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Implementing Clinical Decision Support Aimed at Reducing Co-Prescribing of Opioids and Benzodiazepines at Adventist HealthCare Maryland

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Dedication

I would like to dedicate this work to God and my family (Mom, Dad, John, Kami, Di, and Travis) for supporting me and sticking with me throughout this journey! I would also like to dedicate this to my best and dearest friend, Nakisha Green, who passed away during this journey.

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Abstract

Clinical Decision Support (CDS) leverages computerized toolsets to provide condition specific guidance that aids providers in clinical decision making processes (AHRQ, 2019; AMIA, n.d.; ONC, 2018). Research has shown that applying CDS, interruptive within the electronic health record (EHR) prescribing workflow, can assist providers with avoiding unsafe medication prescribing, such as 1) multiple opioids and 2) opioid-benzodiazepine combinations (Malte et al., 2018; Smith et al., 2019, Price-Haywood et al., 2020; Nelson et al., 2022). In an effort to decrease the co-prescribing rate for 1) multiple opioids and 2) opioid-benzodiazepine combinations, Adventist HealthCare Maryland (AHC) launched a performance improvement project in 2022 that focused on decreasing the health system's average co-prescribing rate to fall within the 2% to 5% range. To achieve this goal, AHC implemented two (2) EHR-based CDS alerts that were interruptive within the prescribing workflow. Project results showed that AHC was not able to reach the 2% to 5% range, yet the overall co-prescribing rate decreased by 1.56%. The limitations with EHR functionality, differences between the planned design versus actual implementation of the alerts, alerting gaps, and alerting noise were all areas that needed to be improved to determine if the performance target could have been met with the CDS. Some recommended paths forward were to 1) address the design and technical challenges with the alerts, 2) enhance provider-level reporting around opioid and benzodiazepine prescribing to hospital and departmental administration, 3) continue educational efforts around co-prescribing, particularly for the top co-prescribing roles, and 4) explore a consistent role of pharmacy in reviewing prescriptions during the discharge process.

Keywords: clinical decision support, electronic health records, co-prescribing, opioids, benzodiazepines

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Section 1: Introduction

Clinical Decision Support (CDS) is often utilized by providers in healthcare settings for guiding decision-making related to medication prescribing (Smith et al., 2006; Terrell et al., 2009; Losby et al., 2016, Kreshak et al., 2018; Zaman et al., 2018; Funke et al., 2019; Marino et al., 2019; Smalley et al., 2019; Calcaterra et al., 2022). A synthesis of the components of CDS, as defined by various healthcare entities and organizations, includes:

1) decision-making guidance for clinicians focused on enhancing overall health and improving patient outcomes,
2) condition-specific guidance and information, and
3) toolsets in computerized and other forms that are leveraged or integrated into the clinical workflow at the point of care (AHRQ, 2019; AMIA, n.d.; ONC, 2018).

The fundamental premise is that CDS empowers providers to improve the quality and delivery of care. To be most effective and deliver valuable outcomes, medication-related CDS should align with the five (5) rights of CDS, which include presenting the right information, to the right person, using the right CDS intervention format (e.g., CDS alerts), leveraging the right channel (e.g., an electronic health record), and presenting at the appropriate time within the clinician's workflow (Sirajuddin et al., 2009, CDC, 2022b). Additionally, medication-related CDS initiatives should align with performance improvement standards and be designed with clinician end-users to maximize acceptance (Sirajuddin et al., 2009). Applying the CDS strategies mentioned above to more specific

medication-related use cases, such as opioid-related medication prescribing, can yield significant benefits (Smith et al., 2006; Terrell et al., 2009; Losby et al., 2016, Kreshak et al., 2018; Zaman et al., 2018; Funke et al., 2019; Marino et al., 2019; Smalley et al., 2019; Calcaterra et al., 2022) and contribute to curbing the overall opioid epidemic in the United States and abroad.

Opioid-Related Medication Prescribing, Opioid Epidemic, and Clinical Decision Support

According to the National Institute of Drug Abuse (n.d.), opioids are chemicals that react with nerve cells within the brain to reduce pain and can be safely utilized by patients if taken in small doses for a short time (NIDA, n.d.). However, prescription opioids taken in large quantities over extended periods, to relieve both cancer and non-related cancer pain or for end-of-life care, may lead to

1) misuse,
2) the development of opioid use disorder,
3) overdose, or
4) death

(Guy et al., 2017; CDC, 2019; NIDA, n.d.). The use and misuse of prescription opioids are the primary drivers of the opioid epidemic in the United States, with estimates showing that

1) 11.5 million Americans reported misusing prescription opioids in 2016, and

2) 68% of drug overdose deaths involved an opioid in 2017 (Wilson et al., 2020, para. 1).

Furthermore, data from the Centers for Disease Control and Prevention (CDC) show that "more than 932,000 people have died since 1999 from a drug overdose" (CDC, 2022a, para. 1) and "nearly 75% of drug overdose deaths in 2020 involved an opioid" (CDC, 2022a, para. 1). Prescription opioids were also responsible for more than 263,000 deaths between 1999 and 2020 (CDC, 2022c). Data from the United Nations demonstrate that opioid use is also a global problem, with an estimated 53 million people in 2017 having utilized opioids worldwide in the previous year (United Nations, 2019). This international estimate "corresponds to 1.1 per cent of the global population aged 15–64" (United Nations, 2019, p. 12) and a 56% increase in use from 2016 (United Nations, 2019).

The practice of co-prescribing, which "refers to having doctors prescribe one pharmaceutical with another to the same patient at the same time" (McDonald, 2020, para. 1), further compounds the issue with opioid prescriptions, especially when simultaneously prescribing benzodiazepines (Li et al., 2020; Richards et al., 2020; Garrett et al., 2021; Heo et al., 2022). Synthesized data from the Electronic Clinical Quality Improvement (eCQI) Resource Center (n.d.) regarding the concurrent use of 1) multiple opioids or 2) opioid-benzodiazepine combinations show that:

- "…5%-15% of patients receive concurrent opioid prescriptions and 5%-20% of patients receive concurrent opioid and benzodiazepine prescriptions across various settings (Liu et al., 2013; Mack et al., 2015, Park et al., 2015)" (as cited in eCQI, n.d., para. 20).
- "Patients who have multiple opioid prescriptions have an increased risk for overdose (Jena et al., 2014)" (as cited in eCQI, n.d., para. 20).

