Individual QI projects from single institutions

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A Quality Improvement Initiative to Improve Pediatric Discharge Medication Safety and Efficiency

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Abstract

Introduction: Medication errors are a leading safety concern, especially for families with limited English proficiency and health literacy, and patients discharged on multiple medications with complex schedules. Integration of a multilanguage electronic discharge medication platform may help decrease medication errors. This quality improvement (QI) project's primary aim (process measure) was to increase utilization in the electronic health record (EHR) of the integrated MedActionPlanPro (MAP) for cardiovascular surgery and blood and marrow transplant patients at hospital discharge and for the first clinic follow-up visit to 80% by July 2021. **Methods:** This QI project occurred between August 2020 and July 2021 on 2 subspecialty pediatric acute care inpatient units and respective outpatient clinics. An interdisciplinary team developed and implemented interventions, including integration of MAP within EHR; the team tracked and analyzed outcomes for discharge medication matching, and efficacy and safety MAP integration occurred with a go-live date of February 1, 2021. Statistical process control charts tracked progress. **Results:** Following the implementation of the QI interventions, there was an increase from 0% to 73% in the utilization of the integrated MAP in the EHR across the acute care cardiology unit-cardiovascular surgery/blood and marrow transplant units. The average user hours per patient (*outcome measure*) decreased 70% from the centerline of 0.89 hours during the baseline period to 0.27 hours. In addition, the medication matching between Cerner inpatient and MAP inpatient increased significantly from baseline to postintervention by 25.6% ($P < 0.001$). **Conclusion:** MAP integration into the EHR was associated with improved inpatient discharge medication reconciliation safety and provider efficiency. *(Pediatr Qual Saf 2023;8:e671; doi: DOI: 10.1097/pq9.0000000000000671; Published online July 10, 2023.)*

INTRODUCTION

Discharge medication schedules can be overwhelming and confusing for patients. Medication errors are a leading safety concern,[1,2] especially for families with limited health literacy, as well as for patients discharged on multiple medications, complex medication weaning schedules, and for those for whom the information provided is not in their native or preferred language.[3,4] Providing a patient-centered, safe medication discharge process for pediatric patients and their caregivers remains challenging, particularly when various medication formulations are involved.[3] According to the Joint Commission National Patient Safety Goals, "there is evidence that medication discrepancies can affect patient outcomes."[2] Identifying gaps in discharge communication practices and improving discharge strategies is essential for safe patient care.[5] Organizations should "maintain and communicate accurate patient medication information" to families.[2] One element for meeting this performance standard includes providing written medication information to the patient and/or caretakers at discharge.[2]

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A focus group of parents of children with medical complexity highlighted the need for high-quality education provided by experts that enables them to "leave the hospital confident in their ability to care for their children once home."[6] Parents wanted complete, consistent information personalized to their literacy level, language, and desire for detail. In addition, the timing and delivery of the information mattered, as well as the ability to feel self-efficacious after receiving medication information.[6] Wong et al[7] assessed medication discrepancies by comparing discharge medication lists with discharge prescriptions. Of 150 adult patients, 106 (70.7%) had at least 1 actual or potential unintentional discrepancy noted on hospital discharge. Additionally, unintentional discharge medication discrepancies confuse patients and community providers.[7] Medication reconciliation continues to be a challenge throughout our health care system, particularly during the transition of care, such as hospital discharge, leading to an increased potential for gaps in communication related to medications. It can place patients at risk for adverse outcomes due to medication errors.[2,8,9] International patients who travel to the United States (US) to receive medical care are particularly at risk for medication errors due to language barriers and unfamiliar medications (Fig. 1).[10,11]

In 2015, a medication error at our hospital involving a patient with a preferred language other than English resulted in an overdose that required an unplanned readmission. This error led to further analysis of our discharge medication practices. A root cause analysis identified a lack of clarity and consistency among discharge medication instructions and limitations with language, including teaching the correct dosing. This failure mode, unfortunately, led to an overdose of a patient that required a preventable admission to the hospital. It is especially important as Morse et al (2021)[12] identified the following 6 most common medication reconciliation errors: duplication errors, missing medication route errors, missing medication dose errors, missing medication frequency errors, and unlisted medication names (generic, unlisted, and nonformulary; and see instructions errors). This analysis led to the adoption of a new patient-friendly discharge medication platform (MedActionPlanPro or MAP, MedActionPlan.com, Peapack, NJ), a standalone platform to improve ease of use, language capabilities, accuracy, and patient education for discharge medication (https://medactionplan.com/). Once providers complete the electronic health record (EHR) discharge medication reconciliation, they fill out the MAP separately. A local pilot project of the standalone MAP demonstrated that integrating the discharge medication platform (MAP) with our EHR could improve the patient discharge medication experience while being less time-consuming for clinicians. Additionally, utilization of this tool could further improve safety by removing the potential for transcription errors and decreasing the time providers spend entering medications into 2 electronic platforms, while also providing information in the patient's native language.[13]

