

Specific Aim 1: The development of a checklist-based cognitive tool was conducted using participatory design methodologies. The tool was developed through cross-discipline team meetings to construct flow diagrams of the processes under improvement (diagnostic study and medication delivery). These meetings served to uncover process failures and to develop measures to prevent these failures.

Specific Aim 2: (NB: This aim was to be started in Year 2 of this grant) The tool was to be implemented in the ED and refined through an iterative process. Ethnographic observations were to be conducted to gain knowledge in how the tool was used in situ and to further guide its refinement.

Specific Aim 3: The third aim involved evaluating the ability of the status tracking tool to reduce the risks of information gaps in the ED. The study design was an interrupted time-series quasi-experimental design to evaluate the effectiveness of the tool, with the main outcome measure being the number of errors and adverse events related to diagnostic study processing (e.g., missing laboratory results, delayed radiology studies) and medication delivery processes (e.g., delayed or missed medications). Additional outcome measures were to include diagnostic study and medication delivery turnaround times, clinician's opinions related to tool implementation, and self-reported awareness of information status. Additionally, AHRQ's Hospital Survey on Patient Safety Culture was to be conducted. Given the premature end of the project at the end of Year 1, only the pre-implementation data were collected for both sites.

Specific Aim 4: After completion of Aims 1 through 3, the intention was to develop and disseminate a toolkit to provide other EDs the means to design, implement, and test their own status tracking system. This activity was scheduled to take place in Year 3 of the project.

RESULTS (Principal Findings, Outcomes, Discussion, Conclusions, Significance, Implications)

As previously reported, the study concluded at the end of the first year. This was a result of the PI moving to AHRQ. The results presented are those from the first year of activity and are organized by specific aim.

Aim 1: Develop a cognitive tool to reduce the risks of gaps in care related to diagnostic study processes and medication delivery in the Emergency Department.

The following information related to Aim 1 is in reference to activities at Site A (University of Maryland Medical Center). As per the initial grant application, the tool development work at Site B (Mercy Medical Center) was to be conducted during the second year of the project.

The initial risk assessment project, *Evaluation of Risk by Active Surveillance in the Emergency Department (ERASED)* (AHRQ Grant No. P20 HS017111), identified the greatest risks in the Emergency Department (ED) to be gaps in care during the processes of laboratory testing, radiology testing, and medication delivery. Aim 1 of this grant served to develop a tool to eliminate the gaps in these three care processes through the use of participatory design methods. Participatory design emphasizes the collaboration between the end users of a tool (e.g., frontline caregivers) and the developer of the tool. This method ensures that the design meets the needs and is functional to those for whom the tool was created.

Task 1.1 – Cross-Discipline Design Team Organization. The first task of the participatory design method involved convening a cross-disciplinary team, consisting of frontline care providers from interns through attending physicians, hospital and ED administration, a human factors engineer, information technology specialists, pharmacists, lab personnel, and radiology staff.

Task 1.2 – Design Team Meetings. The first task of the group was to document, using flow diagrams, the current processes of medication delivery, laboratory testing, and radiology testing (Figures 1-3). As a starting point for discussions, the team used results from the Healthcare Failure Mode and Effects Analysis (HFMEA) for a medication delivery process conducted as part of the initial ERASED grant. The HFMEA results provided a framework for constructing and discussing each of the three processes (laboratory testing, radiology testing, and medication delivery). Constructing the process maps as a group allowed for discussions about how each of the processes fails. The three processes were found to share similar features and failure modes:

(1) The physician places an order in the computer.
The step can fail when the order is not placed. Multiple physicians can care for a single patient (attending physicians, resident physicians), and assumptions often are made as to who has placed orders. This can be particularly troublesome across shift changes and across disciplines.
This step can also fail when there is anticipated or unanticipated computer downtime. Staff must revert back to paper charting, often with great difficulty. Transitioning between the two mediums can be time consuming and lead to unintended consequences (e.g., need to re-enter all medication orders into the computer system once the system is online).

(2) The nurse must recognize that an order was placed.
Often, there is a lack of recognition of orders due to difficulty with tracking order statuses. Nurses voiced their concern about the decline in communication that has occurred as a result of the computer order entry. Nurses must continually seek out new orders that have been placed in the computer, requiring multiple logins and complicated screen navigation.