- "Rates of fatal overdose are ten times higher in patients who are co-dispensed opioid analgesics and benzodiazepines than opioids alone (Dasgupta et al., 2015)" (as cited in eCQI, n.d., para. 20).
- "…concurrent use of benzodiazepines with opioids was prevalent in 31%-51% of fatal overdoses (Dowell et al., 2016)" (as cited in eCQI, n.d., para. 20).
- "… eliminating concurrent use of opioids and benzodiazepines could reduce the risk of opioid overdose-related ED and inpatient visits by 15% and potentially could have prevented an estimated 2,630 deaths related to opioid painkiller overdoses in 2015 (Sun et al., 2017)" (as cited in eCQI, n.d., para. 20).

Research findings further demonstrate that co-prescribing of opioids and benzodiazepines

1) yields a higher hazard ratio than for patients without concomitant use,

2) are associated with higher adjusted odds ratios for continued use of opioids after surgery,

3) are the top predictor for opioid-induced respiratory depression (OIRD), and

4) are the top relative risk factor for prescribing high-dose opioids in primary care settings

(Li et al., 2020; Richards et al., 2020; Garrett et al., 2021; Heo et al., 2022).

Though the evidence regarding the use or misuse of opioids and unsafe opioid prescribing is clear, and trends have decreased since 2012, 58.5 opioid prescriptions were still written per every 100 persons by prescribers in 2017 (CDC, 2019; NASEM, 2020). Furthermore, Guy and colleagues (2017) found that opioid prescriptions quadrupled between 1999 and 2010, partly attributed to an increase in prescribing opioids to treat non-cancer-related pain (NIDA, 2017). However, opioids are not appropriate for treating

pain for all patients (NIDA, 2017). Additionally, Guy and colleagues (2017) found that the increase in opioid prescriptions was correlated to a rise in opioid overdose-related deaths and hospital admissions related to opioid use disorder treatment. The economic burden presented by the patient safety challenges related to opioid prescribing is overwhelming. Hale estimates the economic burden associated with opioid prescribing at "$29 billion in lost productivity, $35 billion in healthcare costs, and $14.8 billion in criminal justice costs" (2022, para. 1).

In response to opioid prescribing challenges, the Centers for Medicare and Medicaid Services (CMS), CDC, and Office of the National Coordinator for Health Information Technology (ONC) have highlighted the need to deploy both CDS and electronic health records (EHR) to facilitate 1) appropriate opioid prescribing and 2) the use of co-prescribing guidelines to combat the opioid epidemic (Dowell et al., 2016; CDC, 2022b, ONC, 2019; eCQI, 2022). CDS demonstrates promise for improving safety related to opioid prescribing and co-prescribing of unsafe medication combinations. CDS tools are valuable for predicting morbidity and mortality risks and guiding prescribing decisions related to opioids (Zedler et al., 2015; Olivia et al., 2017a; Holland et al., 2020). Research further suggests that embedding CDS within EHRs, which interrupts providers during the prescribing process, leads to reductions in:

1) unsafe medication dosing,

2) co-prescribing of opioids and benzodiazepines, and

3) inappropriate prescribing of non-preferred agents (Smith et al., 2006; Terrell et al., 2009; Losby et al., 2016, Kreshak et al., 2018; Zaman et al., 2018; Funke et al., 2019; Marino et al., 2019; Smalley et al., 2019; Calcaterra et al., 2022).

Though promising, CDS results within the medical literature are limited and varied, and populations are not equally studied. Additional translational projects with real-world informatics interventions need to be conducted to develop sound CDS interventions. These interventions should scale across all populations within the same context, e.g., "training, clinician involvement in defining the intervention, workflow changes, incentives to follow the intervention, leadership support, etc." (J. Glaser, personal communication, November 15, 2022).

Purpose of Translational Performance Improvement Project

To address the challenges with opioid prescribing, the CDC issued its initial guidelines for opioid prescribing related to chronic pain in 2016 (Dowell et al., 2016). Critical components of these guidelines relate to 1) safe morphine milligram equivalent (MME) prescribing practices and 2) the avoidance of co-prescribing opioids and benzodiazepines (Dowell et al., 2016). Furthermore, in 2021, the CMS and Joint Commission on Accreditation of Healthcare Organizations (JCAHO) developed the electronic clinical quality measure (eCQM) for Safe Use of Opioids – Concurrent Prescribing (JCAHO, 2021; eCQI, n.d.). The eCQM measure focuses on reducing the number of active prescriptions for 1) multiple opioids or 2) opioid-benzodiazepine combinations at discharge (JCAHO, 2021; eCQI, n.d.). As previously mentioned, the CMS, CDC, and ONC have highlighted the need for CDS prescribing guidelines within EHRs that yield more optimal outcomes and reduce inappropriate prescribing (Dowell et al., 2016; ONC, 2019; CDC 2022b; eCQI, 2022). This author conducted a translational performance improvement project to reduce the co-prescribing rate for 1) multiple opioids and 2) opioid-benzodiazepine combinations at Adventist HealthCare Maryland

(AHC). The goal for the project follows guidelines established by Bovend'Eerdt et al. (2009, p. 352) to be "specific, measurable, achievable, realistic/relevant and timed," often called a SMART goal. The project's goal was to implement EHR-based clinical decision support at Adventist HealthCare Maryland (AHC) that interrupted the opioid prescribing workflow with the aim of decreasing the health system's average co-prescribing rate for 1) multiple opioids or 2) opioid-benzodiazepine combinations within a range of 2% to 5% as measured from May 2, 2022, to July 31, 2022. To achieve this goal, AHC implemented the Opioid High Risk Alert and Naloxone Alert into the Oracle Cerner EHR system, which triggered when providers placed orders for opioids or benzodiazepines that would leave the patient with active prescriptions for multiple opioids or an opioid/benzodiazepine combination at discharge. The methodology, results, discussion, performance improvement limitations, and conclusions from the findings are to follow.

Section 2: Evidence-Based Practice Review

Literature Search

A literature search was conducted to assess the prevalence and impact of evidence-based EHR-based CDS interventions. The concepts utilized for the search related to the performance improvement goal for the project, which was to implement EHR-based clinical decision support at AHC that interrupted the opioid prescribing workflow. This interruption sought to decrease the health system's average co-prescribing rate for 1) multiple opioids and 2) opioid-benzodiazepine combinations to fall between 2% to 5%, as measured from May 2, 2022, to July 31, 2022. With the assistance of the Texas Medical Center librarians (Travis Holder and Emma Silva) and based upon feedback from the advising committee and faculty members at the University of Texas Houston Health Sciences Center, a PubMed search was conducted that focused on deconstructing the goal statement into key concepts. The search used both Mesh and key terms. The investigation focused on finding evidence-based articles related to opioid and benzodiazepine co-prescribing and EHR-based CDS. Those key concepts were

1) opioids,

2) benzodiazepine,

3) co-prescription,

4) electronic health records, and

5) clinical decision support.