The MAP accommodates 15 languages and creates a printed version in the caregiver's preferred language. It can also be integrated into the organization's EHR to promote enhanced communication of medication schedules across inpatient and outpatient areas. Preintervention,

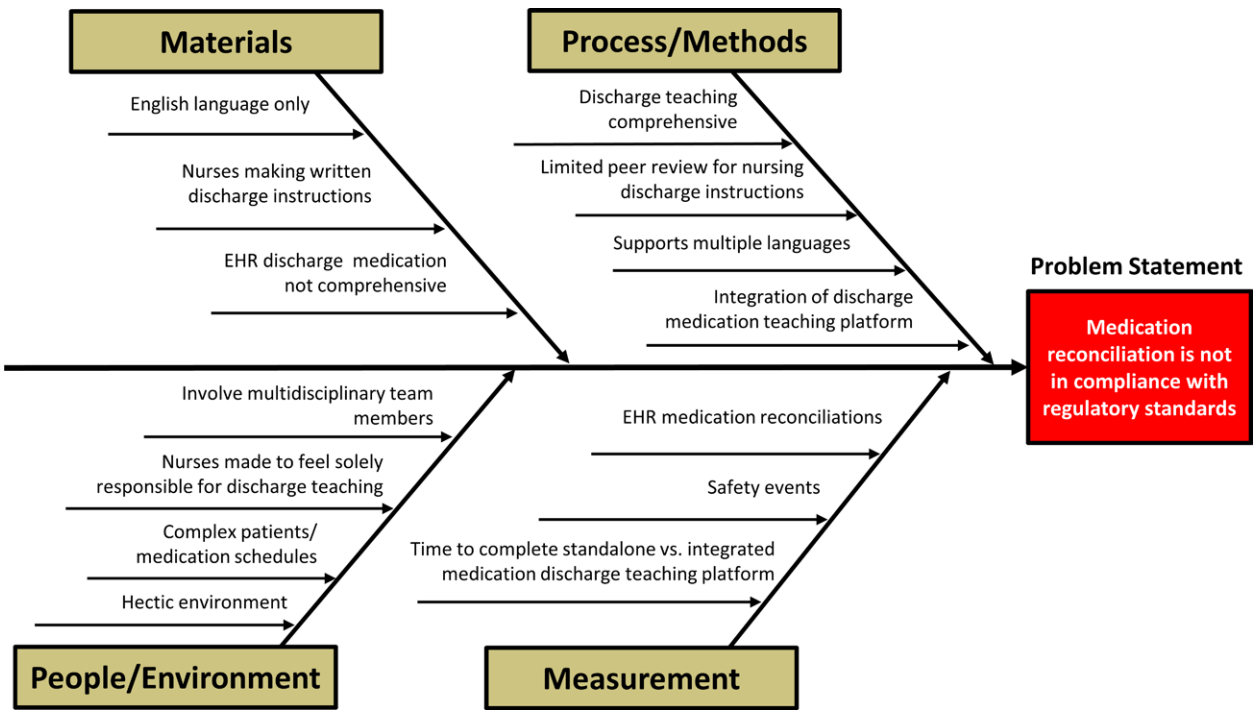

Fig. 1. Fishbone.

our EHR instructions were only in English. The MAP provides clear descriptions of discharge medications, including the right dose, route, and volume. It includes pictures of syringe types, provides example volumes, and supports the creation of individualized calendars and schedules for caregivers to reference. It also includes educational information for teaching and informing users about medications, administration techniques, cautions, and side effects.

The global aim of this quality improvement (QI) project was to improve the safety and accuracy of discharge medication at the time of discharge for cardiovascular surgery (CVS) and blood and marrow transplant (BMT) patients. Our primary aim (process measure) was to increase utilization in the EHR of the integrated MAP for CVS and BMT patients at hospital discharge and for the first clinic follow-up visit to 80% by July 2021.

METHODS

We assembled a team to conduct this QI project, including CVS and BMT advanced practice providers (APPs), a cardiologist, unit-based pharmacists, nurses (unit educator, QI nurse, and clinical program manager), informatics technology experts, and a premed student. The team developed a key driver diagram to reflect desired goals and interventions (Fig. 2).