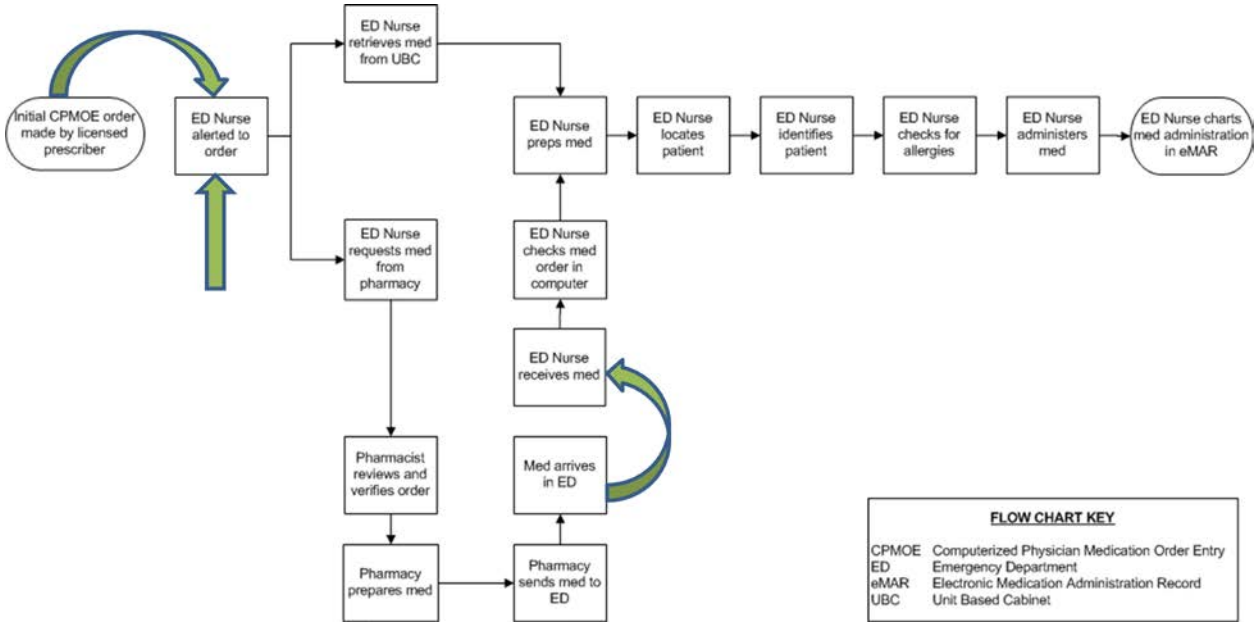
(3) The nurse or technician must carry out the order.
This step can fail due to a lack of shared awareness between team members. Multiple caregivers can be involved in the process of carrying out an order. This step fails when assumptions are made as to who has completed task. These failures are particularly apparent across shift changes.

(4) The physician reviews the results and acts on the results (for laboratory and radiology testing).
This step fails when the physicians do not review the results, often as a result of a lack of awareness that results have returned. Similar to nurses needing to continually seek out orders, the physicians must go to the computer to continually seek out the results. If only a partial set of results is available for viewing, particularly at the time of a shift change, there is a potential for patient harm. The clinicians may assume that all results have been viewed and addressed.

Not surprisingly, the process failures identified in these meetings corresponded to the gaps in care that were identified through the ERASED project and were primarily related to challenges in team cognition. Mismatches of mental models were the primary finding, with lack of awareness of entered and available information and assumptions about the status of the processes being most concerning.

