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Comparison Of Ordering Tools On Compliance With Treatment Protocols In The Emergency Department

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CERTIFICATE OF APPROVAL

This is to certify that the Master's Capstone Project of

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"Comparison Of Ordering Tools On Compliance
With Treatment Protocols In The Emergency Department"

Has been approved

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Abstract

Objective: Evidence-based treatment protocols help emergency department providers reduce unwanted variation and improve quality of care. Order sets are essential tools that aid providers in adhering to recommendations but have inherent opportunities for improvement. This study investigates the impact of treatment protocol adherence after the implementation of new ordering tools, called embedded order panels, as part of menu-style quick lists. This study also evaluates the impact of these new ordering tools on provider satisfaction.

Methods: Five order sets, for COPD, CHF, psychiatric evaluation, sedation, and sexual assault, were built as embedded order panels and implemented at seven of nine departments. Order tool usage and patient encounter totals were collected before and after intervention at all departments. Surveys about order tool usage were sent to providers at all sites.

Results: During the pre-intervention period, there were 2,247 applicable patient encounters compared with 1,723 patient encounters during the post-intervention period ($p < 0.001$). The proportion of patient encounters that providers used ordering tools increased significantly after the implementation of embedded order panels (14% pre-intervention vs. 33% post-intervention, $p < 0.001$). A total of 41 survey responses came from providers at the intervention sites while 12 came from control departments. Providers at the intervention sites agreed more strongly that embedded order panels saved them time ($p = 0.008$) and made it easier to follow treatment protocols ($p = 0.024$).

Conclusion: Implementing order sets as embedded order panels within the emergency department quick list can increase ordering tool usage while also saving providers time and making it easier for them to follow treatment protocols.

Introduction

Emergency medicine began in the 1960s, when it was defined as an official academic specialty.[1] Prior to this time, typical emergency departments used residents and physicians from other specialties, including pathology and psychiatry, who rotated as emergency department staff. However, there was a recognition that patients needed specialists trained in the emergent identification and management of life-threatening diseases. As of 2018, there are more than 36,000 board-certified emergency medicine physicians in the United States.[2] As emergency department visits increase exponentially each year, and as the complexity of medicine grows, emergency medicine physicians have more pressure than ever to accurately identify and manage life-threatening diseases. Additionally, professional liability, reimbursement, surge capacity, and diminishing workforce projections are some of the other challenges facing emergency medicine physicians.[1]

Challenges and Errors

The variety of patient conditions that emergency medicine physicians must be comfortable treating is also a challenge. Furthermore, the variation in disease presentation and symptom progression can add confusion and uncertainty. Emergency medicine physicians are expected to evaluate patients at a rapid pace, identifying those who are sick versus those who are stable to go home. In practice, this often means treating high acuity conditions like cardiac arrest on one patient and then immediately shifting to a low acuity condition for the next patient.

Not surprisingly, these challenges can lead to errors. In the landmark publication, "*To Err is Human*," the authors estimated that medical errors cause between 44,000 and 98,000 deaths

each year.[3] The emergency department has been identified as a location where adverse events are attributable to errors.[4] Some research has estimated that 53-82% of these emergency department adverse events are actually preventable.[5,6] In addition to the challenges listed above, other factors that may lead to such errors include disrupted sleep cycles, multiple interruptions, and acute time constraints.[4,7]

In this setting of numerous challenges and preventable adverse events, much work has been done to improve the design and workflows of healthcare delivery systems. Specifically, there has been significant work done to reduce unnecessary variation for specific conditions using treatment protocols. Reduced variation can not only lead to standardization of care but also higher quality care. Additionally, there can also be financial benefits when using standardized treatment protocols.

Protocols and Order Sets

One method of improving workflows and supporting standardized treatment protocols is through the use of order sets (Figure 1). Order sets are “predefined lists of steps that should be taken to deal with certain recurring situations in the care of patients, typically in hospitals.”[8] In emergency medicine, order sets are often created around specific chief complaints or diagnoses. For example, a healthcare system may have standardized emergency medicine order sets for chest pain, shortness of breath, or abdominal pain. Order sets can contain a variety of orders, including laboratory studies, medications, imaging studies, and nursing communication orders. Many order sets may have the most common or most recommended orders selected by default, while other orders are included but not pre-selected. The use of order sets allows for consistent ordering for patients with specific chief complaints or conditions.

Order sets also allow for increased provider efficiency and satisfaction. Instead of searching for individual orders, providers can use an order set to save time and clicks.