Setting

This QI project was performed in a free-standing 300+ bed pediatric quaternary care, Magnet-designated hospital between August 2020 and July 2021 on the acute care cardiology unit (ACCU) and BMT acute care inpatient and outpatient settings. The ACCU and BMT settings were chosen for this project, as APPs were familiar with the MAP, and these patients have follow-up appointments scheduled in their specialty clinics at the time of discharge. (**Figure 1, Supplemental Digital Content,** Timeline of the QI project, ***http://links.lww.com/PQ9/A505***.)

The ACCU has 26 beds, and the BMT unit contains 11 beds. Four full-time and 1 part-time APPs coordinate care for postoperative CVS patients in the ACCU. In addition, 1 full-time hematology/oncology faculty, BMT fellow, 1 full-time APP, and 1 overnight hospitalist manage the complex needs of BMT patients. ACCU patient-to-nurse ratios can range from 4:1 to 2:1 depending on patient acuity and resources required. Based on patient acuity and nursing staff availability, BMT patient-to-nurse ratios can range from 3:1 to 2:1. The ACCU-CVS APPs service consists of postoperative congenital heart palliation and repaired patients. Their ages range from 2 weeks through adulthood. BMT patients range in age from several months to early adulthood. Our BMT patient diagnoses include malignant, nonmalignant, and various immunodeficient, metabolic, and genetic disorders. Our center conducts over 550 cardiac surgeries and approximately 100 BMT patient admissions/readmissions a year. Each patient will require a discharge medication schedule, some with more than 10 medications, including many high-risk medications with narrow therapeutic indexes.

Our organization utilizes the Cerner (Kansas City, MO) EHR to document medication reconciliation for the following time points: hospital admission, transfer, and discharge. Caregivers received a Cerner printed list of the medications at the time of discharge; however, this list does not include a timetable for medication administration with the appropriate dose and volume. To provide a dosing and time schedule for the caregiver, the bedside clinical nurse must write in both the volume of medication and list the scheduled administration times.

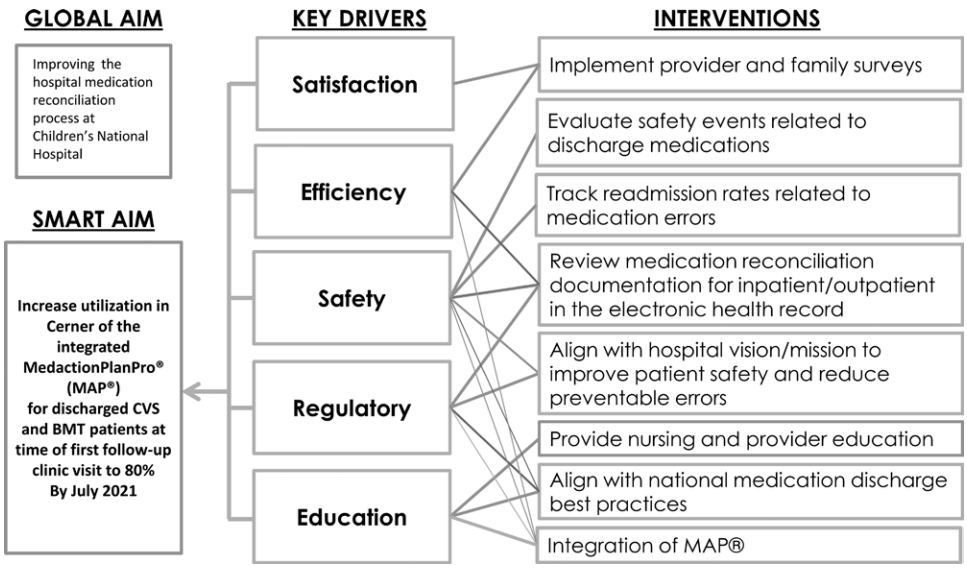

Fig. 2. Key driver diagram.

Patients' Selection

All patients discharged from CVS ACCU or BMT acute care unit were tracked in this QI project. Patients admitted to other services in either unit were excluded.

Interventions

The team implemented several interventions, including (1) integrating the MAP into Cerner, (2) offering educational sessions, and (3) providing feedback and weekly meetings.

MAP implementation occurred, with help from informatics technology experts, with a go-live date of February 1, 2021.

Educational Sessions: Before project implementation, in January of 2021, CVS and BMT nurses and providers received MAP platform education. Additionally, multiple providers and pharmacists performed practice Cerner/MAP patient applications before widespread implementation.

