Implementation of Institute for Safe Medication Practices (ISMP) Initiatives to Reduce Medication Overrides in the Surgical Intensive Care Unit at a Veterans Affairs Academic Medical Center

(I-REMO STUDY)

by
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ABSTRACT

Background: The automated dispensing cabinets (ADCs) now allow for more rapid access to medications for both providers and pharmacists. However, automation may generate its own challenges with patient care. Medication overrides from ADCs circumvent pharmacist verification and creates an opportunity for medication errors.

Methods: A 60-week quasi-experimental study has been conducted at large Veterans Affairs (VA) academic medical center from January 1, 2019 to February 29, 2020 to assess the efficacy of the ISMP-endorsed interventions in reducing medication overrides. Three interventions were implemented for this study: 1:1 nursing education, medication override list, and ADC medication override privilege modification. The interrupted-time series with multiple regression analysis was conducted to assess the efficacy of each intervention. The primary endpoint was the rate of medication overrides (primarily controlled substances and antibiotics) from the unit ADC at each intervention time periods. The secondary endpoints included medication override rates for controlled substances and fentanyl intravenous piggyback (IVPB), the most common overridden item, at each study intervention time periods. The other secondary endpoint was the comprehensive medication override rates for all medications in the unit ADC after November 1, 2019.

Results: Total of 1,783 medication overrides from January 1, 2019 to February 29, 2020 were included in the final analysis from 616 patients. The interrupted time series with multiple logistic regression showed that the 1:1 nursing education significantly reduced the medication overrides (t = -6.10 [95% CI: -15.34 to -7.75]; P < 0.0001) and the decreased trend was maintained afterwards. No significance was found from the medication override list (t = -0.91 [95% CI: -5.17 to 1.94]; P=0.366) and the nursing ADC access privilege restriction (t = -0.82 [95% CI: -4.75 to 1.98; P=0.414]). Secondary endpoints have seen similar results. The 1:1 nursing education significantly reduced controlled substance (t = -6.34 [95% CI: -17.79 to -9.25]; P < 0.0001) and fentanyl IVPB override rates (t = -3.08 [95% CI: -43.69 to -9.28]; P = 0.003). The medication override list did not statistically reduce the controlled substances and fentanyl IVPB; whereas, ADC medication override privilege modification made a significant impact on fentanyl IVPB (t = -2.47 [95% CI: -34.08 to -3.56]; P=0.017). All medication overrides after November 1, 2019 have also significantly decreased monthly medication override rate from 7.63% to 2.90%.

Conclusion: An interdisciplinary approach to ISMP-endorsed interventions significantly reduced the overall medication overrides rates in Veterans Affairs intensive care unit.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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BACKGROUND

Since the 1980s, automated dispensing cabinets (ADCs) have been the standard medication delivery practice in healthcare settings, rendering more rapid access to medications in emergencies and opportunities for pharmacists to participate in direct-patient care.[1] With incorporation of individualized profile settings and integration into electronic health record systems, ADC composes 70% of all health systems' distributive model.[1,2] However, ADCs also have the potential to contribute to medication errors when health care providers utilize the medication override function. Utilizing this function, medications do not undergo pharmacist scrutiny and verification prior to administration to the patient.[2,3,5]

Medication overrides are officially defined by the American Society of Health-System Pharmacists (ASHP) as an action in which the pharmacist verification step of a medication between a physician ordering a medication and medication administration to the patient is bypassed via medication override from the ADC.[2] Medication override is only appropriate when delay of medication administration could result in patient harm[2] While medication overrides are helpful in urgent situations, the bypassing of pharmacist verification increases the risk of medication errors and may not be properly documented within the electronic medical record. One study found that out of 470 medication overrides observed, 11.7% were given without physician support and 10% lacked proper documentation in the electronic health record.[4]