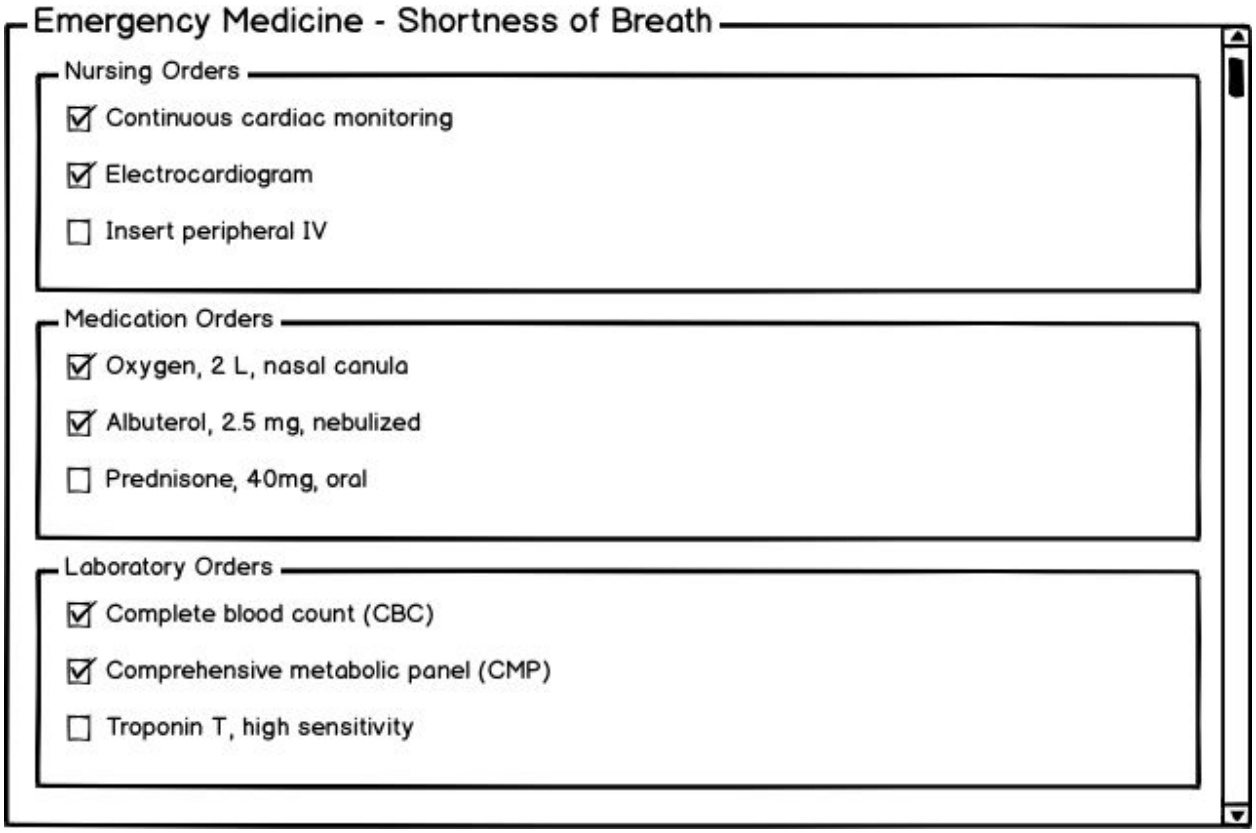

Figure 1 - This is an example of an order set that could be used for shortness of breath in the emergency department. This example contains nursing, medication, and laboratory orders with some pre-selected.

The implementation of order sets to promote evidence-based, guideline-adherent patient care has proven successful. In 2015, Sonstein et al. published an article highlighting their work on implementing an order set for the management of acute exacerbations of chronic obstructive pulmonary disease (COPD).[9] The authors recognized high variation in the management of COPD, specifically in the amount of corticosteroids administered to patients, which were overprescribed. The authors hypothesized that their order set would reduce the amount of

corticosteroids administered to patients. The primary outcome measure in this study was corticosteroid dose administered. The intervention was the implementation of an evidenced-based order set for the management of acute COPD exacerbations. The results of this study were significantly reduced amounts of corticosteroids administered in the first 48 hours of hospital admission as well as during the entire hospital admission.[9] The authors concluded that evidenced-based order sets improve compliance with treatment protocols.

These findings have been replicated at other sites. Also in 2015, Brown et al. implemented a similar evidence-based order set for the management of acute COPD exacerbations.[10] The authors found that order set usage improved physicians' adherence to evidence-based treatment protocols.[10] These findings were associated with reductions in length of hospital stay, as well.

Improved adherence to evidence-based protocols have also been demonstrated with the implementation of order sets for other disease processes. In 2014, Maynard et al. found that compliance with protocol-based medication adjustments significantly improved after the implementation of an order set.[11] In 2017, Bartlett et al. showed that an order set for pediatric patients with asthma reduced variability in practice and increased adherence to national guideline-based treatment protocols.[12] Also in 2017, Goldszer et al. demonstrated a significant decrease in mortality for patients who had a sepsis order set used compared to those who did not have the order set used.[13]

At Geisinger, standardization, reduction of unnecessary variation, and increasing use of treatment protocols are high priorities. Geisinger is an integrated healthcare delivery organization in central Pennsylvania that serves more than 3 million patients in 45 counties. Geisinger was an early adopter of an electronic health record and has been using the same one since the late 1990s. Emergency medicine leadership supervised the implementation of many

chief complaint and diagnosis-based order sets, which have undergone numerous revisions and updates since they were first created. Usage of these order sets and treatment protocols have been incentivized and monitored at both department and provider levels.

Quick Lists

In 2017, upgrades to Geisinger's electronic health record brought new functionality to ordering. Specifically, in the emergency department, providers were now able to choose orders from a quick list. A quick list is a large pre-set menu of commonly placed orders. Providers simply point-and-click over the orders they would like to place. The quick list loads by default whenever a user navigates to the ordering activity in the electronic health record. For providers, advantages to this menu style ordering are once again efficiency and satisfaction. Instead of searching for particular orders or order sets, providers simply click on the ones that are needed (Figure 2).

Research on the topic of quick lists is limited. In 2008, Sard et al. evaluated the impact of a quick list on medication prescribing errors in a pediatric emergency department.[14] This study used a different electronic health record than the one in place at Geisinger; however, the quick list functioned in a similar manner. The authors concluded that the quick list led to a significant reduction in medication prescribing errors.[14]

