

Understanding CancelRx: Impact on Clinical Workflows, Medication Safety Risks, and Patient Outcomes

Principal Investigator: Samantha Pitts, MD, MPH

Funded Faculty Team Members: Yushi Yang, Ayse Gurses, Nicole Mollenkopf, Jessica Schwartz, Nae-Yuh Wang

Johns Hopkins University School of Medicine

Project Period: 09/15/2019 - 08/31/2022

Project Officer: Sheena Patel

This work was supported by Grant R21 HS26584 from the Agency for Healthcare Research and Quality.

I. Structured Abstract

Purpose. The objectives of this study were to 1) develop strategies to optimize CancelRx implementation; and 2) measure the impact of CancelRx on patient outcomes, including dispensing errors.

Scope. We evaluated CancelRx implementation at a single academic medical center.

Methods. We conducted observations with pharmacy staff and semi-structured interviews with prescribers, pharmacy staff, and patients, with thematic analysis of pharmacy interviews. We completed a functionality analysis of workflows for medication change and an interrupted time-series analysis to assess the impact of CancelRx on medication dispensing after discontinuation.

Results. Pharmacy staff sought additional information on prescriber intent, intended medication, and clinical rationale for change. Optimal implementation of CancelRx would facilitate identification of all prescriptions that need to be deactivated at the pharmacy. Additional information at the time of a medication change would support pharmacy staff to dispense the correct medications and provide information/counseling to patients.

We identified workflows to change medication doses which do not result in a CancelRx message to external pharmacies. Standardized EHR workflows would result in improved electronic communications with pharmacies via CancelRx. Real-time visibility of the outcome at the pharmacy of medication discontinuation in the EHR would allow users to learn the function of the system and confirm that the intended outcome has occurred.

Following CancelRx implementation, there was an immediate and persistent reduction in proportion of e-prescriptions that were dispensed after discontinuation in the EHR, to 1.4% from a baseline of 8.0% ($p < 0.0001$).

Key words. CancelRx, e-prescribing, medication safety

II. Purpose

The objectives of this study were to:

1. Develop strategies to optimize CancelRx implementation to support patients in medication management and identify areas for further health IT development
2. Measure the impact of CancelRx on patient outcomes, including dispensing errors, documented adverse drug events, and medication reorders

III. Scope

Background

Preventable harm due to medication errors is estimated to affect one in 30 people, with severe or life-threatening harm in 25% of cases.(1) An estimated 1.5% to nearly 5% of medications are dispensed after discontinuation in the electronic health record (EHR) (2, 3), with 34% meeting criteria for high risk of potential harm (2). Dispensing of discontinued medications leads to patient harm through drug toxicity with unintended continuation of medications (4, 5) or inadequate disease management with incorrect medication dosing (5).

Dispensing of discontinued medications results from a lack of communication of discontinuation from prescribers to pharmacies. In 2006, the National Council for Prescription Drug Programs added CancelRx to the SCRIPT standard for e-prescribing.(6) When implemented, CancelRx enables EHRs to send electronic prescription cancellation messages through the health information network to a pharmacy, in a process similar to e-prescribing. However, adoption of CancelRx has been slower than e-prescribing, and this functionality remains underutilized.(6)

The Johns Hopkins Health System includes 6 hospitals and affiliated outpatient facilities, a community based primary care practice network, and 11 outpatient pharmacies. From 2019 – 2021, all outpatient practices used a shared electronic health record (Epic Systems Corporation, Verona, WI), while the pharmacies used a separate pharmacy management software (EnterpriseRx, McKesson, Irving, TX). After a small pilot, Johns Hopkins implemented CancelRx across the health system in January 2019. In 2022, all Johns Hopkins pharmacies replaced EnterpriseRx with Epic Willow.

Setting

In Aim 1, we examined CancelRx implementation at three clinical practices and their affiliated pharmacies at one academic hospital in Baltimore, MD. The clinical practices included general internal medicine, adult infectious diseases, and pediatric oncology.

In Aim 2, we evaluated the impact of CancelRx implementation among patients receiving outpatient care at two health system hospitals and receiving medications from one of the 11 health system pharmacies.

Participants

Aim 1. Participants included: 1) prescribers of the three clinical practices; 2) pharmacy staff at affiliated pharmacies; and 3) patients (or caregivers for pediatric patients) who had had a medication change.

Aim 2. Patients were included if they had \geq one eligible medication e-prescribed from an included outpatient location to a health system pharmacy within the study period. We excluded e-prescriptions for over-the-counter medications and those with topical, otic, and ophthalmic administration.