The Joint Commission (JC) defines best practice as a pharmacist reviewing all first dose orders prior to medication dispensing and administration.[6] Therefore, it is imperative for healthcare facilities to minimize the medication overrides as much as possible. The Institute for Safe Medication Practices (ISMP) provides guidance on reducing and monitoring the medication overrides.[7] However, recommendations are non-specific and lack considerable evidence.
There has been an increase in regulatory standards that further necessitate hospitals to equip themselves with a robust medication override policy. As of 2018, the JC requires a review of medication override appropriateness by assessing institutional medication override trends.[6] Similarly, ASHP recommends a justified medication override list with limited access to medications within ADCs to reduce medication override rates.[2] Recently, the ISMP added medication overrides from ADCs as an addition to the 2020-2021 Targeted Medication Safety Best Practices for Hospitals.[8]

At the time of this study, a standardized protocol for medication override monitoring was not implemented within the Michael E. DeBakey Veterans Affairs Medical Center (MEDVAMC). The purpose of this study was to evaluate the impact of 1:1 nursing education followed by implementation of a medication override list by a multi-disciplinary team and modification of ADC privileges for nurses.

METHOD

Study Design and Setting

This quasi-experimental study was conducted between August 16, 2019 – February 29, 2020 within the surgical intensive care unit (SICU) at the MEDVAMC, an academic medical center affiliated with the Baylor College of Medicine in Houston, TX. The unit contained one ADC and 18 beds. During the study period, the unit was staffed by forty-nine rotating registered nurses, one nursing manager, two nursing assistant managers, one nursing clinical leader, one nursing educator, one clinical pharmacy specialist, and one rotating clinical pharmacist dedicated to SICU order verification. Three interventions were implemented: Nursing medication override in-services (Intervention 1), implementation of a medication override list (Intervention 2), and ADC Nursing Medication Override Privilege Modification (Intervention 3). The study timeline is found in **Figure 1.**

In-Service Education Sessions (Intervention 1)

A series of education sessions were provided throughout the study period by pharmacy and nursing teams in order to ensure all members of the patient-care team were aware of the changes and their purpose. **Table 1** illustrates the content of the education sessions provided. Initially, one-on-one feedback sessions were provided to SICU nursing staff by the nursing leadership beginning in August 16, 2019. This was followed by SICU nursing in-service education sessions provided by clinical pharmacists on October 1, 2019.

Medication Override List Implementation (Intervention 2)

A multidisciplinary team developed a medication override list after review of the SICU ADC medication override patterns from January 2019 to June 2019. The final list consisted of 32 medications and included the recommended medication dose, route, formulation and indications. The final medication override list can be found in **Figure 2.** Only medications included on the list were able to be overridden in emergent situations. Upon approval, the medication override list was introduced to the nursing and pharmacy department through in-service education on October 1, 2019.

ADC Nursing Medication Override Privilege Modification (Intervention 3)

Prior to the study, the medication override option was available to all nurses in the unit for any medication in the ADC. As of January 21, 2020, only charge nurses were allowed unrestricted medication override privileges to the ADC. All nurses were still able to override the medications included in the medication override list. The nursing medication override privileges were gradually modified on a weekly basis in order to provide a coordinated transition for nursing workflow (7 nurses every week).

Monitoring and Committee Involvement

One pharmacist and two nurses monitored medication override activity and patterns weekly. Nurses with frequent medication overrides were identified and provided one-on-one feedback sessions. The results and trends of the medication override rate were reported to monthly hospital medication safety and critical care committees.

Outcomes

The primary endpoint of this study was the rate of medication overrides at each intervention time period (August 2019, November 2019, and January 2020). This included all medications that were consistently included in the ADC medication override report throughout January 2019 to February 2020. Secondary endpoints included: controlled substance override rates and fentanyl intravenous piggyback (IVPB) override rates at each intervention time period (August 2019, November 2019, and January 2020). Additionally, all medication override rates, including both non-controlled and controlled substances, were captured after all medications in ADC were reprogrammed to be shown in the override report.

Statistical Analysis/Analysis Plan

This quasi-experimental study evaluated the dual impact of a unit-specific medication override list on medication overrides. An interrupted time series regression analysis was conducted to analyze both primary and secondary endpoints.