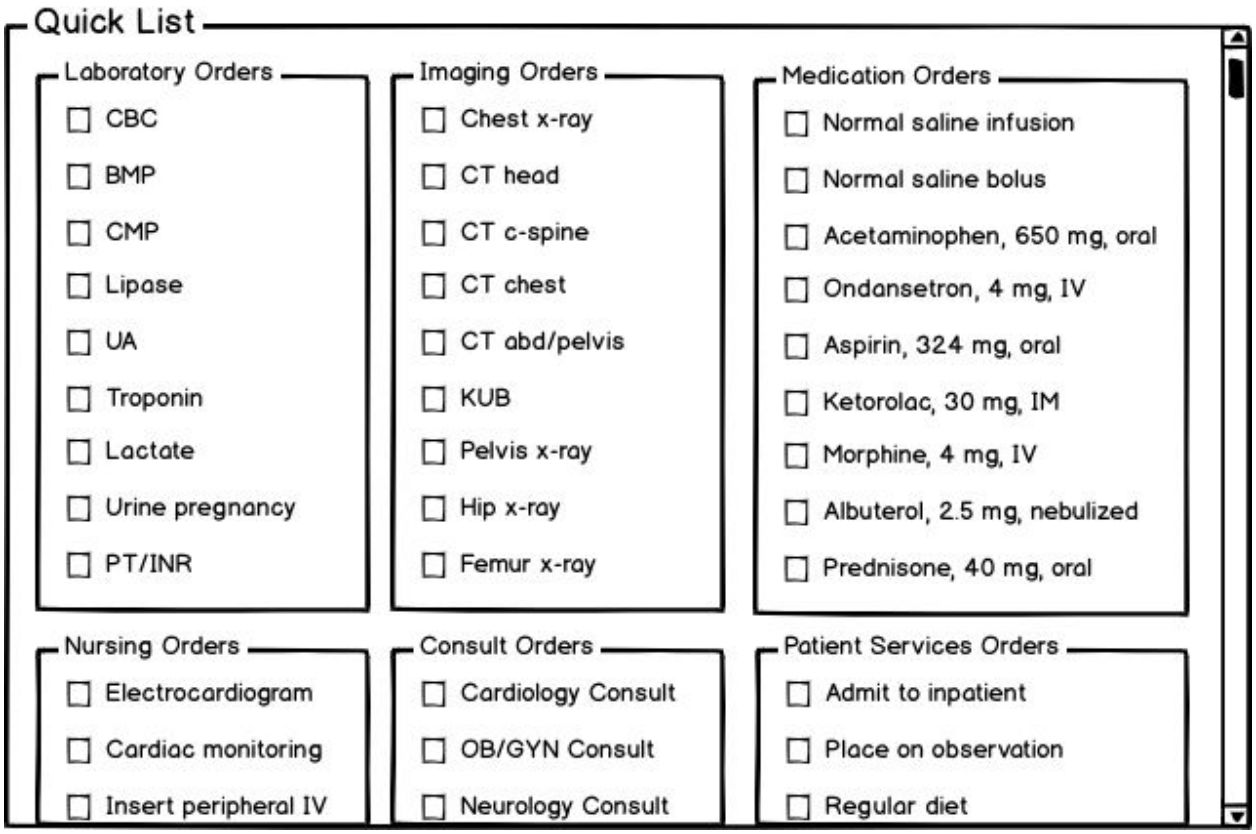

Figure 2 - This is an example of a quick list, which is the default screen when providers navigate to the ordering activity. This example contains various sections which often include the most common emergency department orders.

Unfortunately, emergency medicine leadership at Geisinger noticed an unintended consequence of this new quick list, menu style of ordering. The use of and compliance with order sets significantly declined. Instead of searching for specific order sets, emergency medicine leadership discovered that providers would individually click the orders that they needed on the quick list. As a consequence, the goals of standardization, reduction of unnecessary variation, and increasing use of treatment protocols directly conflicted with that of provider efficiency and satisfaction.

In 2019, Geisinger's electronic health record gained functionality to incorporate order sets directly into quick lists. This new functionality, called embedded order panels, allows

providers to select a group of orders using the familiar quick list, menu-style of ordering (Figure 3). The evaluation of order sets embedded into quick lists as order panels has not occurred in the literature and offers a valuable area of research opportunity.

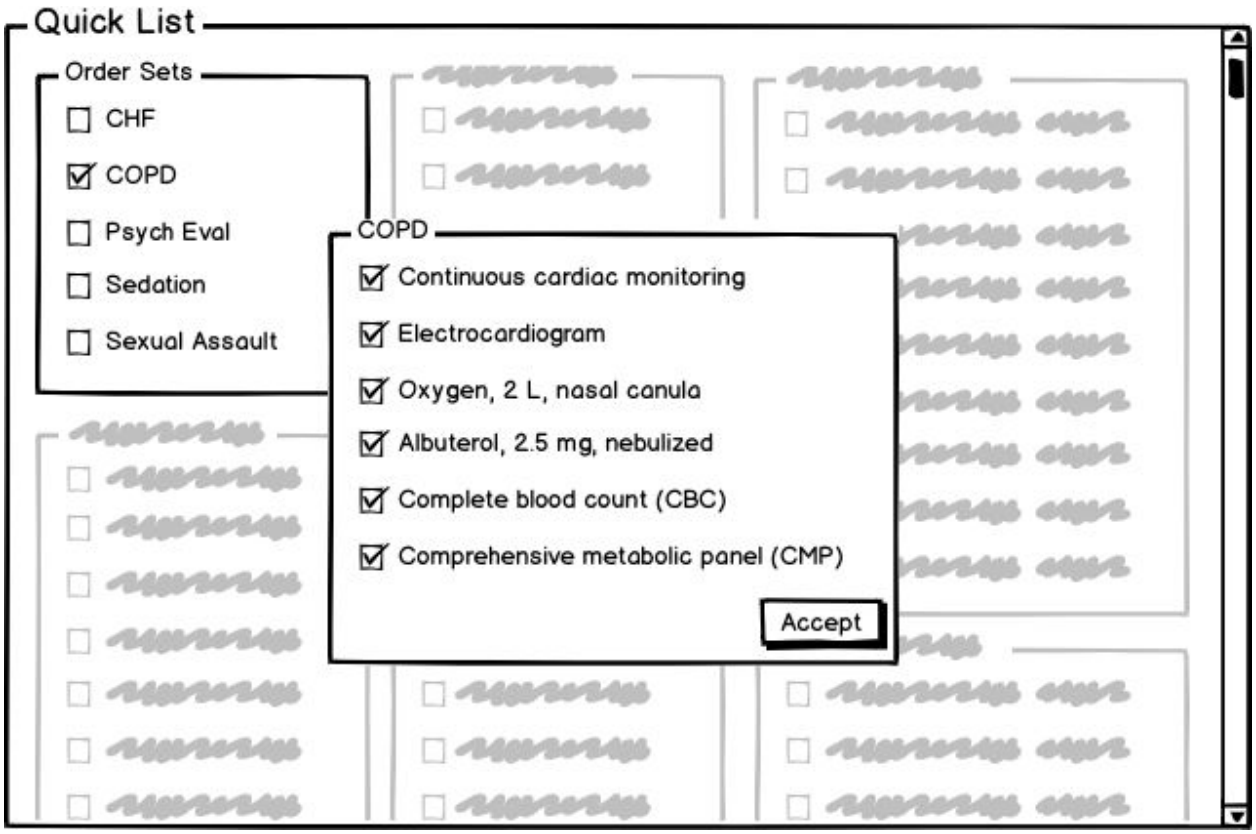

Figure 3 - This is an example of a quick list with order sets, or embedded order panels, incorporated. In this example, when a user selects the COPD order panel, it opens with the recommended orders.

