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Implementation of an Electronic Health Record Integrated Clinical Pathway Improves Adherence to COVID-19 Hospital Care Guidelines

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Abstract

Background: During the COVID-19 pandemic, frequently changing guidelines presented challenges to emergency department (ED) clinicians. The authors implemented an electronic health record (EHR)-integrated clinical pathway that could be accessed by clinicians within existing workflows when caring for patients under investigation (PUI) for COVID-19. The objective was to examine the association between clinical pathway utilization and adherence to institutional best practice treatment recommendations for COVID-19.

Methods: The authors conducted an observational analysis of all ED patients seen in a health system inclusive of seven EDs between March 18, 2020, and April 20, 2021. They implemented the pathway as an interactive flow chart that allowed clinicians to place orders while viewing the most up-to-date institutional guidance. Primary outcomes were proportion of admitted PUIs receiving dexamethasone and aspirin in the ED, and secondary outcome was time to delivering treatment.

Results: A total of 13269 patients were admitted PUIs. The pathway was used by 40.6% of ED clinicians. When clinicians used the pathway, patients were more likely to be prescribed aspirin (OR, 7.15; 95% CI, 6.2-8.26) and dexamethasone (10.4; 8.85-12.2). For secondary outcomes, clinicians using the pathway had statistically significant ($P < 0.0001$) improvement in timeliness of ordering medications and admission to the hospital. Aspirin, dexamethasone, and admission order time were improved by 103.89, 94.34, and 121.94 minutes, respectively.

Conclusions: The use of an EHR-integrated clinical pathway improved clinician adherence to changing COVID-19 treatment guidelines and timeliness to associated medication administration. As pathways continue to be implemented, their effects on improving patient outcomes and decreasing disparities in patient care should be further examined.

Keywords

COVID-19, clinical decision support, process improvement, quality improvement, clinical operations

Despite numerous efforts to accelerate knowledge translation, gaps in emergency department (ED) and overall hospital quality initiatives exist for even the most time-sensitive illnesses such as stroke and sepsis.[1–4] Historically, incorporating new evidence into clinical practice has been slow and inconsistent.[5–8]

This challenge was exacerbated during COVID-19 when clinicians needed up-to-date care guidelines derived from emerging data. The COVID-19 pandemic presented a unique opportunity to use innovative tools and accelerate knowledge translation. The COVID-19 evidence base was rapidly growing and resulted in shifting recommendations as potential therapies were substantiated or debunked. Variation in COVID-19 outcomes has been demonstrated between hospitals, which may have resulted from differences in system capacity and also care practices.[9,10]

To help with knowledge translation, subject matter expert committees within a health system develop clinical guidelines. However, barriers to adoption include poor integration into clinical workflow, lack of clinician awareness, clinician skepticism toward necessity of practice changes, and applicability to heterogeneous patient populations.[11–13] One particular

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difficulty with implementation is the access clinicians have to the guideline, which may exist in a physical form (eg, posted print out) or in electronic media. These formats require clinicians to remember the guideline's existence and to leave their current workflow to retrieve the guideline. Clinical decision support (CDS) tools are often utilized to facilitate implementation of evidence-based practice within the clinician workflow, however measures of their utility are mixed.[14–16] Additionally, these tools have been criticized for contributing to burnout through alert fatigue, information overload and workflow disruption.[11,17]

In the study health system during the COVID-19 pandemic, daily emails to provide updated recommendations and guidelines resulted in health care staff complaints of information overload. This was accompanied by a lack of practice change. Subsequently, the authors implemented an electronic health record (EHR) integrated clinical pathway, a form of passive CDS, that could be accessed by clinicians within their existing workflow when caring for patients under investigation (PUIs) for COVID-19. This pathway integrated evidence, expert consensus on evaluation and treatment, and leveraged the EHR to enable access to all necessary clinical resources and orders directly from the pathway. The authors measured the impact of pathway utilization on both the adherence to ED treatment guidelines as well as the timeliness of these institutional care guidelines.

Methods

Design and Setting

This observational study examined all ED patients of a large health care system that sees 350 000 annual ED patients. Its seven EDs are a mix of academic, community, and freestanding, with the largest-volume site being a tertiary academic facility. The authors constructed a dataset from the institutional data warehouse inclusive of pathway utilization, medication administration, and all ED throughput timestamps between March 18, 2020, and April 20, 2021. This timeframe incorporated the first and subsequent "waves" of COVID-19 hospitalizations in the system. Admitted PUIs for COVID-19 were extracted based upon an admission order checkbox that delineated concern for COVID-19.