RESULTS

Baseline Characteristics

A total of 616 patients and 1,783 medication overrides were included in the study analysis from January 1, 2019 to February 29, 2020. No statistical difference in distribution was noted between patients in the pre- and post-phases with regards to age, sex, and survival status. Baseline characteristics can be found in **Table 2**.

Of the medications included in the primary endpoint, 42 medications were controlled substances (74.8%), antibiotics (23.8%) and antianginal (2.4%). Starting on November 1, 2019, all medications stored in the ADC were shown in the medication override report. After November 1, 2019, 1,099 medication overrides were retrieved for 233 patients. The medication override rates for both the primary and secondary endpoints can be found in **Table 3**.

Primary Endpoint

Prior to project implementation, the average monthly medication override rate was 13.3% from January 1, 2019 to August 15, 2019. Within 1, 3, and 6 months of the project, the medication override rate decreased to 3.0%, 2.9%, and 2.4%, respectively. The interrupted time series with multiple logistic regression (**Figure 3**) illustrates the impact of each intervention. The intervention 1 significantly reduced the number of medication overrides (t = -6.10 [95% CI: -15.34 to -7.75]; P < 0.0001). A statistically significant difference pre- and post-implementation was not found with the intervention 2 (t = -0.91 [95% CI: -5.17 to 1.94]; P=0.366) or intervention 3 (t = -0.82 [95% CI: -4.75 to 1.98; P=0.414]). The overall decreased trend of the medication was maintained throughout the study since the introduction of interventions.

There were some significant differences in the primary endpoint pre- vs post-interventions. There were reductions in the number of overrides per patient (1.93 vs. 1.46; P=0.002) at night (24.2% vs 12.0%; P=0.004), and performed before the order entry (48.6% vs 36.0%; P=0.005). However, it was also observed that there was a considerable increase in medication overrides before pharmacist verification (19.0% vs. 37.3%; P<0.0001) and during the day shift (46.6% vs. 59.4%; P<0.0001). Further analysis of the primary endpoint can be found in **Table 4**.

Secondary Endpoints

Figure 4 shows the breakdown of medication override rates for controlled substances and fentanyl IVPBs. The intervention 1 significantly reduced the controlled substance medication override rate (t = -6.34 [95% CI: -17.79 to -9.25]; P < 0.0001) whereas intervention 2 (t = -1.00 [95% CI: -6.00 to 2.00]; P = 0.32) and intervention 3 (t = -0.70 [95% CI: -5.12 to 2.46]; P = 0.48) did not meet statistical significance. Overall controlled substance override rates decreased at 4.1%, 2.8%, and 3.5% at months 1, 3, and 6 after project implementation. A statistically significant reduction in fentanyl IVPB medication overrides was met with intervention 1 (t = -3.08 [95% CI: -43.69 to -9.28]; P = 0.003) and intervention 3 (t = -2.47 [95% CI: -34.08 to -3.56]; P=0.017). Intervention 2, on the other hand, did not make statistical significance (t = 0.61 [95% CI: -11.20 to 21.04]; P=0.54). Four-month analysis of all medication override rates after November 1, 2019 has also down-trended since implementation of the three interventions. As shown in **Figure 5**, Intervention 3 did not result in a statistically significant reduction of the override rate at 5 weeks (t = -1.39 [95% CI: -3.92 to 0.82]; P=0.184). However, the override rate did decrease from 7.63% in November 2019 to 2.90% in February 2020.

Post Experiment Nursing Survey

A post-experimental satisfaction survey was administered to 10 SICU nurses to assess their satisfaction to the new interventions implemented. As found in **Table 5**, the 2 question survey utilizing the Richter scale (1 = worst to 10 = best) found that nurses

seemed neutral to slightly unsatisfied with the new interventions implemented, citing mostly the delays from order verifications from pharmacy department.