IV. Methods

Aim 1

Study Design. We conducted observations with pharmacy staff from two pharmacies, followed by semi-structured interviews with prescribers, pharmacy staff, and patients from the three participating practices and pharmacies.

Data Sources/Collection and Analysis. Interviews were conducted and recorded via Zoom, then subsequently transcribed for qualitative data analysis. We conducted thematic analysis with initial coding based on the SEIPS model, with additional inductive codes based on the research questions of interest. Following thematic analysis and based on our operational safety work, we further examined workflows for medication dose changes. As Johns Hopkins had recently moved to Epic Willow for its pharmacies, using our EHR test environment, we documented the outcome for each workflow for internal pharmacies using Epic Willow and compared these to the outcomes for external pharmacies via CancelRx. We engaged with members of the NCPDP and Epic to understand current technical functionality to support workflow changes.

Interventions. We developed a table to readily demonstrate the different outcomes of each workflow and potential strategies to optimize medication change workflows. We presented these results to multidisciplinary leadership teams, including Johns Hopkins clinicians, pharmacists, and health IT leaders, and members of the Epic Verona e-prescribing team.

Measures. Not applicable – qualitative analysis.

Limitations. This was conducted in one academic health system using a single EHR and a small number of participants. While this EHR vendor has a significant market share, this analysis may not be generalizable to other practices if the EHR implementation or workflows differ significantly.

Aim 2

Study Design. We conducted an interrupted time-series analysis to assess the impact of CancelRx on medication dispensing after discontinuation in the EHR and stratified pre-post analyses to assess variation in outcome by pharmacy and pharmaceutical class.

Data Sources/Collection. A trained pharmacy data analyst exported EHR data on discontinued medications e-prescribed to a health system pharmacy and matched these to dispensing data from the pharmacy management software.

Intervention. Not applicable – observational study. CancelRx was implemented by the health system in 2019.

Measures. Our primary outcome was the proportion of e-prescription medications dispensed to patients by pharmacies within 6 months after discontinuation in the EHR. We defined a medication as dispensed after discontinuation if the timestamp of dispensing was at least one minute and less than 6 months after the timestamp of discontinuation in the EHR. A secondary outcome was the proportion of discontinued medications which were reordered within 120 days, as a balancing measure.

Limitations. This study was conducted in a single health system. In addition, while medications were dispensed after discontinuation in the EHR, this may not have resulted in a medication error due to duplicate prescriptions at the pharmacy.

V. Results

Principal Findings and Outcomes

Pharmacy information needs.

Following receipt of a CancelRx message, pharmacy staff consistently sought additional information beyond that contained in the CancelRx to 1) ensure correct medication dispensing to the patient when there was a medication change and 2) provide patients with information and/or counseling about their medication changes.

To ensure correct dispensing to patients, pharmacists looked to identify which prescriptions should be cancelled – recognizing that more than one prescription may need to be discontinued due to duplicate prescriptions in the pharmacy system. To be confident in their decision about which prescriptions to deactivate, pharmacists described looking in the EHR for documentation of the intent of the prescriber (e.g., change medications, change dose, discontinue without replacement), the intended medication regimen, and the clinical rationale for the change (e.g., side effect). While the prescriber intent and intended medication regimen could be presumed from the pharmacy management software if there was a prescription for a different dose or a new medication at the same time as a cancellation, pharmacists preferred when this information was explicitly stated. This information sometimes linked in the pharmacy information system if provided in the “notes to pharmacy” with a new prescription. Following a medication change, pharmacy technicians also described seeking this additional information if there was uncertainty about the active prescription(s) during data entry of a new prescription or when patients requested refills of their medications. If needed, they sought assistance from the pharmacist to clarify the medication regimen.

Both pharmacists and pharmacy technicians desired additional information to communicate with patients following medication changes. Pharmacists noted that they may not have sufficient information to answer patient questions about the clinical rationale for a medication change. In addition, pharmacists noted that if they knew the clinical rationale for the change, their counseling could reinforce this rationale with patients. Pharmacy technicians described providing information when a prescription had been cancelled but patients expected to pick up a medication. This often necessitated the involvement of the pharmacist to provide appropriate counseling.

Dose change workflows.