Study Aims

This study seeks to evaluate the effect of embedded order panels within quick lists on the compliance with system-wide and evidenced-based treatment protocols in the emergency department. This study presumes that treatment protocol adherence decreased after the

implementation of quick lists due to the ease of ordering items individually from those quick lists. In comparison to the point-and-click use of quick lists, order sets have to be searched for and opened. This study hypothesizes that treatment protocol adherence will increase after the implementation of embedded order panels within the quick list. This solution has the potential to realize benefits from both ordering tools. Providers gain speed and ease of ordering from the quick list while still using an evidence-based group of orders from a panel. Finally, this study hypothesizes that providers will find the embedded, quick list order panels simple to use, making it easier to follow treatment protocols.

Materials and Methods

This study was conducted in a quasi-experimental manner, with a pre-test/post-test design that utilized a comparison group to evaluate the implementation of embedded order panels into quick lists for emergency department ordering. The study was evaluated in a mixed-method manner, looking at the use of standardized ordering tools and provider impressions of the new embedded order panels. The study protocol was approved by the Geisinger Institutional Review Board by expedited review, with a waiver of the requirement of written informed consent for the evaluation of anonymized order panel and order set usage.

Study Population

The study population consisted of emergency medicine attending physicians, resident physicians, and advanced practitioners who work in nine of Geisinger's emergency departments. These nine emergency departments are diverse in their size, geographic location, staffing models, patient populations, annual volumes, and in available resources. The nine emergency departments are divided into four separate regions based on distinct groups of emergency department providers that staff each region. Each emergency department has their own quick list in the electronic health record but all departments share the same order sets. The intervention, which is implementing embedded order panels in quick lists, was evaluated at three of the four regions (seven of the nine departments). This allowed one region and two departments, who do not share staff with other departments, to be control sites that continued to use the standard order sets and their own quick lists without embedded order panels. The control regions and departments were not educated on embedded order panels but were

included in data collection of order set usage. Table 1 provides a summary of these departments and indicates which were control groups.

Region	Department	Details	Staffing	Annual Visits	Control Site
1	ED 1	Large, academic, tertiary referral center	A, R, AP	45,000	No
	ED 2	Small, community hospital	A, R, AP, S	25,000	No
	ED 3	Small, community hospital	A, R, AP, S	22,000	No
	ED 4	Small, critical access hospital	A	12,000	No
2	ED 5	Large, urban hospital	A, AP, S	60,000	No
	ED 6	Small, community hospital	A, AP, S	20,000	No
3	ED 7	Large, urban hospital	A, R, AP, S	43,000	No
4	ED 8	Large, urban hospital	A, AP, S	60,000	Yes
	ED 9	Small, community hospital	A, R, AP, S	33,000	Yes

Table 1 - These are the regions and emergency departments included in the study, with a summary of each department, staffing models, annual visits, and if they were a control site. For staffing models: A=attending physicians, R=resident physicians, AP=advanced practitioners, S=scribes.

Intervention

Geisinger has 54 emergency department order sets that are shared across all nine departments. In conjunction with emergency department leadership, a decision was made to implement five of these order sets as embedded order panels on the quick lists of the intervention sites. The decision to implement a subset of the order sets was in part to serve as a

proof-of-concept to understand usage, functionality, and provider experience. The order sets that were chosen to be implemented as embedded, quick list order panels were not determined solely by frequency of use. Instead, emergency medicine leadership selected the order sets they felt were most important for providers to follow a standardized treatment protocol.

The order sets that were selected for implementation as embedded, quick list order panels were those for congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), psychiatric evaluation (psych), sedation, and sexual assault. Organizational resources and priorities around some of these processes, such as CHF and COPD, make them important for providers to follow specific recommendations. Geisinger has specific outpatient and inpatient resources addressing these two disease processes and the order sets have detailed guidance for providers. Other order sets, like those for sedation and sexual assault, have a high level of scrutiny by regulatory and accrediting bodies and were chosen for implementation as embedded order panels on quick lists with the hypothesis that it would increase compliance. The psychiatric evaluation order set is frequently used and helps facilitate smoother evaluation and handoff with our psychiatric colleagues.

The order panels were built in the development environment of Geisinger's electronic health record. The corresponding order set was used as a template when building the embedded order panels so that the tools were consistent. The quick lists for the intervention sites were updated to include a new, prominent section for embedded order panels. This build was reviewed by Geisinger's Order Governance group, which is a multidisciplinary team of analysts, pharmacists, providers, nurses, and other key stakeholders. The order panels were approved by this group and moved into Geisinger's test environment. After testing and validation, the build was moved to the production environment, which made it available to end users.

Provider Training

Emergency department providers at the intervention sites were provided training and education on the new embedded order panels. Each region has monthly staff meetings where providers are expected to attend. The new functionality was demonstrated and discussed at multiple meetings leading up to the implementation. Additionally, there is a bi-weekly email update sent to every emergency department provider. Screenshots and information on the embedded order panels were also included in multiple editions of the communication.

Data Collection

Data were collected before and after the intervention. Baseline order set usage was collected for all regions and departments between February 1, 2019 and March 15, 2019. Recognizing there is a seasonality to the incidence of some disease processes, the intervention was implemented on January 30, 2020 so that data could be collected during the same time of year. Order set and order panel usage were collected between February 1, 2020 and March 15, 2020. Surveys were sent to emergency department providers in March 2020.

Data for usage of order sets were collected from a back-end utility provided by our electronic health record. This utility allowed for reporting aggregate usage information at the department level before and after implementation of embedded order panels on the quick list. Data for usage of embedded order panels were collected from front-end reports that also gave aggregate usage information at the department level. Both reporting mechanisms provided the number of times each order set or order panel were used, as well as the total number of orders placed through each tool. Usage data was summarized by regions, given that staff within a specific region work at multiple departments. The regions are described in Table 1 above.