DISCUSSION

Medication overrides from ADC's are a challenging issue to resolve because emergency manifests in innumerable ways and an interpretation of an emergent situation is highly subjective. According to a retrospective review of 583 medication error events reported to the Pennsylvania Patient Safety Authority, 19%, the highest amongst any other locations, came from the surgical and medical ICUs[9]. The same study also identified that opioids were the top class of medications to be overridden (12%), which is consistent with our findings[9]. To our knowledge, this is the first quasi-experimental study conducted to evaluate the efficacy of reducing medication overrides utilizing the ISMP-issued recommendations with an interrupted time series analysis.

Our study has revealed some significant findings. Most notably, one on one nursing feedback sessions were the most effective solution for controlled substances and antibiotics whereas ADC medication override privilege restriction proved to be effective in reducing all medication overrides. All interventions were strategically implemented at different times during the study period to assess each efficacy. Although pharmacy-led nursing education and medication override privilege modification were not found to be statistically significant, we believe the decrease in the number of medication overrides was maintained throughout the rest of the study due to subsequent interventions placed in the pilot study. This is partially validated by the data displaying all medication override rates after November 1, 2019. Given that the overall medication override rate has also decreased, it can be argued that interventions collectively maintained the decreased trend throughout the study. It is also important to optimize the communication with leadership from every pertinent department. Routine meetings with department leadership for updates in progress and discussion for future strategies are critical to decreasing the number of medication overrides. Post experimental nursing satisfaction survey revealed that nurses were either neutral to dissatisfied with the medication override interventions. Majority of reasons for dissatisfaction were due to delays from pharmacy processes, identifying potential areas of improvement for pharmacy operations.

Our study had notable strengths. This quasi-experimental study assessed real-world data impacted by multi-disciplinary interventions. With sequential method that each fulfills ISMP recommendations, the study may potentially serve as a guidance for medication override policy implementation for other similar intensive care units. Furthermore, the study has involved all pertinent health departments for each intervention, which further reinforces the importance of inter-departmental collaborations.

However, there were several limitations of the study as well. Since interventions implemented were highly individualized for one specific unit, this lessens overall external validity. Furthermore, the number of charge nurses initially selected for unrestricted medication override privileges was highly specific to our unit. Subsequently, all comprehensive medication override data was not available throughout the entire study data. Therefore, its data is relatively small and require more endpoints to make more definitive conclusion. Additionally, the efficacy of implementing a two pharmacist verification system could not be evaluated robustly due to staff shortage. Finally, the study was not able to identify whether each medication override was appropriate due to a lack of documentation from the electronic health record and trend of medication errors could also not be evaluated due to overall low facility-wide reporting rate.

CONCLUSION

This four-month quasi-experimental study has shown that using a multi-disciplinary approach to implement sequential interventions was an effective method in reducing medication overrides in a surgical intensive care unit. Each healthcare institution should address their medication override issues using a multi-disciplinary approach and develop their own policy based on their medication usage patterns.

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Table 1.0: Study Interventions

Interventions	Dates of Implementation
Preliminary one to one nursing feedback (provided by nursing)	August 16, 2019 – September 30, 2019
SICU medication override list implementation	October 1, 2019
Nursing Education Sessions (provided by pharmacy) • Unit specific medication override list and introduction to project • Mid-point In-service • ADC access privilege restriction	October 1-2, 2019 December 6, 2019 January 16, 2019
ADC Access Privilege Restriction	January 21, 2020

Table 2.0: Baseline Characteristics

	Control (N=352)	Intervention (N=264)	P value
Age (std. dev)	67 **(10.2)**	68 **(9.6)**	0.50
Gender (%)			
Male	345 **(98.0)**	260 **(98.5)**	0.93
Female	7 **(2.0)**	4 **(1.5)**	
Survival Status (%)	297 **(84.4)**	229 **(86.7)**	0.53
Alive	55 **(15.6)**	35 **(13.3)**	
Dead			
Race (%)			
White	196 **(63.0)**	173 **(65.5)**	0.53
Black	107 **(3.4)**	84 **(31.8)**	0.51
Others	8 **(2.6)**	7 **(2.7)**	