Snowballing of discovered articles. as well as reviewing articles from previous literature searches, yielded additional articles for review and consideration. General internet searches sought to identify additional contextual information around opioid and

benzodiazepine co-prescribing. Personal communications were also held with experts on the related concepts.

Results

The evidence-based analysis and synthesis for this paper included 58 articles and resources determined by:

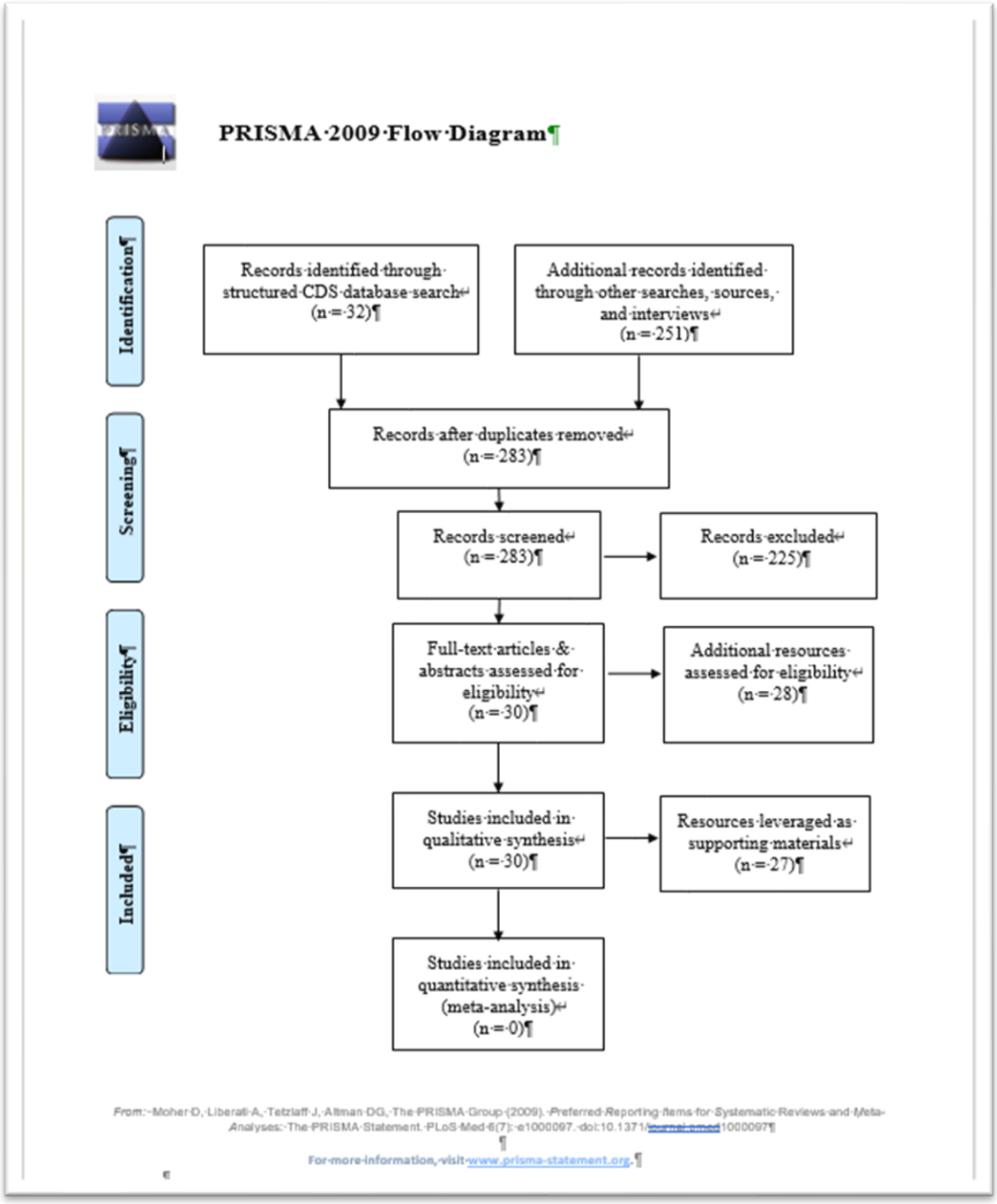
1) reviewing article titles and abstracts for relevance and appropriateness to the topic,
2) eliminating duplicate articles, and
3) conducting interviews with experts on related topics.

Articles were evaluated for their relevance to the performance improvement goal. The sub-topics of the evidence-based review, which is to follow, focused on:

1) clinical evidence related to CDS,
2) non-EHR-based prescribing CDS,
3) EHR-based prescribing CDS, and
4) EHR-based co-prescribing CDS.

Figure 1(below) diagrams the literature search and review process.

Figure 1: PRISMA Diagram for Opioid and Benzodiazepine Co-Prescribing CDS



Analysis and Synthesis of Clinical Evidence Related to Co-Prescribing

Before implementing EHR-based CDS, related to reducing the rate of co-prescribing for opioids and benzodiazepines, it is vital to understand the clinical evidence that supports that co-prescribing across certain medication groups is problematic. As aforementioned, co-prescribing "refers to having doctors prescribe one pharmaceutical with another to the same patient at the same time" (McDonald, 2020, para. 1). An abundance of literature supports this co-prescribing pattern as a challenge. A startling statistic shows that "rates of fatal overdose are ten times higher in patients who are co-dispensed opioid analgesics and benzodiazepines than opioids alone (Dasgupta et al., 2015)" (as cited in eCQI, n.d., para. 20). Table 1 provides an analysis of those studies demonstrating the co-prescribing challenge, with a synthesis to follow.

Table 1: Analysis and Synthesis of Clinical Evidence Related to Co-Prescribing

Author(s)	Year	Findings
Li et al.	2020	When comparing subjects with 1) risk of opioid overdose with concomitant use of opioids and skeletal muscle relaxers versus 2) opioid-only users, adjusted hazard ratios were higher for concomitant use of high-dose opioids (1.50) and benzodiazepines (1.39) in the former group (Li et al., 2020).
Richards et al.	2020	The co-prescription of benzodiazepines presented the top relative risk (3.27) of all factors associated with being prescribed high-dose opioids in a primary care setting (Richards et al., 2020).
Garrett et al.	2021	The most common predictor of opioid-induced respiratory depression (OIRD), with a c-statistic=0.755, was co-prescribing of another sedating medication, with benzodiazepines (29%) and antidepressants (22%) being the most common (Garrett et al., 2021).
Heo et al.	2022	When comparing subjects with chronic opioid use, as compared to those who were opioid-naïve, 1) continuous use of opioids (adjusted odds ratio of 8.58) and 2) concomitant use of benzodiazepines (adjusted odds ratio of 18.60) were strongly associated with chronic opioid use after surgery (Heo et al., 2022).