Feedback and Weekly Meetings: We sought feedback from front-line providers via live discussions and emails. The team addressed and resolved issues with integrating the MAP in real time. Examples include correcting and adding formulary medications and various concentrations of medications and tapering options. Upon go-live integration, weekly follow-up meetings continued to address ongoing integration issues. In addition, providers received a summary of generalizable learning points weekly.

Measures and Metrics

We developed several metrics that we tracked for this project, including outcome, process, and balancing measures. (**Table 1, Supplemental Digital Content,** Measures and Metrics, ***http://links.lww.com/PQ9/A505***.)

The following comparisons were chosen as the medication reconciliation is performed at discharge and outpatient follow-up. An outcome measure compared medication reconciliation matching for eligible patients with 3 interphases: (1) Does EHR inpatient discharge medication reconciliation match the discharge MAP? (2) Does the EHR outpatient medication history snapshot (RN intake) match Cerner's inpatient discharge medication reconciliation? (3) Does EHR CVS/BMT outpatient medication reconciliation match outpatient CVS/BMT discharge MAP?

Matching data were stored and tracked in a locally developed REDCap (Research Electronic Data Capture) survey.[14] The team collected retrospective and prospective deidentified medication reconciliation matching data to compare the MAP program, EHR CVS, and BMT at inpatient discharge and first outpatient follow-up. The second outcome measure focused on reducing provider time to complete the medication reconciliation. Efficacy data were measured by calculating average user time, in hours, spent on MAP (standalone and/or integrated) documentation before and after integration per patient.

The process measure of increasing ACCU-CVS/BMT providers' utilization of the integrated MAP program was the project's primary aim. We tracked the percentage of patients serviced by the integrated MAP program over time. The second outcome measure (efficacy) was based on all MAP (standalone and integrated) users at ACCU-CVS/BMT units.

We chose a balancing measure for safety to ensure MAP integration did not result in any medication safety events. This measure was the ACCU-CVS and BMT readmissions rate due to medication errors from February 1, 2021, to September 30, 2021. (**Table 1, Supplemental Digital Content,** Measures and Metrics, ***http://links.lww.com/PQ9/A505***.)

Study of the Interventions

As described earlier, we sought feedback from first-line providers regarding the tool used (integrated MAP) throughout the project. As a result, the team was able to address and resolve many integration issues in real time. To help understand barriers to success, we next tracked and analyzed reasons for unmatched medication between EHR CVS/BMT inpatient and MAP, EHR CVS/BMT outpatient and EHR inpatient, and finally, EHR CVS/BMT outpatient and MAP. Three team members (2 APPs and a pharmacist) were assigned a list of charts to interpret and document all unmatched reasons, capturing their analysis in the REDcap survey. Capturing the reasons for medication mismatches is particularly important as research indicates that inpatient pediatric patients are particularly vulnerable to serious harm due to medication errors, and additional investigation into mitigating strategies is urgently needed.[8,15]

Statistical Analysis

The measures are provided in **Table 1, Supplemental Digital Content,** Measures and Metrics, ***http://links.lww.com/PQ9/A505***. We performed a prepost test based on binomial distribution to compare the matching rate (first outcome measure). Due to the sample size limitation, we used the Fisher exact test to compare the baseline and postintervention periods. Next, we used a statistical process control u-charts to track the number of patients serviced biweekly in integrated MAP to evaluate utilization (process measure) and to monitor the biweekly user hours per patient serviced to evaluate for efficiency (second outcome measure). We identified special cause variation and shifted the mean centerline when 8 or more consecutive data points were above or below the centerline (shift) after an intervention.[16,17] A Pareto chart displays the reasons for unmatching items for each interphase. Finally, the team compared the readmission rate (balancing measure) using a pre-posttest for CVS/BMT patients (due to the same sample size reason) to check if the intervention created adverse safety issues.

Ethical Considerations

This project was undertaken as a Quality Improvement Initiative at Children's National Hospital and did not

constitute human subjects research. As such, it was not under the oversight of the institutional review board.[18]

RESULTS

The medication matching results (**Table 2, Supplemental Digital Content,** First outcome measure for matching results, ***http://links.lww.com/PQ9/A505***) (first *outcome measure*) demonstrated matching between Cerner inpatient and MAP inpatient increased: significantly from baseline to postintervention by 65.4% for BMT (*P* value < 0.001) and by 25.6% for both units (*P* value < 0.001). In addition, matching between Cerner outpatient and Cerner inpatient increased significantly by 19.2% for BMT (*P* value = 0.026). Matching between Cerner outpatient and MAP outpatient also increased significantly for CVS and BMT: 30% (*P* value < 0.001) for CVS, 61.5% (*P* value < 0.001) for BMT, and 44.6% (*P* value < 0.001) for both.