We identified multiple workflows to change the dose of a medication in our operational medication safety work. We conducted a functionality analysis of the different workflows for documenting a medication change in our EHR and the outcomes for internal and external pharmacies on three outcomes of interest: discontinuation of the old prescription; generation of a new prescription; and instructions to the patient on the after-visit summary. Currently, in addition to a “change” function, prescribers can use a “reorder” function to make changes to the prescription, such as the strength, dose, and quantity. When the “reorder” function is used, it will not send a CancelRx message to an external pharmacy unless the default reason for discontinuation is modified. Both the “change” and “reorder” functions can be modified so that no new prescription is transmitted to the pharmacy by selecting a “no print” option. The “adjust sig” function is used to change the instructions on how to take a medication and does not result in a CancelRx message or a new prescription at external pharmacies. The “no print” and “adjust sig” workflows are used to document a dose change without generating a new prescription at the pharmacy when a patient has supply (e.g., insulin). In our current EHR configuration, “change” was the only function with the same outcome at both internal and

external pharmacies with default settings; change resulted in discontinuation of the old prescription and generation of a new prescription for both pharmacy types.

Dispensing after discontinuation in the EHR.

In the interrupted time series analysis, prior to CancelRx implementation, there was no significant week-to-week trend within the proportion of discontinued orders that were dispensed after discontinuation ($p=.06$). Following CancelRx implementation, the proportion of prescriptions dispensed after discontinuation decreased to 1.4% from a baseline of 8.0% ($p<0.0001$), without a significant week-to-week trend ($p=0.37$). In pre-post analyses, there was no change in the proportion of discontinued medications that were reordered within 120 days (10.4% versus 10.8%, $p=0.15$).

Prior to CancelRx implementation, there was significant variation by pharmacy and medication class in the proportion of medications dispensed after discontinuation. Three pharmaceutical classes had statistically higher rates of dispensing after discontinuation, including immunosuppressants, anticoagulants and antiplatelet agents, and cardiovascular medications. Following CancelRx implementation, this variation in the mean proportion of medications dispensed after discontinuation was reduced.

Discussion

Following CancelRx implementation, there was an immediate and persistent reduction in proportion of e-prescriptions that were dispensed after discontinuation in the EHR, to 1.4% from a baseline of 8.0%. Implementation of CancelRx also reduced variation by pharmacy and by medication class in the proportion of medications dispensed after discontinuation in the EHR, with the greatest reductions among immunosuppressants, anticoagulants and antiplatelet drugs, and cardiovascular medications. There was no change in the proportion of medications reordered in the 120 days after discontinuation. Pharmacy staff sought additional information on prescriber intent, clinical rationale for change, and intended medication to identify all prescriptions that should be discontinued after receipt of a CancelRx and provide information and/or counseling to patients. We identified multiple workflows to change the dose of a medication which do not result in a CancelRx message to external pharmacies.

In previous studies within academic health systems, > 90% of CancelRx transactions resulted in a successful cancellation (7, 8) which reduced discrepancies between health system and pharmacy medication lists (8). This study builds upon Watterman et al to demonstrate a reduction in dispensing of discontinued prescriptions. However, not all medications that were dispensed after discontinuation resulted in a medication error, as patients may have had an existing duplicate prescription in the pharmacy. Chronic medications may be more likely to have duplicate prescriptions at the pharmacy, which could contribute to the higher proportion of immunosuppressants, anticoagulants and antiplatelet drugs, and cardiovascular medications that were dispensed after discontinuation prior to CancelRx implementation. Nevertheless, these chronic medications often require dose adjustment, and failure to communicate discontinuation of previous prescriptions may result in the wrong dose dispensed. (5). Adoption of CancelRx and expansion of its functionality to medications reconciled from outside the EHR could further reduce the risk of medication errors.

We identified several workflows for dose changes which do not send a notification to pharmacies using CancelRx. These workflows result in a discrepancy between the EHR and pharmacy management software which introduces a safety risk. In addition, with implementation of Epic Willow for Johns Hopkins internal pharmacies, these workflows have different behaviors/outcomes for internal and external pharmacies, which further increases the risk of error. To ensure that EHR users know the outcome of their action in the EHR (i.e.,

whether a CancelRx is sent and its result), vendors should ensure there is real-time visibility of the outcome of medication discontinuation. This would allow users to learn the function of the system and confirm that the intended outcome has occurred. We identified potential strategies to facilitate/encourage the use of the change function, including: 1) Preventing changes to a prescription when using the reorder function, 2) Removing the options for alternate workflows, including “adjust sig” and “no print” prescriptions. Removing these alternate workflows for changes to a prescription would force the prescriber to use the change function. Allowing prescribers to indicate that a new prescription should not be dispensed immediately could reduce work at the pharmacy when a prescriber has identified that medication dispensing is not needed at the time of the change.