While helpful, absolute usage data of the ordering tools does not give any indication into how often these tools should be used. In order to obtain a percentage of times used, anonymized, de-identified data were collected on emergency department encounters with specific diagnoses during the same study periods. These encounters served as the denominator while total times used were the numerator. For COPD, all encounters with a primary diagnosis of chronic obstructive pulmonary disease (ICD-10-CM code J44), or one of its modifiers, were included. For CHF, all encounters with a primary diagnosis of heart failure (ICD-10-CM code I50), or one of its modifiers, were included. For sexual assault, all encounters with a chief complaint of sexual assault or a primary diagnosis of sexual assault (ICD-10-CM code T74.2), were included.

For psychiatric evaluations, all encounters with a chief complaint of psych evaluation were included. Using the chief complaint alone, and not diagnoses, was more reliable given the volume and variety of primary diagnoses for this encounter type. Additionally, Geisinger has a number of operational mechanisms in place to accurately identify patients who need psychological evaluation so that the appropriate resources and teams can be contacted and meet the patient in the department.

Data for the total number of sedations performed in Geisinger's emergency departments were collected from a front-end report that included all encounters with specific nursing-events that mark the start/stop of a sedation. This method was used to determine the denominator of total sedations because sedation is not typically listed as a chief complaint or primary diagnosis.

Surveys

Two surveys were created consisting of five questions. The surveys were identical but one used language for order sets while the second survey used language for order panels

(Appendix A). The surveys asked structured questions about how easy it was to learn to use the ordering tool, how easy it was to follow treatment protocols, if the ordering tool saved providers time, and an overall impression of the ordering tool. These questions were designed using Likert scales from 1 to 5, with 1 being a strongly disagree or negative answer while 5 was a strongly agree or positive answer. There was also a question to allow providers to indicate if any adverse events occurred secondary to the ordering tools. The survey for order set usage was sent to all emergency department providers at the control sites where embedded, quick list order panels were not implemented. The survey for embedded order panels was sent to all emergency department providers at the intervention sites.

Analysis

Summary and statistical analyses were performed using Microsoft Excel (Microsoft Corporation, Redmond, WA) and PSPP (https://gnu.org/software/pspp). Order tool usage was enumerated as frequencies. Chi-square and Fisher's exact tests were conducted, as appropriate, to investigate differences in use before and after intervention by topic and facility. For chi-square analyses, the chi-square test statistic and p-value are reported, along with odds ratios and 95% confidence intervals. For scenarios that had 5 or fewer usages during a time frame, Fisher's exact test analyses were conducted and the p-value is reported. For scenarios that did not have any usage during the study time frames, no statistical analyses were conducted. An alpha of 0.05 was used for all analyses. Survey data of provider survey responses were summarized as mean, standard deviation, median, and interquartile range. For questions 1 to 4, Mann-Whitney *U* tests were conducted to investigate differences in provider responses between intervention and control sites and the *p*-value was reported. For questions 5, which was answered as either yes or no, a Chi-square test was conducted.

Results

Demographic Characteristics

Across all nine emergency departments, there were a total of 37,095 patient encounters during the pre-intervention study period. Of those encounters, 2,247 (6.1%) met the chief complaint and diagnosis criteria described in the methods section. During the post-intervention study period, there were a total of 39,190 patient encounters across all nine emergency departments. Of those encounters, 1,723 (4.4%) met the chief complaint and diagnosis criteria described in the methods section. As compared to the pre-intervention study period, there was a significant decrease in the proportion of encounters that met the chief complaint and diagnosis criteria described in the methods section (Table 2). The chief complaints or diagnoses that had a significant decrease in encounters during this time were CHF, COPD, and psych (Table 2).

Complaint or Diagnosis	Pre-Intervention	Post-Intervention	X^2 (df)	OR (95% CI)	*p*-value
CHF	323/37,095 (0.9%)	221/39,190 (0.6%)	25.34 (1)	0.65 (0.54, 0.77)	<0.001
COPD	297/37,095 (0.8%)	245/39,190 (0.6%)	8.32 (1)	0.78 (0.66, 0.92)	0.004
Psych	1,507/37,095 (4.1%)	1,114/39,190 (2.8%)	85.49 (1)	0.69 (0.64, 0.75)	<0.001
Sedation	96/37,095 (0.3%)	124/39,190 (0.3%)	2.20 (1)	1.22 (0.94, 1.60)	0.138
Sexual Assault	24/37,095 (0.1%)	19/39,190 (0.05%)	0.89 (1)	0.75 (0.41, 1.37)	0.346
Total	2,247/37,095 (6.1%)	1,723/39,190 (4.4%)	106.56 (1)	0.71 (0.67, 0.76)	<0.001

Table 2 - Proportion of encounters during the study periods that met chief complaint and diagnosis criteria outlined in the methods section. X^2 = Chi square statistic. OR = odds ratio. CI = confidence interval.

Overall Usage

Order set usage was collected from all nine emergency departments from February 1st, 2019 to March 15th, 2019. Across all nine emergency departments these five order sets were used 258 times during the pre-intervention study period. Embedded order panel usage, as well as order set usage, was collected from all nine emergency departments from February 1st, 2020 to March 15th, 2020. Across these departments the order tools were used 410 times during the post-intervention study period. Data are summarized by regions in Table 3, Table 4, Table 5, Table 6, and Table 7.

Overall, in the three intervention regions, there was a significantly greater proportion in the use of the order tools after implementation of embedded order panels (Table 3). This was

driven overall, and at each site, by a significantly greater proportion of use of the psych order tools. For CHF, sedation, and sexual assault, there was an increased proportion of use of the order tools; however, it was not significant in these categories (Table 3).

Topic	Pre-Intervention Use	Post-Intervention Use	X^2 (df)	OR (95% CI)	*p*-value
CHF	17/239 (7%)	15/137 (11%)	1.65 (1)	1.61 (0.77, 3.33)	0.200
COPD	32/247 (13%)	21/181 (12%)	0.18 (1)	0.88 (0.49, 1.59)	0.675
Psych	152/864 (18%)	324/667 (49%)	151.42 (1)	4.06 (3.22, 5.11)	<0.001
Sedation	0/66 (0%)	2/99 (2%)	1.35 (1)	NA	0.245
Sexual Assault	5/17 (29%)	5/14 (36%)	0.34 (1)	1.56 (0.35, 6.94)	0.340
Total	206/1433 (14%)	367/1098 (33%)	119.96 (1)	2.87 (2.37, 3.49)	<0.001

Table 3 - Order tool usage and statistical analyses at all intervention sites. X^2 = Chi square statistic. OR = odds ratio. CI = confidence interval. NA = not calculated given minimal or no use in either pre or post intervention.