Table 3.0: Medication Override Rate Trend

	Before Implementation (Jan 19 – Aug 15, 2019)	After Implementation (Aug 16, 2019 – Feb 29, 2020)
Primary - Medication override	**685/5134 (13.34)**	**172/5035 (3.4)**
1 month		22/724 (3.0)
3 months		17/586 (2.9)
6 months		21/864 (2.4)
Controlled Substance Override	**642/3790 (16.9)**	**154/3507 (4.4)**
1 month		21/514 9(4.1)
3 months		13/461 (2.82)
6 months		21/607 (3.46)
Intravenous Fentanyl Order	**333/813 (41.0)**	**78/512 (15.23)**
1 month		12/115 (10.4)
3 months		11/37 (29.73)
6 months		5/57 (8.77)
Override Timing		
After order verification	113 (18.8)	25 (14.5)
Before order verification	114 (19.0)	63 (36.6)
Before the order entry	292 (48.6)	65 (37.8)
No order placed	82 (13.6)	19 (11.0)

Table 4.0: Override Patterns (Primary Endpoint)

	Control Data (n=352)	Intervention Data (n=110)	P value
Number of overrides per patient	1.93	1.46	**0.002**
Order entered (%)			
Yes	518 **(86.2)**	143 **(88.8)**	0.43
No	83 **(13.8)**	18 **(11.2)**	
Override Timing (%)			
Before the order entry	292 **(48.6)**	58 **(36.0)**	**0.005**
Before pharmacist verification	114 **(19.0)**	60 **(37.3)**	**<0.0001**
After pharmacist verification	113 **(18.8)**	25 **(15.6)**	0.34
Shift of override			
Day (07:30-16:00)	75 **(46.6)**	357 **(59.4)**	**0.004**
Afternoon (15:30-23:00)	47 **(29.2)**	172 **(28.6)**	0.60
Night (22:30-07:30)	39 **(24.2)**	72 **(12.0)**	**<0.0001**

Table 5.0: Post Experimental Nursing Survey

Q1 On a scale of 1-10, how satisfied are you with the new medication override policy? (1=worst, 10=best)	On a scale of 1-10, do you think the medication override policy improves patient care? (1=worst, 10=best)
4.3 (3.08)	4.3 (3.16)