Another consideration is whether a cancellation message should be sent with every medication reorder. During implementation, Johns Hopkins elected to suppress CancelRx messages with medication reorders. However, as CancelRx is a one-to-one match between a prescription and cancellation message, this does contribute to multiple active prescriptions at the pharmacy. Sending a CancelRx transaction with every reorder would result in a significant increase in CancelRx transactions at the pharmacy but would preserve the one-to-one matching of a prescription and cancellation.(9)

Pharmacists and pharmacy staff in our health system often sought additional information from our EHR following medication changes communicated by CancelRx to identify which prescriptions should be deactivated and filled. With duplicate prescriptions in the pharmacy, multiple prescriptions may need to be deactivated to ensure the correct medication and dose are dispensed. Ideally, the system should identify all prescriptions that need to be deactivated at the pharmacy. Providing additional information to pharmacy staff about the prescriber intent, intended medication, and clinical rationale for change would allow them to verify the actions of the system and improve communication and patient counseling following medication changes.

Conclusions, Significance, and Implications

CancelRx implementation reduced dispensing after discontinuation in the EHR for e-prescriptions. Adoption of CancelRx and expansion of its functionality to medications reconciled from outside the EHR could further reduce the risk of medication errors. Real-time visibility of the outcome at the pharmacy of medication discontinuation in the EHR would allow users to learn the function of the system and confirm that the intended outcome has occurred.

Standardized EHR workflows for medication changes by prescribers would result in improved electronic communications with pharmacies via CancelRx. Optimal implementation of CancelRx would facilitate identification of all prescriptions that need to be deactivated at the pharmacy. Additional information at the time of a medication change would support pharmacy staff to dispense the correct medications and provide information and counseling to patients.

This study was conducted in one academic health system using a single EHR and our qualitative analysis had a small number of participants of each role. While our EHR vendor, Epic, has a significant market share, these analyses may not be generalizable to other sites if the EHR implementation or local workflows differ significantly. These analyses may be modified in response to feedback and peer-review.

We are currently participating in discussions with Johns Hopkins Health IT leadership and our EHR vendor, Epic, to determine which strategies might be implemented at Johns Hopkins with the current EHR functionality and to inform EHR development in response to the communication needs we identified.

List of publications and products

Three manuscripts are currently in draft form for submission for peer review.

References

1. Hodkinson A, Tyler N, Ashcroft DM, Keers RN, Khan K, Phipps D, et al. Preventable medication harm across health care settings: a systematic review and meta-analysis. *BMC medicine*. 2020;18(1):313.
2. Allen AS, Sequist TD. Pharmacy dispensing of electronically discontinued medications. *Annals of internal medicine*. 2012;157(10):700-5.
3. Copi EJ, Kelley LR, Fisher KK. Evaluation of the frequency of dispensing electronically discontinued medications and associated outcomes. *Journal of the American Pharmacists Association : JAPhA*. 2018;58(4S):S46-S50.
4. Shervani S, Madden W, Gleason LJ. Electronic Health Record Interoperability-Why Electronically Discontinued Medications Are Still Dispensed. *JAMA Intern Med*. 2021.
5. Lourenco LM, Bursua A, Groo VL. Automatic Errors: A Case Series on the Errors Inherent in Electronic Prescribing. *J Gen Intern Med*. 2016;31(7):808-11.
6. Nelson SD, Kumah-Crystal Y. Underuse of Electronic Health Record Features-The Case for CancelRx. *JAMA Intern Med*. 2021.
7. Pitts SI, Barasch N, Maslen AT, Thomas BA, Dorissaint LP, Decker KG, et al. Understanding CancelRx: Results of End-to-End Functional Testing, Proactive Risk Assessment, and Pilot Implementation. *Appl Clin Inform*. 2019;10(2):336-47.
8. Watterson TL, Stone JA, Brown R, Xiong KZ, Schiefelbein A, Ramly E, et al. CancelRx: a health IT tool to reduce medication discrepancies in the outpatient setting. *Journal of the American Medical Informatics Association : JAMIA*. 2021;28(7):1526-33.
9. Pitts SI, Yang Y, Thomas B, Chen AR. Discontinuation of outpatient medications: implications for electronic messaging to pharmacies using CancelRx. *Journal of the American Medical Informatics Association : JAMIA*. 2022;29(12):2101-4.