A synthesis of these findings demonstrates that co-prescribing of opioids and benzodiazepines

1) yields a higher hazard ratio than for patients without concomitant use,

2) are associated with higher adjusted odds ratios for continued use of opioids after surgery,

3) are the top predictor for opioid-induced respiratory depression (OIRD), and

4) are the top relative risk factor for prescribing high-dose opioids in primary care settings

(Li et al., 2020; Richards et al., 2020; Garrett et al., 2021; Heo et al., 2022).

Analysis and Synthesis of Evidence-Based CDS

Though understanding the clinical evidence is vital, it is also imperative to assess the impacts of evidence-based CDS on medication prescribing and its relationship to the co-prescribing of opioids and benzodiazepines. The medical literature suggests that CDS, in various forms, can be leveraged to influence medication prescribing decisions. Examples of these tools span many years, have evolved to include non-EHR-based and EHR-based solutions (e.g., triggering within the prescribing workflow), and yield differing results. The following is an analysis and synthesis of those tools.

Non-EHR-Based Prescribing CDS

Non-EHR-based prescribing solutions are not incorporated within the EHR nor automatically triggered within the EHR prescribing workflow. The following is an analysis and synthesis of some fundamental studies related to these CDS types. Furthermore, these studies (Table 2) overlap the opioid crisis associated with opioid use disorder (OUD) prescribing, as outlined by Coley (2020)

Table 2: Non-EHR-Based Prescribing CDS

Author(s)	Year	Purpose	Intended Purpose of CDS	Effectiveness
Zedler et al.	2015	"To develop, validate, and publish a risk index to predict the probability of overdose or serious opioid-induced respiratory depression (RIOSORD) based on VHA administrative data" from [an] "1) Inpatient & Outpatient Database" and a "2) VHA Decision Support Database" (Zedler et al., 2015)" (as cited in Coley, 2020, para. 4)	"Serve as 1) [a] screening tool for healthcare providers prior to prescribing opioids, 2) [an] ongoing opioid treatment to assess risk of OSORD, and 3) patient education for decision-making and avoidance of overdoses (Zedler et al., 2015)" (as cited in Coley, 2020, para. 4)	The risk index is predictive with C-Statistic = .88 (Zedler et al., 2015) (as cited in Coley, 2020, para. 4)
Oliva et al,	2017s	"To develop, validate, and deploy the VHA Stratification Tool for Opioid Risk Mitigation (STORM) to estimate the risk of an overdose or suicide-related event for prioritization and focusing of resources (Oliva et al., 2017a)" (as cited in Coley, 2020, para. 5)	"Provides dashboard view to providers that displays risk scores, clinically relevant information, risk factors, and proposed risk mitigation strategies for patients at risk for overdose or suicide-related events (Oliva et al., 2017a)" (as cited in Coley, 2020, para. 5)	Risk estimate is predictive with C-Statistic = .83 (Oliva et al., 2017a) (as cited in Coley, 2020, para. 5)
Holland et al.	2020	"To implement user-centered EHR clinical decision support in an urban, academic ED setting to increase the prescribing rates for buprenorphine/naloxone treatment (BUP) and secondary outcomes related to MAT/OAT for OUD patients (Holland et al., 2020)" (as cited in Coley, 2020, para. 6)	"EMBED button available to launch within the EHR to build clinical pathways for administering and [prescribing] treatment for identified OUD patients (Holland et al., 2020)" (as cited in Coley, 2020, para. 6)	"Increase in BUP initiation or discharge prescriptions to 6.6% during the implementation phase (p =.03; 95% CI) (Holland et al., 2020)" (as cited in Coley, 2020, para. 6) "Increase in naloxone discharge prescriptions at discharge 11.5% during the implementation phase (p =.009; 95% CI) (Holland et al., 2020)" (as cited in Coley, 2020, para. 6)

A synthesis of these findings demonstrates that CDS tools can be valuable for both 1) predicting morbidity and mortality risks and 2) guiding prescribing decisions (Zedler et al., 2015; Oliva et al., 2017a; Holland et al., 2020).

EHR-Based Prescribing CDS

EHR-based prescribing CDS relates to alerts that trigger within the provider's prescribing workflow. Table 3 provides an analysis of those studies, with a synthesis to follow.

Table 3: EHR-Based Prescribing CDS

Author(s)	Year	Pertinent CDS Findings
Smith et al.	2006	Computerized alerts within the EHR, which fired at the point of prescribing non-preferred agents for the elderly population, led to a 22% decrease in non-preferred agent prescriptions from the month before the implementation.
Terrell et al.	2009	A CDS alert that triggered when an inappropriate prescription was placed for ED patients aged 65 or older led to a 2% decrease in inappropriate medication prescriptions within the intervention group. The number of inappropriate prescriptions for the intervention group compared to the control group was 2.6% and 3.9%, respectively.
Losby et al.	2016	Multi-modal interventions focused on how chronic pain is viewed and treated, which included EHR-based CDS, led to a 1) 30% decrease in high-dose opioid prescriptions, 2) a 98% reduction in prescriptions with quantities greater than 200 pills, and 3) a 90% reduction in opioid co-prescriptions of benzodiazepines and carisoprodol. Other pertinent medication findings were noted.
Kreshak et al.	2018	Best practice alerts (BPA) triggering within the EHR for ED patients at high risk for an opioid overdose led to 3.7% of encounters resulting in a prescription for naloxone. Naloxone prescriptions were also written for 73 patients for which a BPA did not fire.
Zaman et al.	2018	A multi-modal intervention, including 1) a clinical dashboard identifying patients co-prescribing opioids and benzodiazepines and 2) embedded safety recommendations in electronic progress notes and email communications, yielded a 33% decrease in co-prescribing over a 6-month period. Decreased medication dosing and increased naloxone distribution were also outcomes from the study.
Funke et al.	2019	Best practice advisories (BPA) triggering within the EHR for ED patients at high risk for an opioid overdose led to a 1) 21% increase in the number of patients receiving naloxone prescriptions and 2) a 16% increase in the number of naloxone order sets that were placed.
Marino et al.	2019	An EHR prompt within the ED discharge process, triggering for patients discharged with an opioid overdose, led to a 2.8% increase in patients being prescribed take-home naloxone (THN). Disparities were also eliminated for THN prescriptions across population groups.
Smalley et al.	2019	Multi-modal EHR interventions in the ED, including CDS alerts at the point of prescribing, yielded a 1) 7% absolute reduction in opioid prescriptions, 2) 5.2% reduction in opioid prescriptions exceeding three days, 3) 4% reduction in prescriptions exceeding 30 MEDD, and 4) .2% reduction in non-formulary opioid prescriptions.
Calcaterra et al.	2022	Integration of the PDMP within the EHR as a clinical decision support tool led to a 20.7% decrease in high-dose MEDD prescribing for the intervention group. Groups not receiving the intervention also demonstrated reductions in high-dose MEDD prescribing. An approximate 1% change was realized for overlapping opioid prescriptions and overlapping opioid and benzodiazepine prescriptions.