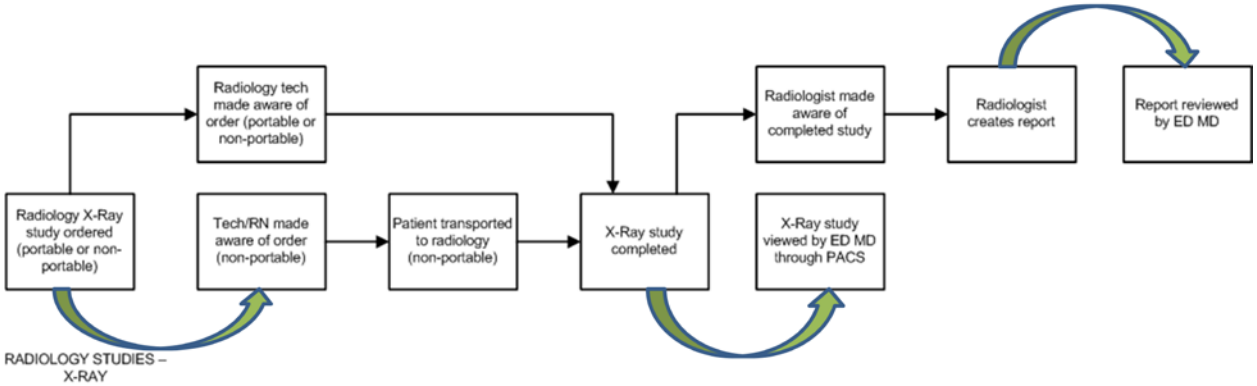
Using these findings, the design team began work to construct a preliminary cognitive tool for status tracking for each of the three processes. The tool would be used to "push" information to the clinicians in a single display and will contain changes in process status, delays, and new data as it is returned. As voiced by the clinicians, the tool would contain not only where in the process the item is located (e.g., specimen received, in process, result returned) but also the time that it reached that step. Colors would be used to indicate that the process step is on time (green), slightly delayed (yellow), or significantly delayed (red). At the end of the first year, the team was working with radiology and laboratory administration to determine what were appropriate expected times required for completion of each type of lab and radiology test. Medical Center Pharmacy Services has a policy indicating that all medications ordered by the ED should be administered between 30 minutes and 1 hour of the order being placed. A preliminary, paper-based version of the tracking tool can be found in Appendix A.

Figure 1. Medication Delivery Process Overview (Site A) *[large arrows represent gaps in the process]*



Figures 2 & 3. Diagnostic Testing Processes Overview (Site A) *[large arrows represent gaps in the process]*

LABORATORY STUDIES



RADIOLOGY STUDIES – X-RAY

Aim 2: Implement the cognitive tool in the Emergency Department.

The following information related to Aim 2 is in reference to activities at Site A (University of Maryland Medical Center). As per the initial grant application, the tool implementation work at Site B (Mercy Medical Center) was to be conducted during the third year of the project.

During the second year of the project, a paper form of the status tracking tool was to be implemented in the ED. Ethnographic observations of the prototype tool in use were to be conducted using trained observers with experience in qualitative research methods. Data were to be collected as described in Aim 3 (Evaluation Phase). Information gained through the observations was to be used to refine the tool and to determine if there were changes in process that needed to occur to improve the quality of the ED operations. These data were to be shared with department and hospital administration as well as with members of the laboratory, radiology, and pharmacy leadership.

Aim 3: Evaluate the ability of the status tracking tool to reduce the risks of information gaps in the Emergency Department.

The following information related to Aim 3 is in reference to activities at both Site A (University of Maryland Medical Center) and Site B (Mercy Medical Center). At the time the grant stopped (end of Year 1), the data were being collected at both sites for pre-implementation evaluation.

Task 3.1 – Determination of Event Rates. One of two main outcome measures was the number of events reported relating to laboratory testing, radiology testing, and medication delivery processes. The data collection tool listing nonideal events being tracked was reiteratively refined during the first month of data collection to more precisely reflect the incidents occurring. A list of the events tracked can be found in Table 1. Using a method similar to that successfully used in the ERASED grant, real-time surveillance of the ED was conducted by trained research assistants (RAs). For a randomly selected group of patient visits, caregivers were queried as to the occurrence of events. In addition, basic nonidentifying demographic data for the visits were collected. For pre-implementation data, 365 visits were queried at Site A, and 218 visits were queried at Site B. Preliminary results are presented in Figures 4-6.