Following the implementation of the QI interventions, there was an increase from 0% to 73% in the utilization of the integrated MAP in the EHR across the ACCU-CVS/BMT units [*process measure (primary aim)*], as shown in Figure 3. Also, the average user hours per patient (second *outcome measure*) decreased by 70% from a centerline of 0.89 hours during the baseline period to 0.27 hours, with the shift change also happening right after the intervention (Fig. 4).

We looked at the unmatched cases for both units by reason category with the results shown in Figure 5. (**Figure 2, Supplemental Digital Content,** Unmatched reasons for Cerner outpatient vs. Cerner inpatient, ***http://links.lww.com/PQ9/A505***; **Figure 3, Supplemental Digital Content,** Unmatched reasons for Cerner outpatient vs. MAP® outpatient, ***http://links.lww.com/PQ9/A505***.) For Cerner inpatient versus MAP inpatient (Fig. 5), the most frequent reasons were "other" (capsule versus tablet, missing meds, and incorrect end dates) and no MAP. The most common mismatch for Cerner outpatient versus Cerner inpatient (**Figure 2, Supplemental Digital Content,** Unmatched reasons for Cerner outpatient vs. Cerner inpatient, ***http://links.lww.com/PQ9/A505***) was no RN outpatient medication reconciliation (67%). The top mismatch for Cerner outpatient versus integrated MAP outpatient (**Figure 3, Supplemental Digital Content,** Unmatched reasons for Cerner outpatient vs. MAP® outpatient, ***http://links.lww.com/PQ9/A505***) was no MAP, followed by no EHR outpatient medication reconciliation. Reasons for unmatched cases were not specifically addressed at weekly meetings as we were primarily focused on addressing any integration flow/process issues, and the reasons for unmatched cases were extracted from the chart retrospectively postimplementation.