A synthesis of these articles demonstrates that EHR-based CDS is effective in guiding provider prescribing choices (Smith et al., 2006; Terrell et al., 2009; Losby et al., 2016, Kreshak et al., 2018; Zaman et al., 2018; Funke et al., 2019; Marino et al., 2019; Smalley et al., 2019; Calcaterra et al., 2022). Additionally, these study results highlight that EHR-based CDS has effective benefits in curbing opioid-related medication prescribing as it relates to reducing

1) MEDD dosing,
2) co-prescribing of opioids and benzodiazepines,
3) inappropriate prescriptions of non-preferred agents, and
4) increasing prescribing rates of naloxone for patients at risk for or having experienced opioid overdoses

(Smith et al., 2006; Terrell et al., 2009; Losby et al., 2016, Kreshak et al., 2018; Zaman et al., 2018; Funke et al., 2019; Marino et al., 2019; Smalley et al., 2019; Calcaterra et al., 2022). Some multi-modal studies (Losby et al., 2016; Zaman et al., 2018) may yield more effective medication-related prescribing outcomes. Finally, approximately 55% of these studies were focused on the ED, which might present a slight challenge with generalizability to other patient populations and specialties (Terrell et al., 2009; Kreshak et al., 2018; Funke et al., 2019; Marino et al., 2019; Smalley et al., 2019; Calcaterra et al., 2022).

EHR-Based CDS for Co-Prescribing

EHR-based CDS for co-prescribing focuses on interruptive alerts within the provider's workflow that are aimed explicitly at reducing co-prescribing rates for opioids and benzodiazepines and high-dose prescribing (indirectly or directly related to co-

prescribing). A paucity of medical literature exists concerning these specific scenarios. Tables 4 through 7 provide an analysis and synthesis of those studies.

Table 4: Electronic Medical Record Alert Associated with Reduced Opioid and Benzodiazepine Coprescribing in High-risk Veteran Patients

Study	CDS Findings
Author(s): • Malte et al., 2018 **Purpose:** • To assess whether an EHR-based medication alert would decrease co-prescribing of opioids and benzodiazepines "among Veterans with known high-risk conditions (substance use, sleep apnea, suicide-risk, age 65 and above) at 1 Veterans Affairs (VA) health care system" (Malte et al., 2018, p. 171) **Design & Timeframe:** • Retrospective and Prospective Analysis; 12 months before and after medication alert implementation (specific dates/times not listed) (Malte et al., 2018) • Comparison between implementation versus non-implementation sites (Malte et al., 2018) **Eligibility:** • Patients being seen at VA Puget Sound Health Care System (VAPSHCS) that activated the alert due to high-risk conditions of substance use, sleep apnea, or $\geq$ 65 years of age (Malte et al., 2018) • Patients being seen at a comparable VA site (unnamed) (Malte et al., 2018) **Study Population:** • 1332 patients (Malte et al., 2018) **Methodology:** • Implemented an alert within the EHR that activates during the prescribing workflow when the "(1) prescriber ordered an outpatient benzodiazepine/opioid medication; (2) patient had an active VA or documented non-VA prescription for the other medication class, and (3) patient had a risk condition documented in the EMR in the past 12 months" (Malte et al., 2018, p. 172) • Targeted for primary care and mental health providers • Data analyzed from VISN 20 Data Warehouse, pharmacy data, and non-VA medication files (Malte et al., 2018)	**EHR Rules-Based CDS:** • Yes - CDS launched within the prescribing workflow (Malte et al., 2018) **Intended CDS Use:** • To alert providers of patients with high-risk conditions, with synthesized key patient information, to guide decision-making when considering prescribing opioids and benzodiazepines (Malte et al., 2018) **Opioid-Related Medication Prescribing Outcomes of Interest:** • (Primary) "The primary outcomes were change in the proportion of patients who were coprescribed opioids and benzodiazepines…at VAPSHCS in the 12 months before and after alert launch foreach of the 4 risk conditions." (Malte et al., 2018, p. 173) • (Secondary) "Secondary outcomes included: (1) change in proportion of patients with each risk condition prescribed opioids in the12 months before and after alert launch; (2) change in pro-portion of patients with each risk condition prescribed benzodiazepines in the 12 months before and after alert launch;(3) among patients activating the alert, changes in proportion prescribed benzodiazepines, opioids, and both medication classes in the 6 months after patients' initial alert activation" (Malte et al., 2018, p. 173) **Effectiveness:** • Co-prescribing rates for opioids and benzodiazepines decreased for patients with substance use (25%), sleep apnea (38.5%), and suicide risk (61.5%) at the implementation site (Malte et al., 2018) • Decreases in co-prescribing between implementation versus non-implementation sites were statistically significant "(AOR=0.92, 95% CI=0.86–0.97)" (Malte et al., 2018, p. 171) • Decrease in benzodiazepine prescriptions at the implementation site; Opioid prescription decreases at both sites

Table 5: The Association of EHR Drug Safety Alerts and Co-prescribing of Opioids and Benzodiazepines

Study	CDS Findings
Author(s): • Smith et al., 2019 **Purpose:** • To assess the impact of an EHR-based alert on co-prescribing rates for opioids and benzodiazepines for office and outpatient clinic visits at Fairview Health System (Smith et al., 2019) **Design & Timeframe:** • Retrospective Analysis; April 2017 to April 2018 (Smith et al., 2019) **Eligibility:** • Patients being seen at Fairview Health System during the study period that had an active opioid or benzodiazepine prescription at the time of the visit (Smith et al., 2019) **Study Population:** • 211,323 patients with a current opioid prescription at the time of visit; 85,817 with a current benzodiazepine prescription at the time of visit (Smith et al., 2019) **Methodology:** • Implemented an EHR-based alert that was triggered when an opioid or benzodiazepine order led to a co-prescription of the two (2) medication groups (Smith et al., 2019) • Provided warnings about the risk of co-prescribing and a recommendation to prescribe naloxone via the alert (Smith et al., 2019) • Data analyzed from EHR data (Smith et al., 2019)	**EHR Rules-Based CDS:** • Yes - CDS launched within the prescribing workflow (Smith et al., 2019) **Intended CDS Use:** • To notify providers of the risks of co-prescribing opioids and benzodiazepines and recommendation to prescribe naloxone when co-prescribing opioids and benzodiazepines (Smith et al., 2019) **Opioid-Related Medication Prescribing Outcomes of Interest:** • Change in the probability of co-prescribing both immediately at implementation and trending over the time of the intervention from pre-implementation of the alert (Smith et al., 2019) **Effectiveness:** • No statistically significant changes in opioid nor benzodiazepine co-prescribing immediately at implementation ($p=0.24$ and $p=0.56$, respectively) (Smith et al., 2019) • Decrease in benzodiazepine co-prescribing trending over the time of the intervention ($p=0.02$) (Smith et al., 2019) • No statistically significant change in opioid co-prescribing trending over the time of the intervention ($p=0.80$) (Smith et al., 2019)