Intervention Site Usage

In regions 1 and 2, use of the order tools before and after implementation of the embedded order panels reflected that of all intervention sites. There was a significantly greater proportion of use of the order tools in the post-intervention period driven solely by a greater proportion of use of the psych order tools (Table 4 and Table 5). For sedation order tools, there was insufficient data to calculate confidence intervals. For sexual assault, there was use of the

order tools before and after intervention, but overall use was too low to use a chi-square test for analysis so a Fisher's exact test was used.

Topic	Pre-Intervention Use	Post-Intervention Use	X^2 (df)	OR (95% CI)	*p*-value
CHF	8/96 (8%)	11/65 (17%)	2.75 (1)	2.24 (0.85, 5.92)	0.097
COPD	11/116 (9%)	15/88 (17%)	2.57 (1)	1.96 (0.85, 4.51)	0.109
Psych	29/416 (7%)	103/323 (32%)	76.95 (1)	6.25 (4.01, 9.74)	<0.001
Sedation	0/32 (0%)	1/44 (2%)	0.74 (1)	NA	0.391
Sexual Assault	2/4 (50%)	3/4 (75%)	NA	3.00 (0.15, 59.89)	1.004*
Total	50/664 (8%)	133/524 (25%)	71.62 (1)	4.18 (2.95, 5.92)	<0.001

Table 4 - Region 1 order tool usage and statistical analyses. X^2 = Chi square statistic. OR = odds ratio. CI = confidence interval. NA = not calculated given minimal or no use in either pre or post intervention. * = Fisher's exact test used.

Topic	Pre-Intervention Use	Post-Intervention Use	X^2 (df)	OR (95% CI)	*p*-value
CHF	1/97 (1%)	2/44 (5%)	NA	4.57 (0.40, 51.81)	0.496*
COPD	5/93 (5%)	5/64 (8%)	NA	1.49 (0.41, 5.38)	0.742*
Psych	7/61 (11%)	75/75 (100%)	110.12 (1)	NA	<0.001
Sedation	0/34 (0%)	1/43 (2%)	0.80 (1)	NA	0.371
Sexual Assault	3/7 (43%)	2/3 (67%)	NA	4.00 (0.25, 63.95)	0.523*
Total	16/292 (5%)	85/198 (43%)	71.62 (1)	10.26 (5.80, 18.15)	<0.001

Table 5 - Region 2 order tool usage and statistical analyses. X^2 = Chi square statistic. OR = odds ratio. CI = confidence interval. NA = not calculated given minimal or no use in either pre or post intervention. * = Fisher's exact test used.

In region 3, use of the order tools before and after implementation of the embedded order panels was similar to that of all intervention sites. There was a significantly greater proportion of use of the order tools in the post-intervention period driven by a greater proportion of use of the psych order tools (Table 6). For sedation and sexual assault order tools, there was insufficient data to perform statistical analyses. For COPD, there was a significantly smaller proportion of use of the order tools in the post-intervention period (Table 6).

Topic	Pre-Intervention Use	Post-Intervention Use	X^2 (df)	OR (95% CI)	*p*-value
CHF	8/46 (17%)	2/28 (7%)	NA	0.37 (0.07, 1.86)	0.301*
COPD	16/38 (42%)	1/29 (3%)	NA	0.05 (0.01, 0.40)	<0.001*
Psych	116/387 (30%)	146/300 (49%)	25.03	2.21 (1.62, 3.03)	<0.001
Sedation	0/0 (0%)	0/12 (0%)	NA	NA	NA
Sexual Assault	0/6 (0%)	0/7 (0%)	NA	NA	NA
Total	140/477 (29%)	149/376 (40%)	9.91	1.58 (1.19, 2.10)	0.002

Table 6 - Region 3 order tool usage and statistical analyses. X^2 = Chi square statistic. OR = odds ratio. CI = confidence interval. NA = not calculated given minimal or no use in either pre or post intervention. * = Fisher's exact test used.

Control Site Usage

In region 4, the control sites, use of the order tools was not significantly different when comparing the two study periods (Table 7). Similar to the intervention sites, use of the psych ordering tools was most common. In the second study period, there was increased use of the sexual assault order tools in 100% of encounters (Table 7).

Topic	Pre-Intervention Use	Post-Intervention Use	X^2 (df)	OR (95% CI)	*p*-value
CHF	1/84 (1%)	0/84 (0%)	NA	NA	NA
COPD	0/50 (0%)	0/64 (0%)	NA	NA	NA
Psych	46/643 (7%)	32/447 (7%)	0.00	1.00 (0.63, 1.60)	0.998
Sedation	5/30 (17%)	5/25 (20%)	NA	1.25 (0.32, 4.93)	1.000*
Sexual Assault	0/7 (0%)	6/6 (100%)	13.00	NA	<0.001
Total	52/814 (6%)	43/625 (7%)	0.12	1.08 (0.71, 1.64)	0.728

Table 7 - Region 4 order tool usage and statistical analyses. X^2 = Chi-square statistic. OR = odds ratio. CI = confidence interval. NA = no statistical test was performed given low frequency of use.

Survey Results

Surveys were sent to 101 emergency department providers on March 9, 2020. Reminder emails were sent to emergency department providers on March 16, 2020. Two separate surveys were sent and questions are listed in Appendix A. One survey went to 66 emergency department providers who worked at the intervention sites that used embedded order panels. The second survey was sent to 35 emergency department providers who worked at the two control sites that did not use embedded order panels. At the intervention sites, a total of 41 (62%) emergency department providers completed the survey. At the control sites, a total of 12

(34%) emergency department providers completed the survey. These results are listed below in Table 8.

Providers at the intervention sites agreed more strongly that embedded order panels saved them time when compared to the responses of the control sites (Table 8, Question 3). Providers at the intervention sites also agreed more strongly that it was easier to follow treatment recommendations using order panels when compared to the responses of the control sites (Table 8, Question 2). Questions 1 and 4 had no significant difference between the intervention and control sites. For Question 5, there was no difference in the reported occurrence of negative patient outcomes between the ordering tools (Table 9).