Figure 1.0: Timeline of intervention

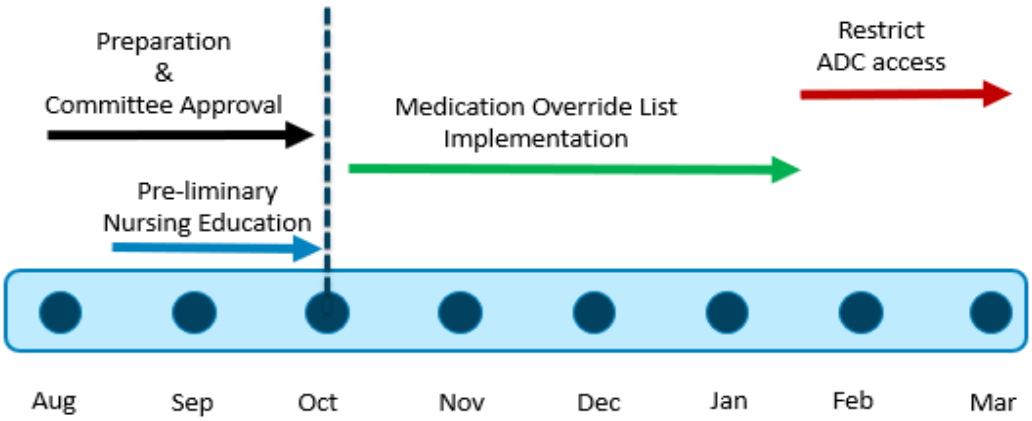


Figure 2.0: SICU Medication Override List

Medication	Indication
Adenosine 6MG/2ML Syr	Supraventricular Tachycardia
Alteplase, Recombinant 100 MG/VIL Inj	Ischemic Stroke/Pulmonary Embolism
Amiodarone 150MG/3ML 3ML Inj	Cardiac Arrest
Amiodarone 150 MG/100ML D5W INJ BAG	Cardiac Arrest
AMIODARONE 360MG/200ML D5W INJ BAG	Cardiac Arrest
Aspirin 325 mg tablet	Chest pain
Atropine 1 MG/10ML Syr	Cardiac Arrest
Calcium Chloride 10% 10ml Syr	Hyperkalemia
Cisatricurium 2MG/1ML 10 ML Inj	Intubation
Dexamethasone Na Phos 4MG/1ML 5ML Inj	Laryngeal Edema
Dextrose 50% 25 GM/50ML 50ML Inj	Hypoglycemia
Diltiazem HCL 5MG/1ML Inj	Atrial flutter/fibrillation
Diphenhydramine Hcl 50MG/1ML 1 ML inj	Anaphylaxis
DOPamine in D5W 800MG/500ML 500 ML IVPB	Hypotension
Epinephrine 1:10,000 1MG/10ML Syr	Cardiac arrest
Epinephrine 1:1,000 Inj. 30ML Inj	Anaphylaxis
Etomidate 2MG/1 ML 20ML Inj	Sedation/Intubation
Fat Emulsion 20% 250ML IVPB	Lidocaine Toxicity
Fentanyl 50MCG/1ML 2ML Inj	Pain/Sedation
Flumazenil 0.1MG/1ML 5ML Inj	Antidote
Furosemide 10MG/1ML 2ML Inj	Pulmonary edema
Glucagon 1mg/ Vi Inj	Hypoglycemia
Haloperidol 5MG/1ML 1ML Inj	Agitation
HydrALAZINE 20MG/IML 1ML Inj	Hypertension
Hydromorphone 2MG/1ML 1ML Inj	Acute pain
Ins Reg (Human) 100units/ml Novolin R 10ml Inj	Hyperkalemia
Labetalol 5MG/1ML 20 ML Inj	Hypertension/Tachycardia
Lidocaine 2% 20MG/1ML 5ML SYR	Arrythmia
Lorazepam 2MG/1ML 1ML Inj	Seizure
Magnesium SO4 16mEq/50ml IVPB	Torsades de pointe
Methylprednisolone 125MG Inj	Anaphylaxis
Metoprolol 5MG/5ML 5ML Inj	Myocardial Infarction/Tachycardia
Midazolam HCl 1MG/1ML 2ML Inj	Sedation
Morphine Sulfate 2MG/1ML 1ML Inj	Acute pain
Naloxone 0.4MG/1ML 1ML Inj	Opioid overdose
Nitroglycerin 0.4 MG SL tablet	Chest pain
Nitroglycerin/D5W 0.2MG/1ML 250ML Inj	Chest pain/Pulmonary Edema
Norepinephrine Bitartrate 1mg/1ml 4ml Inj	Hypotension
Protamine Sulfate 50mg/5ml 5ml Inj	Heparin toxicity
Propofol 100ML 10MG/1ML INJ	Sedation
Phenylephrine 1% 10MG/I ML 1 ML Inj	Hypotension
Sodium Bicarbonate 8.4% syringe	Metabolic acidosis
Succinylcholine 20MG/1ML 10ML Inj	Intubation

Figure 3.0 Primary Endpoint (Jan 1, 2019 – Feb 29, 2020)