Table 6: Clinical Effectiveness of Decision Support for Prescribing Opioids for Chronic Noncancer Pain: A Prospective Cohort Study

Study	CDS Findings
Author(s): • Price-Haywood et al., 2020 **Purpose:** • To assess the "clinical effectiveness of electronic medical record clinical decision support (EMR CDS) for opioid prescribing." (Price-Haywood et al., 2020, p.157) **Design & Timeframe:** • Prospective Cohort; January 2017 to October 2018 (Price-Haywood et al., 2018; Price-Haywood et al., 2020) **Eligibility:** • Patients ≥ 18 years of age at Ochsner Health System • 1) receiving chronic opioid therapy for the entire study timeframe • 2) seeing a primary care physician within the health system, • 3) having no cancer diagnosis on the problem list, • 4) not receiving hospice care, and • 5) not experiencing a terminal illness (Price-Haywood et al., 2020) **Study Population:** • 14,221 total patients meeting the eligibility criteria (Price-Haywood et al., 2020) • Targeted patients from internal medicine and family medicine visits **Methodology:** • Implemented EMR CDS within the Epic EHR to guide providers at the point of prescribing to 1) appropriately assess risks and 2) follow CDC guidelines when prescribing opioids (Price-Haywood et al., 2018; Price-Haywood et al., 2020) • Provided access to the Opioid Risk Toot (ORT) assessment, morphine equivalent daily dose (MEDD) calculator, pharmacy drug monitoring program, and health maintenance tool display for opioid-related risk mitigation at the point of prescribing (Price-Haywood et al., 2018; Price-Haywood et al., 2020) • Data analyzed from the enterprise data warehouse	**EHR Rules-Based CDS:** • Yes - CDS launched at the point of prescribing an opioid (Price-Haywood et al., 2018; Price-Haywood et al., 2020) **Intended CDS Use:** • To prompt documentation and calculation of ORT risk score to utilize during prescription writing decision-making (Price-Haywood et al., 2018; Price-Haywood et al., 2020) • To flag patients as high risk if ORT score ≥7 OR "(1) co-prescriptions for opioids and benzodiazepines, (2) a MEDD >90 mg, or (3) active diagnosis of substance abuse in the last 12 months" (Price-Haywood et al., 2018, p. 31) **Opioid-Related Medication Prescribing Outcomes of Interest:** • Change from baseline in 1) average MEDD prescribed and 2) naloxone prescribing rates from baseline (Price-Haywood et al., 2020) • Association of co-prescribed benzodiazepines with high-dose opioids (Price-Haywood et al., 2020) **Effectiveness:** • No statistically significant change in the average MEDD prescribed ($p=0.653$) (Price-Haywood et al., 2020) • A statistically significant increase (1.9%) in naloxone prescribing rates ($p<0.001$) (Price-Haywood et al., 2020) • Association of co-prescribed benzodiazepines and opioids (OR 1.06 and 1.02 for MEDD ≥50 mg and ≥90 mg, respectively, with 95% CI (not statistically significant at $p<0.001$) (Price-Haywood et al., 2020)

Table 7: Assessment of a Naloxone Coprescribing Alert for Patients at Risk of Opioid Overdose: A Quality Improvement Project

Study	CDS Findings
Author(s): • Nelson et al., 2022 **Purpose:** • To answer the question, "Does identifying patients at risk for opioid overdose using an alert in the electronic health record increase naloxone prescribing?" (Nelson et al., 2022, p. 26) **Design & Timeframe:** • Retrospective and Prospective Analysis; January 2019 to April 2021 (Nelson et al., 2022) **Eligibility:** • Patients being seen at Vanderbilt University Medical Center during the January 2019 to April 2021 timeframe who were at high risk for an opioid overdose (Nelson et al., 2022) **Study Population:** • Pre-Implementation of Alert – 22,334 patients at high risk for overdose • Post-Implementation of Alert – 22,772 patients at high risk for overdose (Nelson et al., 2022) **Methodology:** • Implemented an alert within the Epic EHR "when a patient has a high risk of opioid overdose based on a high morphine equivalent daily dose (MEDD) ≥90 mg, concomitant benzodiazepine prescription, or a history of opioid use disorder or opioid overdose" (Nelson et al., 2022, p. 26) • The EHR alerted providers to order naloxone when an opioid or benzodiazepine was prescribed until naloxone was prescribed or added to the home medication list (Nelson et al., 2022) • Data analyzed from enterprise clinical data warehouse (Nelson et al., 2022)	**EHR Rules-Based CDS:** • Yes - CDS launched within the prescribing workflow when providers sign an opioid or benzodiazepine prescription (Nelson et al., 2022) **Intended CDS Use:** • To prompt the provider to order naloxone for high-risk patients and notify them of "before" and "after" MEDD for incoming prescriptions (Nelson et al., 2022) **Opioid-Related Medication Prescribing Outcomes of Interest:** • (Primary) Change from baseline in the average institutional rate of naloxone prescribing (Nelson et al., 2022) • (Secondary) Changes in patients with "1) MEDD ≥90, 2) OUD, opioid or benzodiazepine ordered, 3) opioid and benzodiazepine ordered together, 4) active benzodiazepine and history of opioid overdose or opioid ordered, and 5) active opioid and benzodiazepine" that are associated with a naloxone prescription (Nelson et al., 2022, p. 29) **Effectiveness:** • The average institutional rate of naloxone prescribing increased from 0.28 to 4.51 per 100 prescriptions ($p<0.001$, CI 95) (OR 28 over that of pre-implementation) (Nelson et al., 2022) • Patients with high-dose MEDD were more associated with naloxone prescriptions ($p<0.006$), though the change in the average MEDD prescribing rate was not statistically significant ($p=0.372$) • Secondary outcomes results demonstrated statistically significant improvements associated with a naloxone prescription at $p<0.2$ (Nelson et al., 2022)

A synthesis of the evidence-based literature related to EHR-Based CDS demonstrates similarities and variances across study methodologies, outcomes of interests, and results. Similarities across the studies were that each 1) utilized an alert that was interruptive within the prescribing workflow and 2) did not prevent providers from prescribing/provided the ability to override the alert (Malte et al., 2018; Smith et al., 2019, Price-Haywood et al., 2020; Nelson et al., 2022). An opioid stewardship committee or opioid safety initiative was involved in most studies, which provided a natural coupling with quality improvement initiatives (Malte et al., 2018, Price-Haywood et al., 2020; Nelson et al., 2022). Using the Epic EHR in two (2) studies may result in generalizability and scalability of the alerts across the Epic customer base (Price-Haywood et al., 2020; Nelson et al., 2022).