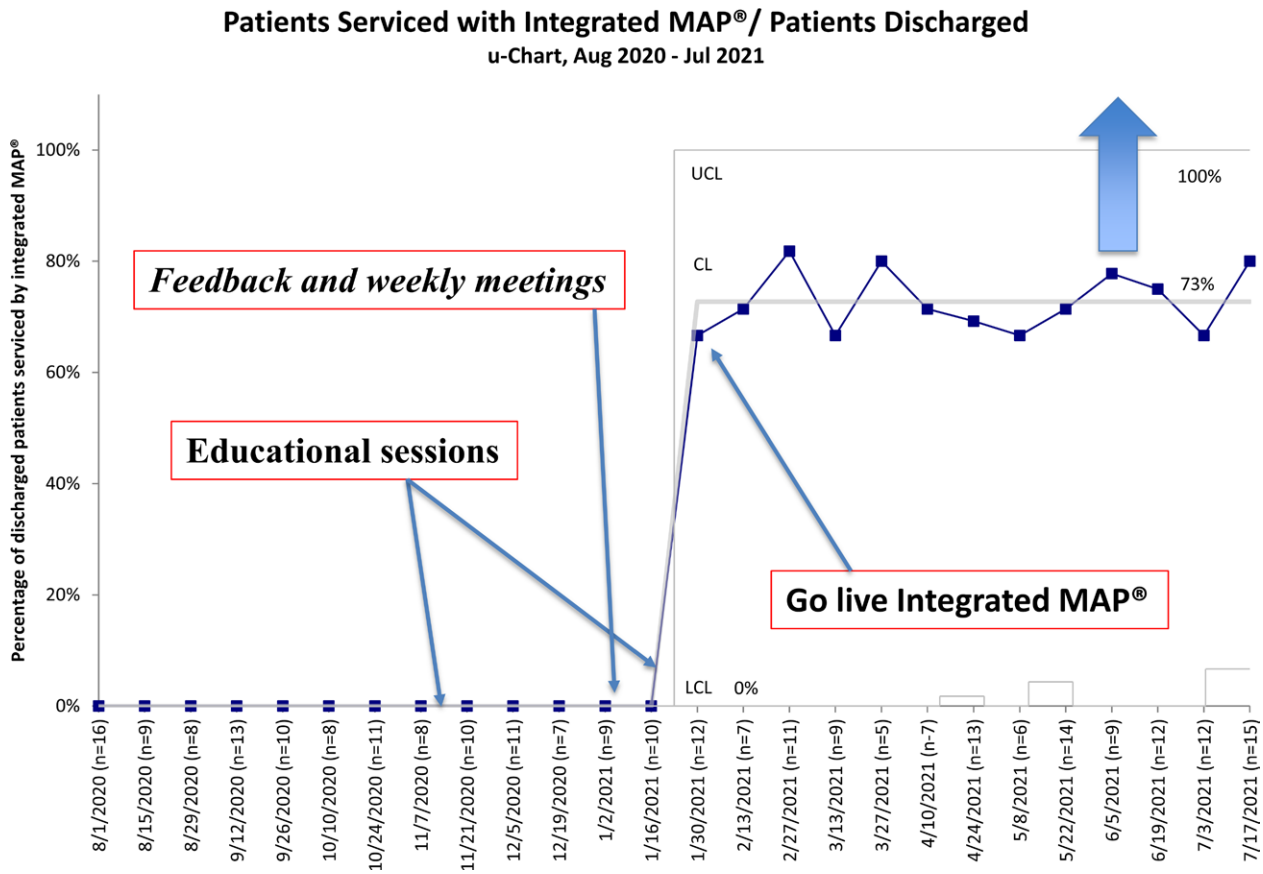

Fig. 3. Process measure: utilization of integrated MAP.CL indicates centerline; LCL, lower control limit; UCL, upper control limit.

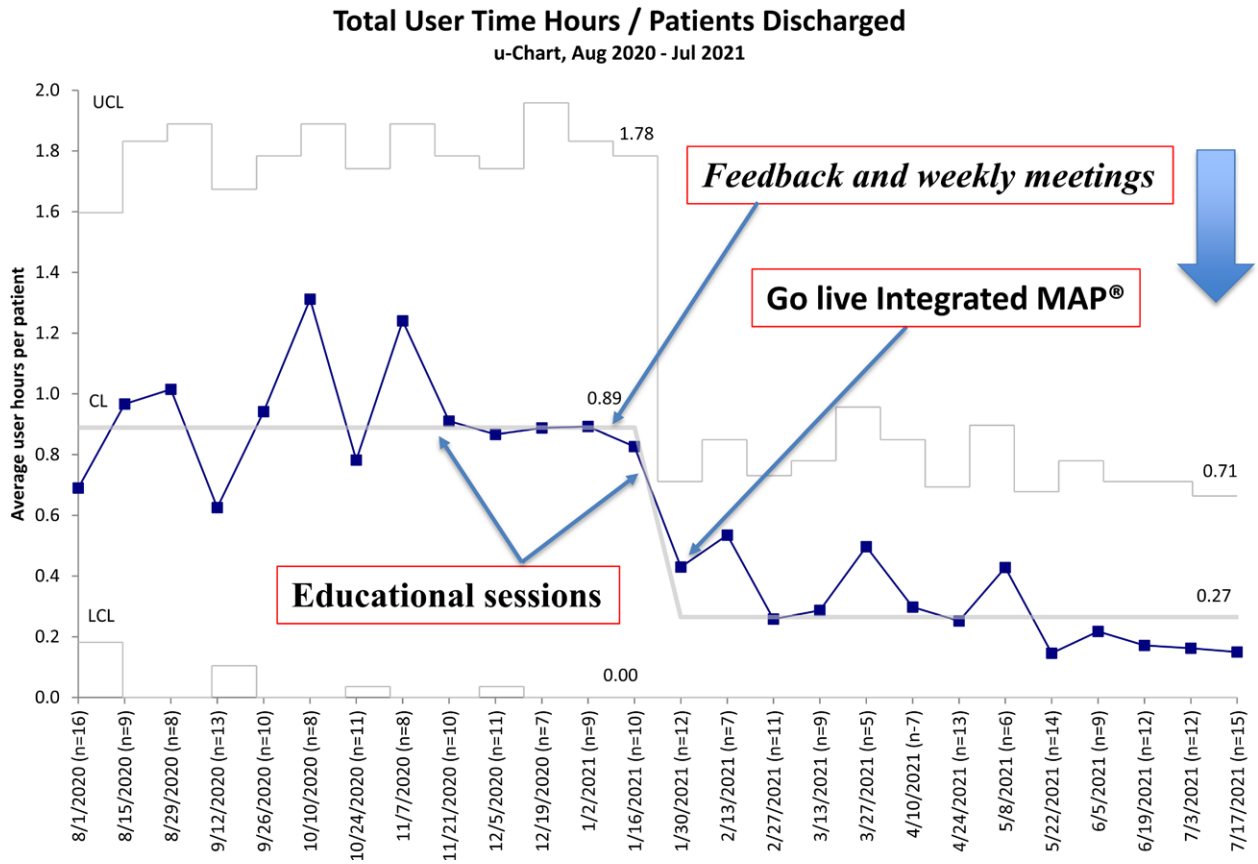

Fig. 4. Second outcome measure: efficiency. CL indicates centerline; LCL, lower control limit; UCL, upper control limit.