Question	**Mean (SD)**		**Median (IQR)**		***p*-value**
	Intervention	**Control**	**Intervention**	**Control**	
1	3.95 (1.09)	3.50 (0.80)	4.00 (2.00)	3.50 (1.00)	0.096
2	3.90 (1.02)	3.25 (0.75)	4.00 (2.00)	3.00 (0.75)	0.024
3	3.95 (1.22)	3.08 (0.90)	4.00 (2.00)	3.00 (1.00)	0.008
4	3.83 (1.14)	3.33 (0.78)	4.00 (2.00)	3.00 (1.00)	0.053

Table 8 - These are the results of the survey sent to emergency department providers at the intervention and control sites. Questions are in Appendix A. Questions 1-4 used a 5-point Likert scale. Mann-Whitney *U* test conducted. SD = standard deviation. IQR = interquartile range.

Question	**Intervention (answered no)**	**Control (answered no)**	**X^2 (df)**	**OR (95% CI)**	***p*-value**
5	32/39 (82%)	10/12 (83%)	0.01 (1)	0.91 (0.16, 5.13)	0.919

Table 9 - These are the results of question 5 of the survey sent to emergency department providers at the intervention and control sites. Questions are in Appendix A. Question 5 was answered yes or no. X^2 = Chi-square statistic. CI = confidence interval.

Discussion

Order Tool Usage

Overall order tool use at the intervention departments increased when compared to pre-intervention data. As highlighted in the results section, this was driven by increased usage of the psych order tools. There are a few factors that may explain this. First, the population of patients seen for psych complaints during the study periods was greater than the populations seen for other complaints. If providers are seeing more of a specific complaint, they may be more motivated to use ordering tools to save time for repetitive ordering. Additionally, the contents of the psych order set may contribute to its increased use. There are specific orders that consultants and admitting providers for psych patients require before evaluating the patient. Furthermore, there are orders within the psych order set that facilitate rapid communication with other treatment team members, like care management. The potential for saving time not only when ordering, but during the entire encounter, may provide positive reinforcement.

In one region (region 3), it is interesting that there was a significant decrease in order tool usage for COPD after implementation of the embedded order panels. This indicates that the order panels and order sets were used less often than prior to the intervention. Likely causes include the limited data collection periods and the statistically significant decrease in COPD patients when comparing pre and post intervention populations. These are discussed in more detail in the limitations section below.

In regions 1, 2, and 4, there was an increase in the overall use of the sexual assault order panel. However, it was not significant given the low totals. The low usage of this particular embedded order panel and order set could have been predicted prior to implementation. In fact,

this order panel was chosen for implementation not because of high use but because of the importance of adhering to specific guidelines and recommendations that are highly scrutinized by internal and external auditors. Luckily, evaluation for sexual assault is not something that emergency department providers in our system have to deal with on a frequent basis. For some emergency department providers, it may be months between evaluations. Emergency department leadership felt it was imperative to increase usage of these standardized treatment protocols so that providers do not forget specific portions of the process, given the potential for unfamiliarity. Perhaps evaluating usage of the order tools for sexual assault over a longer period of time, like an entire year, may provide more insight into the effect of the embedded order panels.

It was somewhat surprising to see how low the usage of these five order sets was after the intervention; the degree to which order sets were not used was greater than subjectively expected. Beyond what is discussed in this study, such as the impact of quick lists, other possible causes for these low usage numbers include poor order set design, lack of training or awareness, and little accountability for treatment protocol adherence. Specifically, other studies have found that unclear prioritization of requests, lack of coordination between teams, and lack of communication between producers and requesters to be root causes in poor order set design.[15] Idemoto et al. showed that implementing a systematic and cyclic order set review process with defined responsibilities for various stakeholders and formalized communication can significantly improve the quality of order sets, as well as the usage of those tools.[15]

Given the low usage at some departments, this is one reason that the study used regions when comparing data. Grouping the departments provided more data to analyze. Additionally, regions were ideal given the fluidity of providers within the emergency departments. Particularly in regions 1 and 2, the providers routinely work at multiple sites within

a given week. While this aggregation method provided a number of benefits, it potentially ignores the impact that department size and patient volume have on order tool usage. It is possible that order tool usage may vary in departments that see more or less patients.

Finally, there may be a significant component of Hawthorne effect present in this study. The intervention group received training and additional communications on the importance of using treatment protocols through embedded order panels. The training and awareness alone may have contributed to the increase in order tool usage. This potentially could have been controlled for if re-education and communication about order sets had occurred at one of the non-intervention departments. This would have allowed for comparison between the sites that received order panel training, a site that received a refresh on their order set training, and a site that received no additional training or education.

Provider Impressions

Providers at the intervention sites agreed more strongly that embedded order panels saved them time and made it easier to follow treatment recommendations when compared to the responses of the control sites. This confirmed one of the study hypotheses.

It is likely that providers saved time because of a simplified ordering process. Embedded order panels are directly available to providers on the main screen of the ordering activity. This reduces the time and clicks required to select the search box, enter an order set name, search for the order set, and then open the order set. Additionally, the ability to quickly find embedded order panels likely improves the ease of following treatment recommendations.

While providers at the intervention sites did agree more strongly that embedded order panels save them time and made it easier to follow treatment protocols when compared to the responses at the control sites, the providers at the intervention sites did not significantly agree

that learning how to use order panels was easy, when compared to the providers in the control regions using order sets. Besides the small sample sizes being a contributing factor to the non-significance of this finding, it is also possible that the responses to this question simply reflect providers needing to learn a new tool. Additionally, there is a component of recall bias. Order sets were implemented many years ago and it is possible the providers in this study do not accurately recall how easy or difficult it was to learn how to use them.

The providers at the intervention sites also did not have a significantly more positive or negative reaction to embedded order panels as compared to providers at the control sites using order sets. Again, the small sample size may contribute to these findings. Additionally, there is likely both selection and sampling biases present in the intervention and control groups of this study.