Medication-related outcomes from the studies yielded both similarities and differences. Concerning MEDD, outcomes related to CDS were mixed (Price-Haywood et al., 2020; Nelson et al., 2022). Across studies, a statistically significant change in the average MEDD prescribing rate and high-dose MEDD prescriptions were not realized (Price-Haywood et al., 2020; Nelson et al., 2022), nor a reduction in high-dose MEDD prescriptions being co-prescribed with opioids and benzodiazepines (Price-Haywood et al., 2020). However, Nelson and colleagues (2022) did find that high-dose MEDD prescriptions were associated with naloxone prescriptions at a statistically significant level. Statistically significant increases in naloxone prescribing for high risk patients, including those co-prescribed opioids and benzodiazepines, were promising outcomes related to the CDS (Price-Haywood et al., 2020; Nelson et al., 2022), yet Smith and colleagues (2019) did not report naloxone prescribing results for their study.

Based on these findings, efforts to lower high-dose MEDD prescriptions should continue. CDS-based improvement in naloxone prescribing will be impactful and promising. Targeting high risk patient groups will continue to be valuable when developing and implementing CDS. Continuing quality improvement efforts should leverage these initiatives to improve outcomes and performance. Efforts to advance quality improvement initiatives should gleam lessons from other studies that leveraged differing methods of CDS alerting and multi-modal interventions in conjunction with their CDS initiatives to drive outcomes.

Critical to any study evaluation, it is essential to understand the characteristics of the

1) study population,
2) confounding factors, and
3) generalizability of the findings.

The following is an analysis of the EHR-based CDS studies evaluated (Table 8).

Table 8: EHR-Based CDS Study Characteristics

Author(s)	Population	Potential Confounding Factors	Generalizability
Price-Haywood et al., 2020	• Predominantly female, non-Hispanic Whites • Average age 56.5 (Price-Haywood et al., 2020)	• Louisiana state law regarding controlled substances was in place that required 1) querying the PDMP and 2) 3 hours of continued education required • ORT risk scores and MEDD calculations were reviewable outside of the alert in the patient's banner bar in the EHR • Focused interventions were underway in the ED related to opioid prescribing, lower dose prescribing, and alternative therapies (Price-Haywood et al., 2020)	• Included only one (1) health system; may not be generalizable • May not be generalizable outside of internal medicine and family medicine patients and providers • May not be generalizable to male and minority populations • May scale to other Epic EHR customers (Price et al., 2020)
Nelson et al., 2022	• Predominantly female, non-Hispanic whites, and uninsured • Average age range of 35-64 (Nelson et al., 2022)	• The implementation began at the height of COVID-19, which may have skewed the results • Younger adults are over-represented in the population due to participation in the addiction counseling service • Patients in the addiction counseling program are receiving buprenorphine-naloxone prescriptions for treatment • Unknown, but potential provider bias towards younger patients (e.g., hit by job loss, uninsured status, fare more poorly in recovery programs) (Nelson et al., 2022)	• May not be generalizable to populations younger than 35 and older than 65, males, the insured, and minorities • May scale to other Epic EHR customers (Nelson et al., 2022)

Author(s)	Population	Potential Confounding Factors	Generalizability
Malte et al., 2018	• Predominantly male; non-Hispanic Whites • Average age 48-71 (Malte et al., 2018)	• The study targeted primary care and mental health providers in the intervention, who were also a part of the CDS design • VA had a targeted initiative around safe opioid prescribing (Malte et al., 2018)	• Only 1 VA health system was included in the study; therefore, results may not be generalizability to other VA and non-VA facilities • The study may not be generalizable to providers outside of primary care and mental health • The study may not be generalizable to female and minority populations (Malte et al., 2018)
Smith et al., 2019	• Predominantly female; non-Hispanic Whites • Average age range 53-55 (Smith et al., 2019)	• Not enough information to assess (Smith et al., 2019)	• The study may not be generalizable outside of the outpatient clinic setting • The study may not be generalizable to female and minority populations (Smith et al., 2019)

A synthesis of the study characteristics provides valuable insights related to the

1) study population

2) confounding factors, and

3) generalizability of the co-prescribing CDS.

The most notable finding is that the populations studied were predominantly white, non-Hispanic females with varying average age ranges (Malte et al., 2018; Smith et al., 2019, Price-Haywood et al., 2020; Nelson et al., 2022). Even though implemented in a variety of specialty settings, the CDS was only employed in a limited number of facilities (Malte et al., 2018; Smith et al., 2019, Price-Haywood et al., 2020; Nelson et al., 2022). Except for Smith and colleagues (2019), each study also presented differing confounding factors that could have influenced the results of the CDS concerning the actual correlation between the CDS and the observed outcomes of interest (Malte et al., 2018; Price-Haywood et al., 2020; Nelson et al., 2022). Based on these findings, the studies may not be generalizable across varying birth sex/gender groups, minority populations, and across care settings. Furthermore, it is crucial to focus on outcomes for diverse populations, as

> "a meta-analysis of 14 studies published from 1990 to 2018 comparing racial and ethnic differences in the administration of analgesia for acute pain in EDs showed that black and Hispanic patients were less likely than white patients to receive analgesia for acute pain (OR=0.60, 95% CI 0.43–0.83 and OR=0.75, 95% CI 0.52–1.09, respectively) (Lee et al., 2019)" (as cited in NASEM, 2020, p. 32).

Summary

The opioid epidemic in this country requires continued focused and effective strategies. Though clinical evidence exists for appropriate prescribing and co-prescribing of opioids and benzodiazepines, opioid-related morbidity and mortality continue to be unacceptably prevalent within our society. CDS provides promise as an intervention strategy at the point of prescribing to curb both inappropriate and co-prescribing of opioids and unsafe prescribing combinations. However, the results within the medical literature are limited, results vary, and populations are not equally studied. Additional translational projects with real-world informatics interventions need to be conducted to develop sound CDS interventions. These interventions should scale across all populations within the same context, e.g., “training, clinician involvement in defining the intervention, workflow changes, incentives to follow the intervention, leadership support, etc.” (J. Glaser, personal communication, November 15, 2022).