Table 1. Laboratory Testing, Radiology Testing, and Medication Delivery Process Events

LABORATORY TESTING	RADIOLOGY TESTING	MEDICATION DELIVERY
Ordering Delay or failure to order lab(s) Wrong lab(s) ordered	**Ordering** Delay or failure to order Wrong study ordered	**Ordering** Delay or failure to order Wrong drug ordered Wrong dose ordered Wrong route ordered Ordered for wrong patient Ordered for wrong time
Performance Delay or failure to get specimen Specimen hemolyzed Lost or misplaced specimen Specimen mislabeled or not labeled Wrong test performed by lab Lab delay or failure to perform test	**Performance** Delay or failure to perform study Wrong study performed Study performed on wrong patient Technical errors	**Dispensing** Wrong drug dispensed Wrong dose dispensed Wrong route form dispensed Dispensed for wrong patient Delayed or dispensed at wrong time
Results & Processing Delay or failure to report results Delay or failure to act on results	**Results & Processing** Delay or failure to report results Delay or failure to act on results Difference in interpretation between ED physician and radiologist	**Administration** Wrong drug administered Wrong dose administered Administered by wrong route Administered to wrong patient Delayed/administered at wrong time Drug not administered Failure to monitor patient after admin
		Other Not available in ED Not available in pharmacy Allergic reaction/adverse drug event