Limitations

There are a number of limitations in this study that make it difficult to extrapolate results to broader populations and use cases. First, only 5 of 55 (9%) order sets were implemented as order panels. This limited implementation of the intervention created fragmented workflows where providers could use embedded order panels for some topics but would still need to search for and find order sets for other topics. It is possible that providing all order sets as embedded order panels would have provided a more accurate comparison of the tools.

At the intervention sites, for the five studied topics, both embedded order panels and order sets were available for use. While education and training were available, provider behavior can be difficult to change.[16, 17] Completely removing the order sets at the intervention sites and forcing providers to use the embedded order panel might have driven providers to

these tools more consistently. This approach would also have given a more direct comparison between order sets and embedded order panels.

Another limitation was the short period of observation. Usage data was collected for only six weeks, from February 1st to March 15th. In the post-intervention study period, this was immediately after the implementation of the tools. It is possible a longer study period or using a period of time more distant from the implementation of new tools may have allowed providers to be more familiar with embedded order panels.

It is also important to note that the proportion of encounters that met the chief complaint or diagnosis criteria, outlined in the methods section, was significantly decreased in the post-intervention period (Table 2). While the exact reason for this is unclear, there are a few possible causes. The chief complaints or diagnoses that had a significant decrease in encounters during the post-intervention study period were CHF, COPD, and psych. This may reflect the organization's effort over the past year to increase the availability of appropriate outpatient resources for these specific topics.

It is also possible that the COVID-19 (novel coronavirus) pandemic that occurred during the post-intervention study period had a significant impact on the chief complaint and diagnoses seen in the emergency departments. Initial reports from other countries indicated that emergency department visits have dropped significantly during this time.[18] The pandemic may also have impacted the response rate to the provider surveys.

The next limitation is that this study did not account for compliance with the recommended treatment protocols if the provider manually selected each order. Compliance with the treatment protocol was only counted if the provider used the order set or embedded order panel. It is possible that some providers adhered to recommendations while not using these order tools by independently selecting each order.

Finally, the employment status of the control region and departments may have impacted the results. In regions 1, 2, and 3, all emergency department providers are employed by the healthcare system. In comparison, the emergency department providers in the control region and departments are contracted employees that work for a third-party group. These departments were specifically chosen as controls for this reason. Logistically, it would have been more difficult to provide training and education to these providers. However, it is possible that these groups have different priorities or practice patterns than the employed providers. It is also possible that contracted employment status also negatively impacted the response rate of the provider survey.

Next Steps

Additional work is needed to fully understand the impact of quick lists on the compliance with treatment protocols in the emergency department. Specifically, a more robust study would implement all order sets as embedded order panels, instead of just a subset. This would create a uniform workflow for ordering providers.

Furthermore, studying the order panels over a longer period of time may yield additional insights. It will also be important to study the impact of embedded order panels across multiple organizations, to understand if the conclusions are generalizable. Previous work using time-motion analyses of providers in the electronic health record[19,20] could be extended to investigate additional benefits in the use of embedded order panels. This would allow greater insight into the time or click impact that ordering tools have on provider workflows.

Finally, the electronic health record in this study only allows quick lists and embedded order panels to be used in the emergency department. Expanding this functionality to inpatient and outpatient ordering tools could capture additional benefits and patterns of use.

Conclusion

Emergency department providers see a wide variety of disease processes and acuities. Treatment protocols are effective ways to reduce unwanted variation and standardize patient care in these busy settings. Within the electronic health record, order sets have been shown to improve treatment protocol adherence, as well as patient outcomes. Newer tools, such as quick lists, were designed to improve provider experience and facilitate easier point-and-click ordering. However, unintended consequences of improved provider satisfaction within the electronic health record may conflict with organizational priorities of treatment protocol and order set compliance. This study demonstrated that implementing order sets as embedded order panels within the quick list can synergistically accomplish both goals, increasing treatment protocol adherence while also improving provider satisfaction. After the implementation of embedded order panels at the intervention sites, the proportion of encounters that used the recommended ordering tools significantly increased. Additionally, providers at the intervention sites felt that embedded order panels save them time and made it easier to follow treatment protocols.

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Appendix A - Survey Questions

Question 1:
It was easy to learn to use [Order Sets or Embedded Order Panels].

Strongly Disagree	1 2 3 4 5	Strongly Agree

Question 2:
It is easy to follow treatment protocols using [Order Sets or Embedded Order Panels].

Strongly Disagree	1 2 3 4 5	Strongly Agree

Question 3:
The [Order Sets or Embedded Order Panels] save me time when following treatment protocols.

Strongly Disagree	1 2 3 4 5	Strongly Agree

Question 4:
What is your overall reaction to using the [Order Sets or Embedded Order Panels]?

Negative	1 2 3 4 5	Positive

Question 5:
Have there been any negative patient outcomes using either the [Order Sets or Embedded Order Panels]?

Yes	No
Explanation:	

Appendix B - Participant Recruitment Letters

Initial Invitation:
Dear Dr. [Last Name],

You are invited to take part in a study survey as a participant. The purpose of this study is to understand and compare different ordering tools in Epic on the compliance with treatment protocols in the Emergency Department. Please read the attached information sheet for additional details.

Your participation in this survey is voluntary. You may refuse to take part in the research or exit the survey at any time without penalty. You are free to decline to answer any questions you do not wish to answer for any reason. Survey participation and results are anonymous.

If you agree to participate in the study and complete the survey, please click the link below:
[link to survey]

I will send you a reminder email in about 1 week. If you have any questions, please do not hesitate to call or email me.

Thank you,
Kyle Marshall

Reminder:
Dear Dr. [Last Name],

This is a reminder of an email I sent you last week regarding an invitation to participate in my study through completing a survey. The purpose of this study is to understand and compare different ordering tools in Epic on the compliance with treatment protocols in the Emergency Department. I have attached an information sheet for additional details.

Your participation in this survey is voluntary. You may refuse to take part in the research or exit the survey at any time without penalty. You are free to decline to answer any questions you do not wish to answer for any reason. Survey participation and results are anonymous.

If you agree to participate in the study and complete the survey, please click the link below:
[link to survey]

If you have any questions, please do not hesitate to call or email me.

Thank you,
Kyle Marshall