Intervention

The intervention was an EHR-integrated clinical pathway introduced November 3, 2020, at 3 EDs within the health system. This "early intervention" group was chosen to receive the tool earlier than other health system EDs because of their regional proximity and clinician cross-coverage of sites. This CDS tool (Agile MD, San Francisco, CA) consisted of an interactive flow chart embedded into the system EHR (EPIC, Verona, WA) where clinicians could see up-to-date clinical care guidelines and directly order diagnostics and therapeutics for the patient whose chart was open. This was considered passive as there was no forced workflow to drive clinicians to the pathway and instead they had to decide to navigate to the CDS tool (Appendix 3, see Supplemental Digital Content, available at http://links.lww.com/AJMQ/A57). No aspects of care were only available in the pathway. The intervention was in effect at the study sites for five weeks prior to full implementation across the entire seven ED health system on December 10, 2020 (Appendix 1, see Supplemental Digital Content 1, available at http://links.lww.com/AJMQ/A57). The four later sites were grouped into a "later intervention" group. Clinicians do not cross over between early and later intervention EDs. Alternative methods of information dissemination without the passive CDS tool included email communications sent to staff and guideline placement onto the hospital intranet.

Clinical Pathway Development

The ED pathway was designed to complement the inpatient and ICU treatment algorithms, which were already administering CDC recommended medications to COVID-19 positive patients. The ED COVID-19 EHR-integrated clinical pathway was developed through multidisciplinary stakeholder involvement including the departments of emergency medicine, internal medicine, and pulmonary and critical care using the pathway development framework described previously.[16] Delineation of patient treatment expectations were established based on available resources including medication availability, staffing, and patient flow. The pathway included consensus agreement regarding diagnostic testing and treatment recommendations (eg aspirin and dexamethasone), and established a threshold of oxygen saturation for admission (Appendix 2, see Supplemental Digital Content 1, available at http://links.lww.com/AJMQ/A57).[18–20] Institutional guidelines recommended initiating dexamethasone therapy for PUIs within the ED to avoid treatment delays that could result from delays in SARS-CoV-2 testing results or ED boarding. Of note, steroid therapy was discontinued if the patient was later found COVID-19 negative or not persistently hypoxic.

Measures

The primary outcomes were proportion of admitted PUIs receiving first dose dexamethasone and aspirin in the ED. The secondary outcomes included measures of the timeliness of primary outcomes including the time from ED patient arrival to medication administration or admission order in minutes.

Analysis

The primary analysis first examined the incremental effects of the pathway on outcomes by constructing difference-in-difference regression models. This isolated differences in outcomes when the pathway was implemented for five weeks at early intervention EDs compared with routine workflow at later intervention EDs. The post change time period was November 3, 2020, to December 9, 2020. The proportion of PUIs receiving aspirin and dexamethasone was analyzed adjusting for time period, intervention site, and an interaction term between the two. The primary analysis then examined the overall association between pathway utilization and outcomes using descriptive statistics. A chi-square test of independence during the entire study period was performed to determine if there was a statistically significant relationship between users of the passive CDS tool and primary outcomes.

Secondary analysis compared the association between pathway utilization and timeliness of medication administration, as well as admission decision between pathway users and nonusers. Data were analyzed by week; weeks with less than five PUIs were excluded to minimize effect of small sample size on proportion reporting. Data analysis was conducted using R (version 3.6.3). This study was approved by the University Institution Review Board.

Results

Study Characteristics

A total of 13 269 patients were PUIs over the study period with 6600 (49.7%) PUIs cared for after pathway implementation. The pathway was used by 40.6% of ED clinicians across the health system.

Primary Analysis

After the intervention was implemented at the three early intervention EDs, the adjusted odds ratio of aspirin and dexamethasone prescribing was 2.15 (95% CI, 1.70-2.72) and 2.44 (95% CI, 1.69-3.55) times higher than later intervention sites, respectively (Figure 1). After the pathway was implemented at all sites, when clinicians used the pathway, patients were more likely to be prescribed aspirin (OR, 7.15; 95% CI, 6.2-8.26) and dexamethasone (10.4; 8.85-12.2]) (Figure 2). Summary statistics are available in Appendix 4, see Supplemental Digital Content 1, available at http://links.lww.com/AJMQ/A57.

Secondary Analysis

Across all sites, clinicians using the pathway had statistically significant ($P < 0.0001$) improvement in timeliness of ordering medications and admission to the hospital. Aspirin, dexamethasone, and admission time were improved by 123.32 [135.51, 111.12], 54.28 [63.67, 44.88], and 71.92 [80.61, 63.22] minutes, respectively (Figure 3).