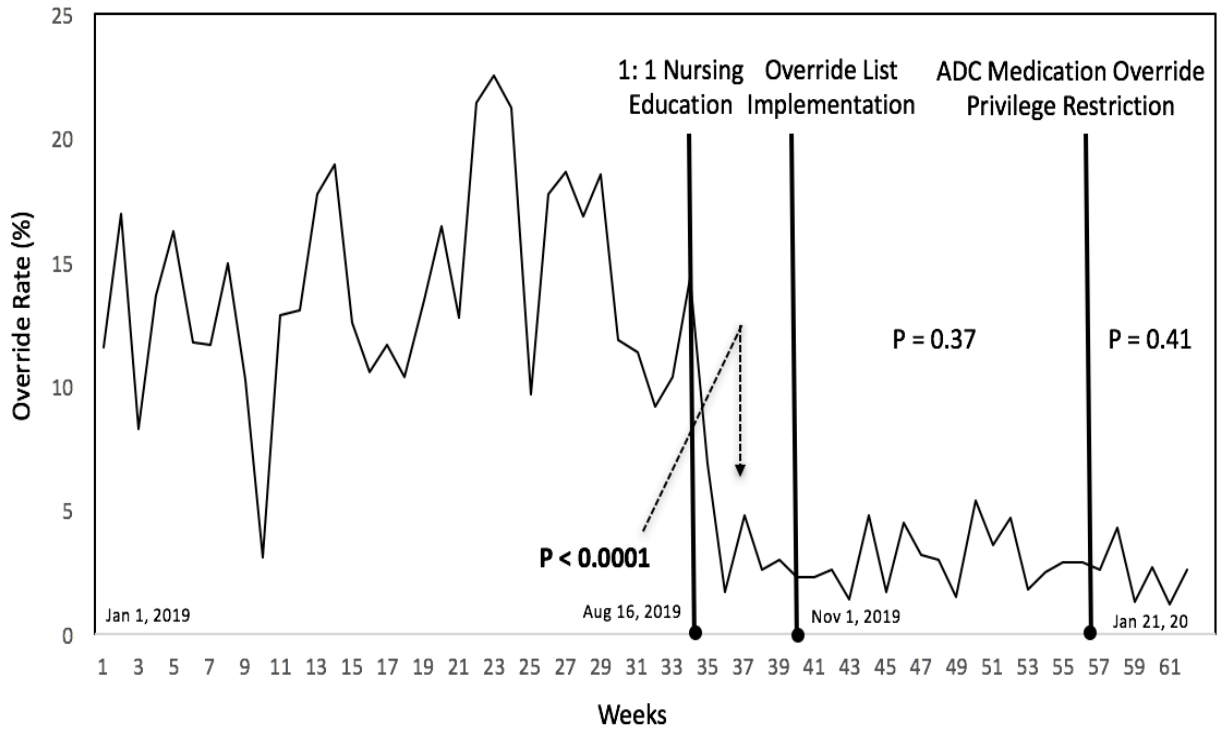
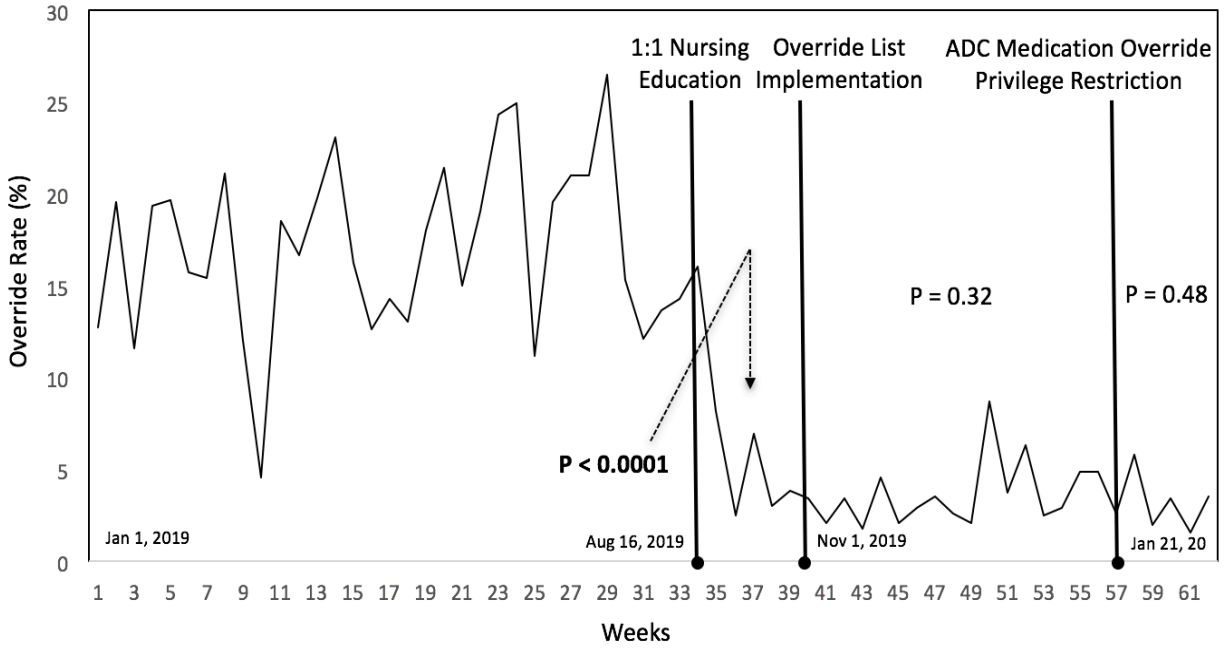