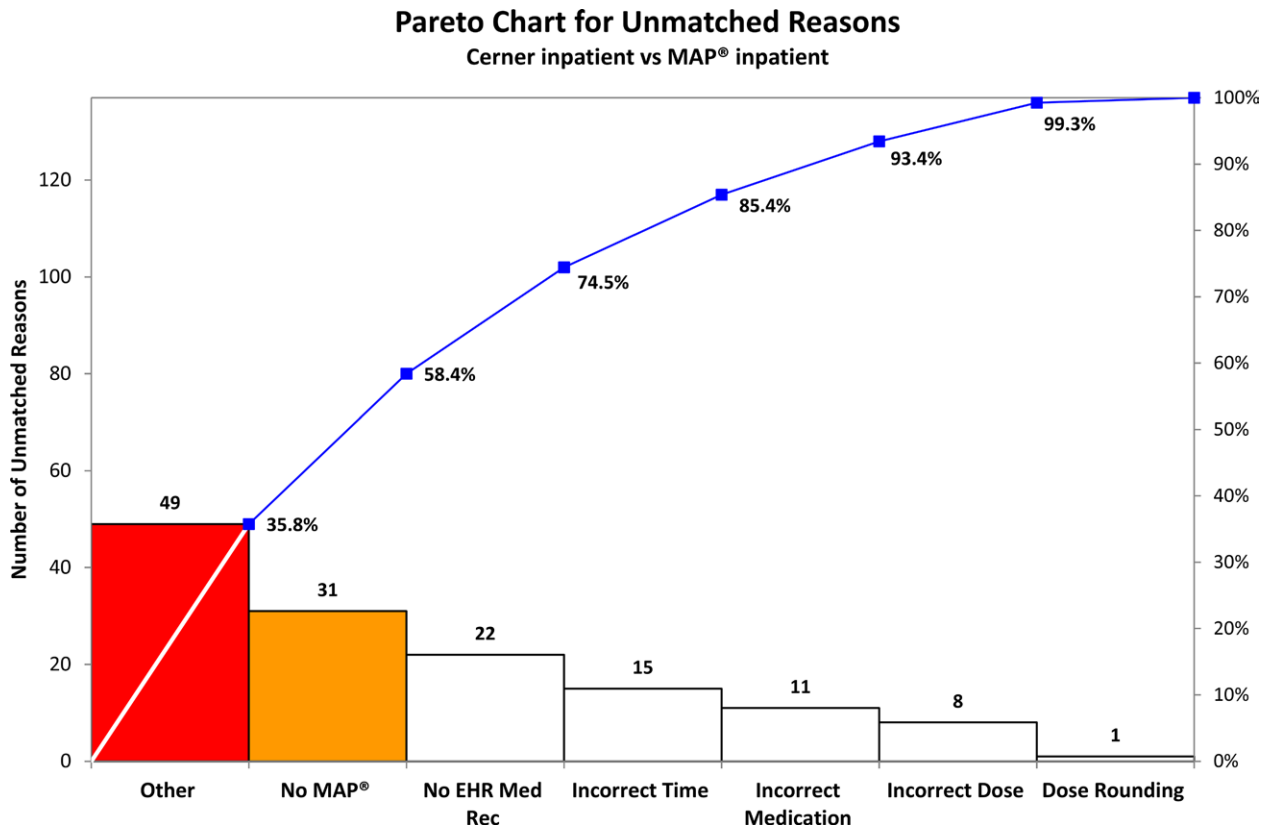

Fig. 5. Unmatched reasons for Cerner inpatient vs MAP inpatient.

The *balancing measure* (medication error readmissions) remained unchanged at 0% from baseline to postintervention.

DISCUSSION

Our team demonstrated an association between the integrated MAP at discharge with improved medication accuracy and provider efficiency with no serious adverse effects (zero medication error readmissions). Drivers of success included the involvement of APPs and a standardized approach utilizing the integrated MAP at discharge.