Discussion

The authors found that the use of an EHR-integrated clinical pathway was associated with increased medication administration adherence as well as improved time to treatment and patient admission decision for COVID-19. This study is particularly strengthened by the large sample size as well as the phased approach of implementation. Specifically, incorporating the pathway at the early intervention sites allowed comparison to later intervention sites and the difference-in-difference model showed increased odds of adherence to COVID-19 process measures (Figure 1). This suggests that while traditional forms of mass communication (eg, email, town halls) can be rapidly deployed, there is a limit to their effectiveness.[21] Some reasons that explain inefficiencies of electronic or paper communications include the volume of email received and lack of top-down specificity for the ED,[21–24] which may contribute to overall lower guideline adherence. Of note, while general awareness of dexamethasone was increasing in September 2020 after the results of the RECOVERY trial,[25] in the institution prescribing was at clinical discretion compared to standardized within the pathway.

COVID-19 pandemic literature has suggested use of CDS tools for COVID-19 severity and risk stratification.[26,27] Prior literature has presented a conceptual model of implementing this same EHR-integrated clinical pathway software in pediatric patients at a Children's Hospital for the care of COVID-19 patients.[28] Another study examined the use of an EHR-integrated clinical pathway on decreasing COVID-19 readmissions.[29] The current study adds to the existing body of COVID-19 literature by reporting more granular details of an EHR-integrated

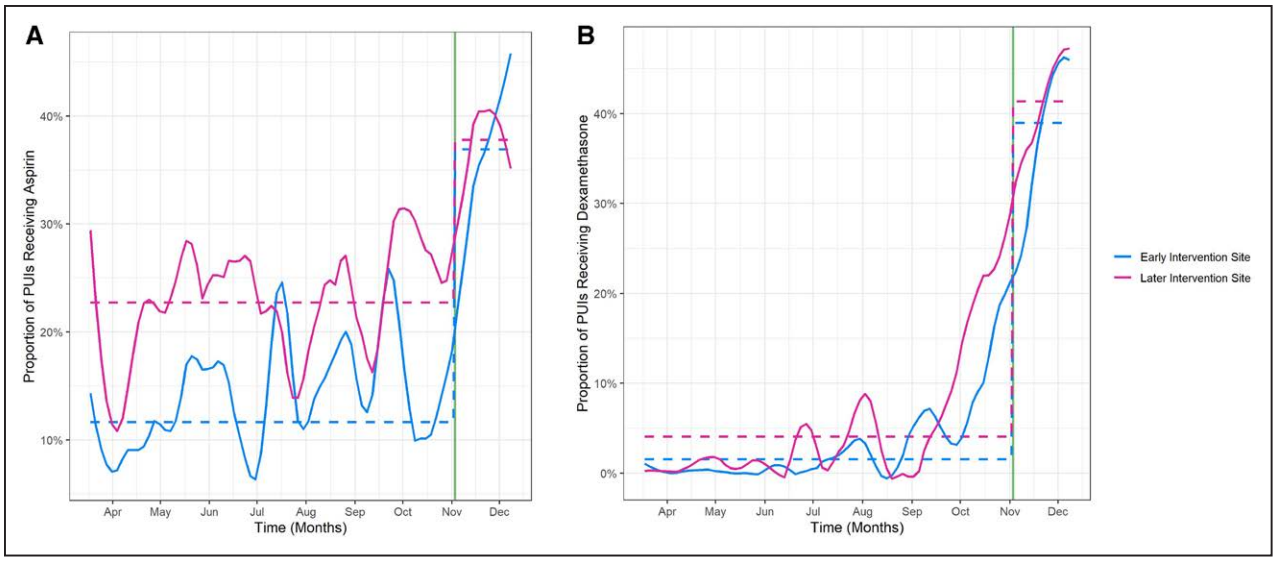

Figure 1. Proportion of PUI receiving aspirin (A) or dexamethasone (B) in the early intervention site EDs and later intervention site. Vertical line indicates the intervention, an EHR-integrated clinical pathway, implementation at the early intervention EDs which occurred for 5 weeks before implementation at all sites. The odds ratio of aspirin and dexamethasone prescribing was 2.15 (95% CI [1.70, 2.72]) and 2.44 (95% CI [1.69, 3.55]) times higher than later intervention sites, respectively, after implementation using a difference-in-difference regression approach. Dashed lines indicate modeled results. Abbreviations: ED, emergency department; EHR, electronic health record; PUI, patients under investigation.