Figure 4. Percent of Laboratory Tests with Events, by Site

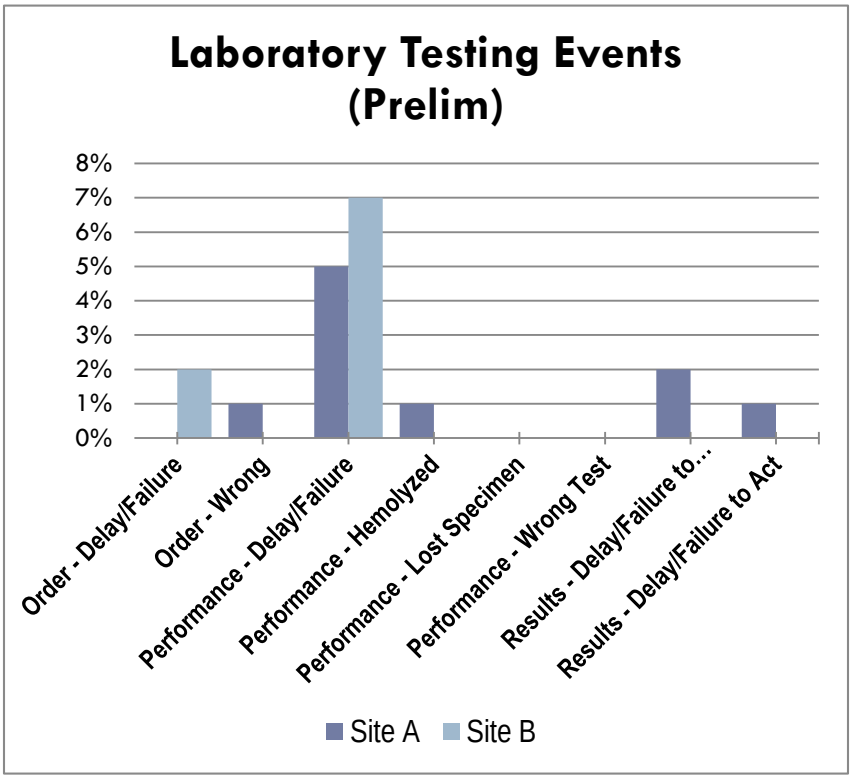


Figure 5. Percent of Radiology Studies with Events, by Site

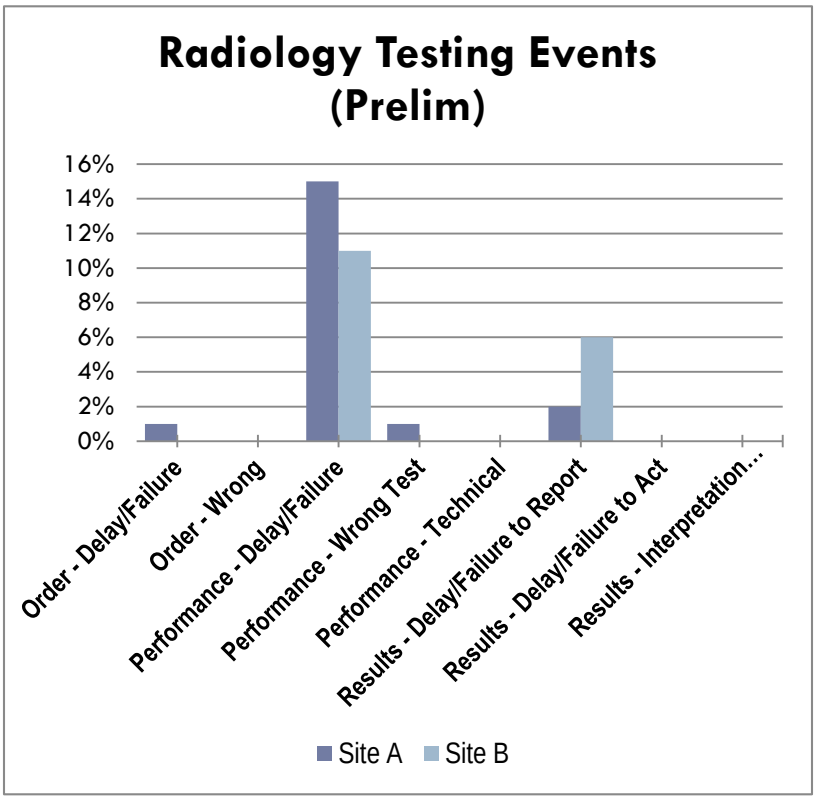
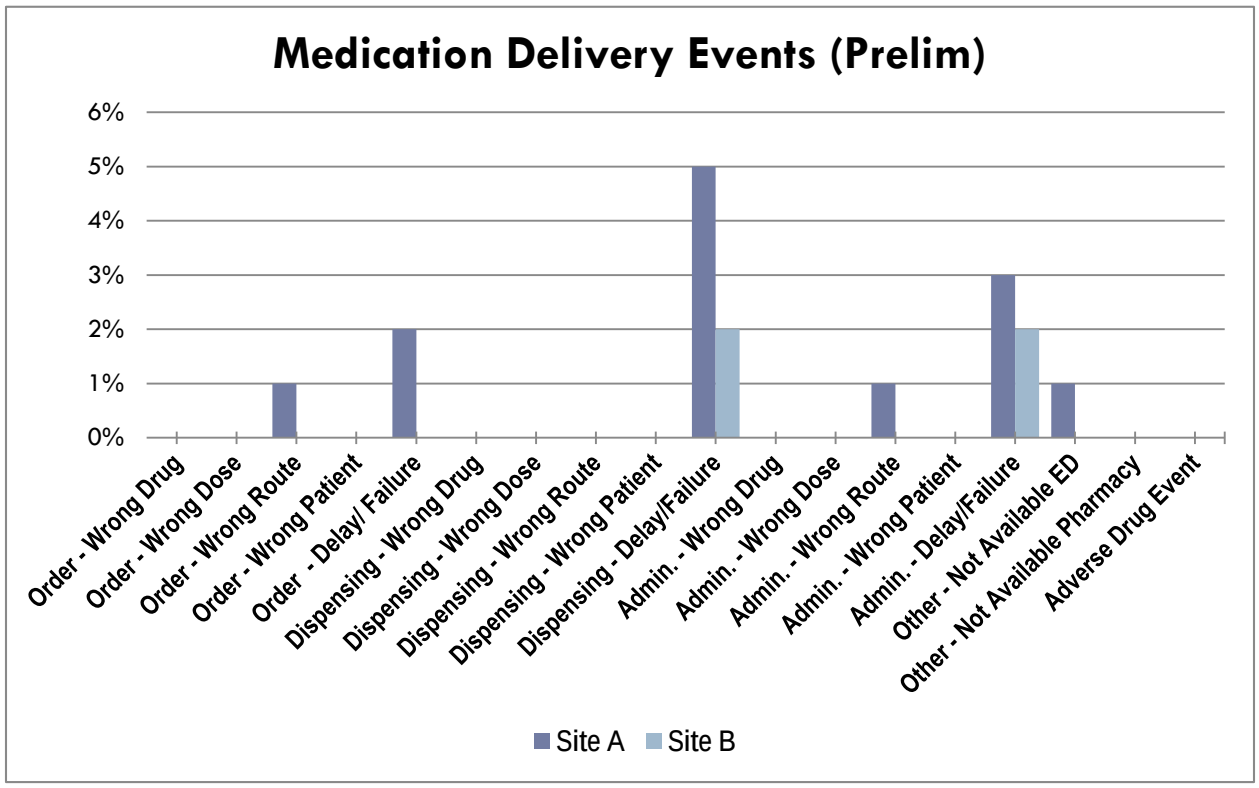