Figure 4.0 Secondary endpoints: Controlled Substance & IV fentanyl overrides (Jan 1, 2019 – Feb 29, 2020)

Controlled Substances



IV Fentanyl Override Rates

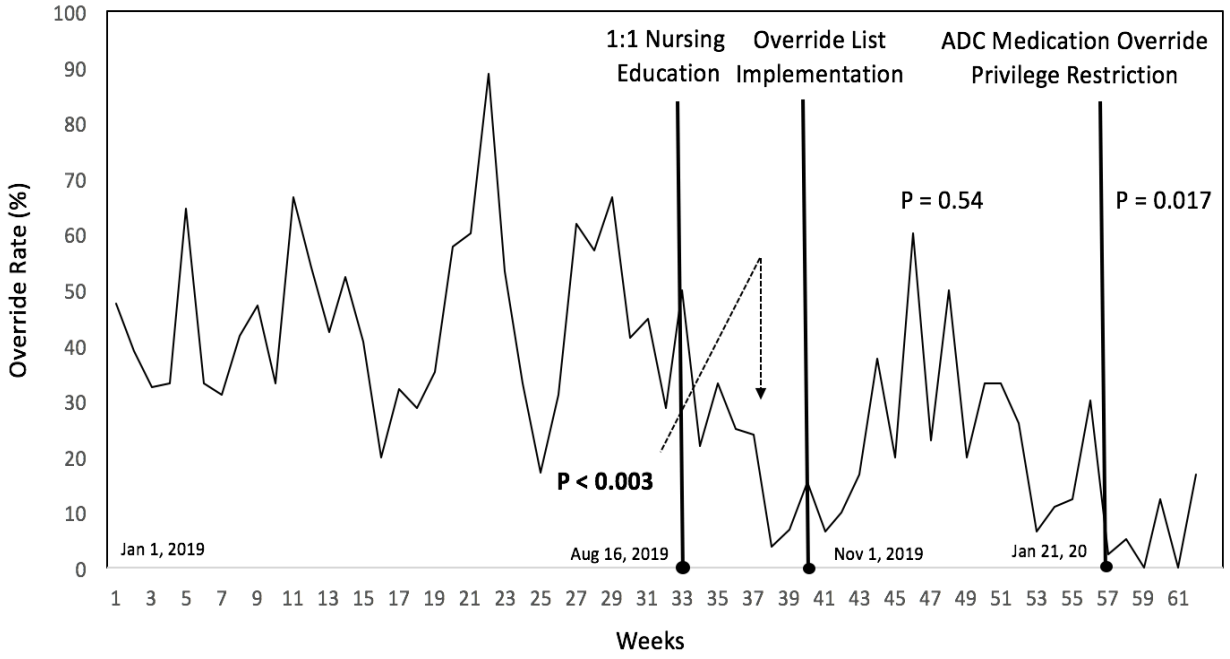


Figure 5.0 Secondary Endpoint: All Medication Override Rates (Nov 1, 2019 – Feb 29, 2020)