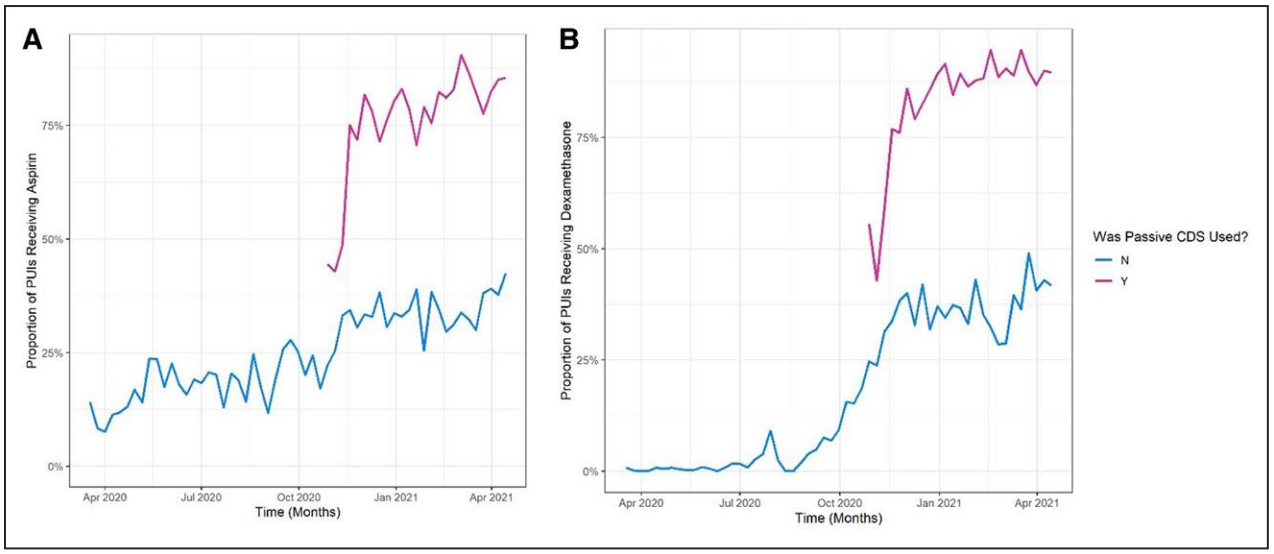

Figure 2. Proportion of PUI receiving aspirin (A) or dexamethasone (B) based on usage of the passive clinical decision support tool, an EHR-integrated clinical pathway. Odds of receiving aspirin was 7.15 times greater than when passive CDS was not used ($p<0.0001$; 95% CI [6.20, 8.26]). Odds of receiving dexamethasone was 10.4 times greater than when passive CDS was not used ($p<0.0001$; 95% CI [8.85, 12.20]). Abbreviations: CDS, clinical decision support; EHR, electronic health record; PUI, patients under investigation.

clinical pathway to achieve adherence to COVID-19 institutional care guidelines while simultaneously improving ED throughput in adult patients. In fact, while ED volumes rebounded and length of stay for non-PUIs increased, users of the pathway for PUIs demonstrated shortened length of stays (Figure 3C). This as well as increased ordering of aspirin and dexamethasone in the waning months of the study suggest that behavior was learned and maintained even when providers stopped regular use of the CDS tool.

Overall, clinical pathways have been promoted as a tool to help health care systems provide consistent high quality health care in a timely and cost-efficient