Figure 6. Percent of Medication Orders with Events, by Site



Task 3.2 – Process Time Data Collection. The second of the two main outcome measures was the turnaround times for laboratory testing and radiology testing (from order entry through study completion and result availability) and medication processes (from order entry through medication administration). These data were collected for the randomly selected visits, as described above. Data being collected included the times of each critical, time-dependent step in the laboratory, radiology, and medication processes, from the initial computer order through the completion of the task (medication administration) or through the review of the results (laboratory and radiology processes). The team had been working with Information Technology services to refine the means by which these data would be collected, as initial attempts to collect the process times revealed that a single source for the data did not exist. At the time of the conclusion of the project, we had developed a method to get coordinated data from numerous sources to provide a single, continuous overview of the processes at the level of the individual patient. In addition to providing general operational data, these times, when compared with the delays reported as events for the queried visits, would have provided an indication as to the culture and tolerance for nonideal care in the ED.

Task 3.3 – Clinician Focus Groups. Clinician focus groups were scheduled to be conducted at Site A (UMMC ED) at the beginning of the second year, preceding the implementation of the tracking tool. As with the event and time data, these groups would be conducted pre- and post-implementation at both of the study sites. We estimated that, at each site, we would conduct a total of three cross-discipline focus groups during each of the evaluation periods. The participants would be asked to comment on their experience of

nonideal care events that occurred as a result of gaps in the processes, how they track the status of diagnostic studies and medications, and how they exchange the information at transitions of care.

Task 3.4 – AHRQ's Hospital Survey on Patient Safety Culture. The participatory design methods being used during the tool development (Aim 1), gives the frontline caregivers a personal stake in the improvement activities. We anticipated that these intensive actions to improve the work processes would have had an added benefit of improving the culture of safety in each of the departments. The AHRQ Hospital Survey on Patient Safety Culture was to have been administered to both sites pre- and post-implementation.

Aim 4: Toolkit Development and Dissemination.

After the completion of Aims 1 through 3, it was our intention to develop and disseminate a formal toolkit to provide other EDs the means to design, implement, and test their own status tracking systems. This toolkit development activity was scheduled to take place during Year 3 of the project.

LIST OF PUBLICATIONS AND PRODUCTS

Given the premature conclusion to this project, there were no publications developed as a result of the work.

Appendix A. Draft Version of Cognitive Tool

Rm 9

14:03

LABS	order	received	in process	posted	reviewed
BMP	11:47	12:09	12:58	13:13	
CBC	11:47	12:09	12:26	12:39	
Coags	11:47	12:09	12:25	12:41	
RADS	**order**	**performed**	**posted**	**reviewed**	
MEDS	**order**	**pharmacy**	**administered**		
Morphine	12:13	NA	12:52		
Reglan	12:13	NA	12:52		
Morphine	13:00	NA			

Rm 10

14:03

LABS	order	received	in process	posted	reviewed
BMP	13:21	13:58	14:00		
CBC	13:21	13:56	13:56	13:59	
UA	13:21	13:45	13:45	13:51	
RADS	**order**	**performed**	**posted**	**reviewed**	
CT A/P	13:21				
MEDS	**order**	**pharmacy**	**administered**		
Morphine	13:15	NA	13:41		

Rm 11

14:03

LABS	order	received	in process	posted	reviewed
BMP	12:58	13:26			
CBC	12:58	13:26			
Coags	12:58	13:26			
RADS	**order**	**performed**	**posted**	**reviewed**	
CXR	12:58	13:04			
CT A/P	12:58				
MEDS	**order**	**pharmacy**	**administered**		
Morphine	12:59	NA	13:20		
Morphine	13:32	NA			

Key:
Green – No Delay
Yellow – Slight Delay
Red – Significant Delay