Project meetings highlighted the success and challenges of integrating the MAP. We learned that during the early phases of the QI project, the BMT team utilized the standalone MAP, not the EHR, as the "source of truth" for patient discharge medication reconciliation. This practice brought to light a potentially significant safety issue. Using the standalone MAP as the "source of truth" meant that other departments would not have the correct list of discharged medications for BMT patients. This practice may explain why inpatient matching increased significantly for the BMT. On the other hand, ACCU-CVS APPs utilized the Standalone MAP version on the inpatient service before implementing this QI project. The lack of significant improvement in the matching rate on the ACCU-CVS might be related to the high baseline matching rate compared to BMT. Finally, CVS outpatient service did not utilize MAP before this QI project; thus, we noticed an improvement in matching. We also identified the need to add tapers and specialty medications to the MAP. Additionally, how the clinical discharge medication reconciliation information should look when reconciled and printed was shared by clinicians. This intervention allowed informatics experts to better understand how to build the EHR program on the back end. Baylor University Medical Center, which performs 200 BMT every year and uses MAP, also found that adding visual tools within MAP significantly improved education and adherence to complex medication regimens.[19]

The strength of this project was the standardized approach implemented at 2 distinct acute care units that host medically complex patients. Dedicated and specialized APPs are essential to the care provided in both units and are familiar with the MAP. The involvement of APPs in ACCUs has been shown to improve the discharge process and patient experience, leading to shorter postoperative lengths of stay than expected.[20,21] The devoted team and unified approach suggest the importance of consistency and standardization for improving care.[22,23]

The absence of MAP remains a significant contributor to medication mismatches beyond discharge. In a prospective study comparing inpatient medication lists for pediatric patients discharged after a >24-hour stay, Gattari et al[24] found medication discrepancies from multiple documentation sources, with addition/omission errors noted as more common than dosing ones. Medication mismatch remains a challenge to the health care system. In a retrospective evaluation of medication reconciliation across care transitions in an academic pediatric care center, Condren et al[25] also found that these medication discrepancies often lead affected patients to experience delays in therapy, confusion among family members, and insurance rejections. Karliner et al[26] (2012) compared limited English-proficient patients' understanding of follow-up appointment type, medication category, and purpose with English-proficient patients. They found overall low medication category understanding for those with limited English proficiency. Chuang et al[19] found that transplant patients using the MAP allowed for enhanced communication and continuity of care between inpatient and outpatient settings. Patients also had improved compliance and understanding of the medication regimen. Therefore, providing a "structured medication reconciliation may help to prevent discharge medication discrepancies."[7] Marien et al[27] assessed the usability of a team-developed medication reconciliation app and found the importance of a user system-based approach for the integration of a medication reconciliation system with the EHR.

Future Directions

The natural next steps for this project are to expand to other units within our center and establish a multicenter QI project. Author (L.M.R.) is now a full-time APP educator within the department of APPs and is positioned well to help spread the project within the organization. Nationally, we partnered with other centers to deploy a multicenter QI project to improve the discharge medication experience for patients, families, and providers. One, in this regard, would consider partnering with the Acute Care Cardiology Collaborative (PAC),[3] whose mission includes improving "cardiac acute care outcomes" and "family and staff experience."[28–31] Furthermore, in Figure 5, **Figure 2, Supplemental Digital Content,** Unmatched reasons for Cerner outpatient vs. Cerner inpatient, ***http://links.lww.com/PQ9/A505***, and **Figure 3, Supplemental Digital Content,** Unmatched reasons for Cerner outpatient vs. MAP® outpatient, ***http://links.lww.com/PQ9/A505***, we provide the readers with reasons for medication mismatches, which can be the focus of future interventions to improve medication accuracy.

Limitations

This was a single-center QI project and might not apply to other settings. Before successful MAP integration can occur, the team must fix identified "build issues" within EHR (tapers/crushing, etc.). The team analyzed the reasons for matching discrepancies after the integration phase of this QI project was complete; therefore, we could not conduct real-time PDSAs to improve the matching rates as part of this project. However, we did not establish interrater reliability; the 3 team members (L.M.R., J.F., and S.A.W.) met and discussed the plan to extract the data, including the best source documents within the

EHR. The raters resolved challenges and questions raised during the data extraction to provide consistency.

CONCLUSIONS

Integration of MAP into the EHR is associated with safely improved inpatient discharge medication reconciliation and provider efficiency. Further multicenter evaluation is needed to assess the impact of MAP integration on patients' compliance and outcomes.

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DISCLOSURE

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

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