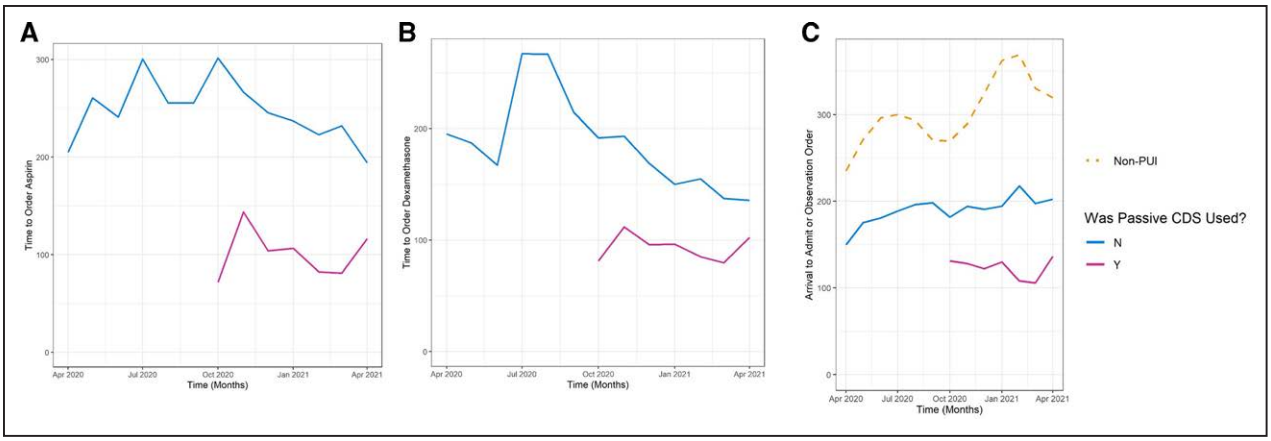

Figure 3. Timeliness to order aspirin (A), dexamethasone (B), or inpatient bed (C) for PUI based on clinician usage of a passive clinical decision support tool. Results were statistically significant for aspirin, dexamethasone, and admission time which were improved by 123.32 [135.51, 111.12], 54.28 [63.67, 44.88], and 71.92 [80.61, 63.22] minutes, respectively. Abbreviations: PUI, patients under investigation.

manner through standardization of care. However, the process of standardization may create a tension between perceived rigidity of treatments and customization for patient needs.[30]As health care systems expand to incorporate broader networks of regional hospitals, reducing variation in care becomes more important. Quality improvement projects may be locally conducted and implemented, but translation across other hospitals in a health care system has not yet materialized.[31] Consistent with literature, this EHR-integrated clinical pathway avoided multiple pitfalls of prior CDS tools.[8,32] Specifically, the pathway preserved clinical workflow, avoided alert or pop-up fatigue, alleviated email overload, and delivered accurate clinical content with grouped order entry. In aggregate, these features of successful CDS tools build trust between clinicians and administration but also provide workflow improvements for clinicians that benefit patient care.

Limitations

The results of this quality improvement intervention should be interpreted within the local context of the authors' implementation and study design. One limitation is that the EHR-integrated clinical pathway was not used by a majority of ED clinicians. This may have been due to a lack of awareness regarding the pathway's existence or unfamiliarity with using this new tool. However, this would bias away from finding an effect and as such, the results may be a conservative estimate of CDS effects. The COVID-19 pathway was the first to be implemented across EDs as an EHR-integrated clinical pathway and its use was not mandated. Had incorporation of the tool been required, utilization would likely have been higher. However, frustration surrounding mandatory CDS tool use must be weighed appropriately.[17]

Besides the newness of this CDS tool, another possible explanation for lower pathway use may be that over time, experienced pathway users may have supervised pathway-naïve users without navigating through the pathway itself. If this occurred, it would suggest that clinicians learn appropriate behaviors with the EHR-integrated clinical pathway. Future works should consider learning effects that may sustain interventions beyond initial CDS. Additionally, it is likely that this process measure performance estimate is an underestimate because the authors did not examine the absolute or relative contraindications to aspirin or dexamethasone. For example, they did not examine allergies, outpatient prescriptions or routine home medications as reasons not to administer these recommended medications in the ED. While not a direct limitation, it is important to mention they did not examine de-implementation of low value practices. Literature suggests de-implementation is a challenge exacerbated by patient expectations for testing, organizational culture and clinician practice patterns which is specifically influenced by malpractice fears, and attitude towards change.[33] Future work might explore if pathway use decreases low value care. Finally, the authors cannot directly associate patient outcomes to the use of the pathway given they did not collect such outcome data and focused on the process metrics of institutional guideline adherence. While PUIs throughout the pandemic were receiving CDC recommended medications during their hospitalization, ED pathway use was focused on giving medications earlier in patient disease course.

Conclusions

The use of a passive CDS tool during the COVID-19 pandemic improved clinician adherence to treatment guidelines and timeliness to guideline adherence. As the COVID-19 pandemic evolves and new diagnostic modalities and therapeutics are developed, utilization of innovative knowledge translation tools that can be embedded within existing clinical workflows are essential to accelerating best practices and ensuring better patient outcomes.

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Conflicts of Interest

The authors report no conflicts of interest or financial support in relation to this manuscript.

Author Contributions

Dr Sangal, Dr Venkatesh, and Dr Liu conceptualized and designed the study. Dr Sangal, Dr Liu, Dr Ulrich, Cole, and Dr Rhodes primarily developed the clinical pathway. Dr Rothenberg, Dr Venkatesh, and Dr Sangal obtained and analyzed data. Dr Sangal and Dr Liu primarily drafted article, which was significantly edited by all authors.

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