Section 3: Methodology

Purpose and Model Framework

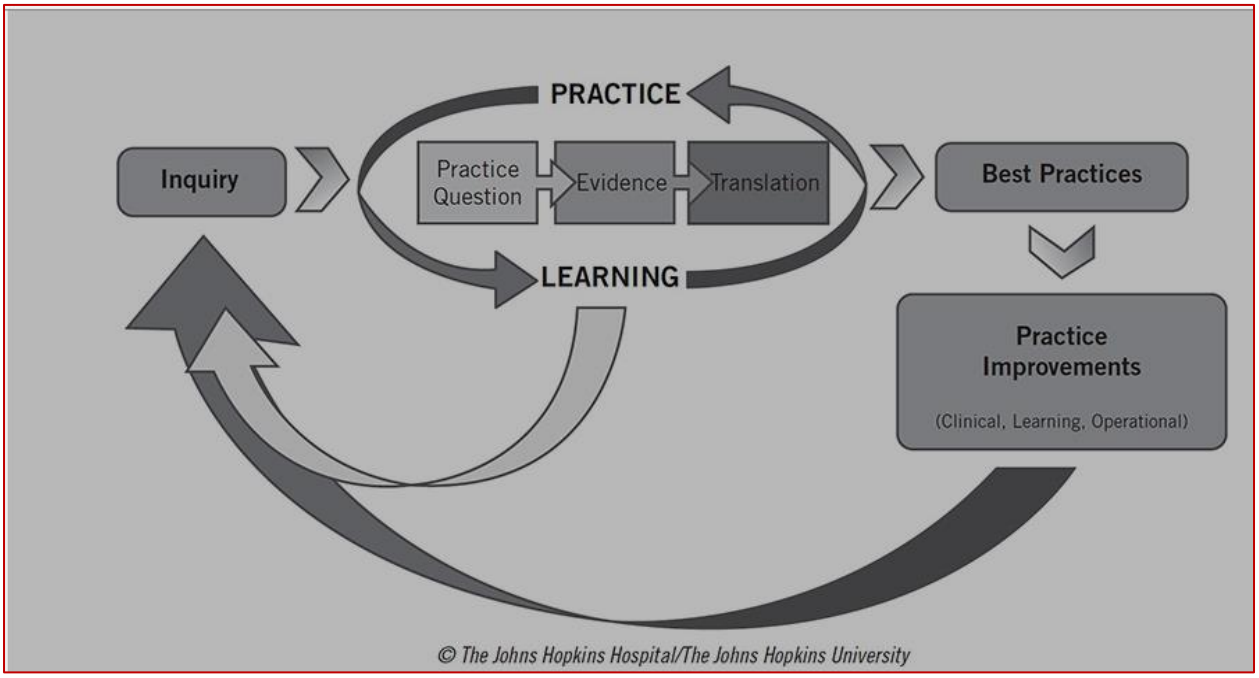
AHC launched a performance improvement project to decrease the co-prescribing rate for 1) multiple opioid and 2) opioid-benzodiazepine combinations. This initiative focused on 1) driving patient safety outcomes and 2) satisfying Maryland's Health Services Cost Review concurrent prescribing reporting requirement for the 2022 calendar year. To accomplish these goals, AHC implemented two (2) EHR-based CDS alerts that were interruptive within the clinician's prescribing workflow. Oracle Cerner provided the Opioid High Risk Alert and the Naloxone Alert in their original form as a component of their standard EHR content. To assess the impact of the alerting rules on co-prescribing outcomes, AHC utilized the CMS Safe Use of Opioids –Concurrent Prescribing electronic clinical quality measure (eCQM) reporting mechanism. eCQMs "are tools that help measure and track the quality of health care services that eligible hospitals and critical access hospitals (CAHs) provide, as generated by a provider's electronic health record (EHR)" (CMS, n.d., para. 1). With regard to the Safe Use of Opioids, the eCQM functionality provided reporting capabilities to collect, monitor, and report co-prescribing rates for the "proportion of inpatient hospitalizations for patients 18 years of age and older prescribed, or continued on, two or more opioids or an opioid and benzodiazepine concurrently at discharge" (eCQI, n.d., para. 8).

The performance improvement goal for the project was to implement EHR-based CDS at AHC. The CDS interrupted the prescribing workflow in an effort to decrease the health system's average co-prescribing rate for 1) multiple opioids or 2) opioid-benzodiazepine combinations to fall between 2% to 5% as measured from May 2, 2022,

to July 31, 2022. As the eCQM solely measured the inpatient population, only three (3) AHC facilities were in scope for the project. Those inpatient facilities were Fort Washington Medical Center, Shady Grove Medical Center, and White Oak Medical Center. The Johns Hopkins Nursing Evidence-Based Practice (JHNEBP) Model was utilized as the framework for this initiative. This model

1) begins with an inquiry that informs the development of an evidence-based practice question,
2) leads to the initiation of a translational project to explore the question,
3) leverages the outcomes and lessons learned to develop best practices, and
4) translates best practices into practice improvements (Dang and Dearholt, 2018).

Figure 2: Johns Hopkins Nursing Evidence-Based Practice Model



Taken from Dang, D. and Dearholt, S.L. (2018). Johns Hopkins Nursing EVIDENCE-BASED PRACTICE: MODEL AND GUIDELINES. Third Edition. Kindle Edition. – Figure 3.1 (2017)

Table 9 outlines the application of the model during the project

Table 9: Application of Johns Hopkins Nursing Evidence-Based Practice Model

Inquiry	Baseline data generated via Oracle Cerner's eCQM Safe Use of Opioids: Concurrent Prescribing report (highlighted in the data analysis section) demonstrated that the year-to-date (YTD) co-prescribing rates did not fall within the 2% to 5% range.
Practice Question	"Will the implementation of EHR-Based Clinical Decision Support (CDS) at AHC that interrupted the prescribing workflow decrease the average co-prescribing rate for 1) multiple opioids and 2) opioid-benzodiazepine combinations to fall within the range of 2% to 5% as measured from May 2, 2022, to July 31, 2022?
Evidence	Evidence suggests that EHR-based CDS reduces co-prescribing rates for opioids and opioid-benzodiazepine combinations (Malte et al., 2018; Smith et al., 2019, Price-Haywood et al., 2020; Nelson et al., 2022). EHR-based CDS also enhances prescribing outcomes overall (Smith et al., 2006; Terrell et al., 2009; Losby et al., 2016, Kreshak et al., 2018; Zaman et al., 2018; Funke et al., 2019; Marino et al., 2019; Smalley et al., 2019; Calcaterra et al., 2022).
Translation	Oracle Cerner's Patient Safety Council provided evidence-based clinical decision support rules to its EHR customers. AHC implemented two (2) of those rules, the Opioid High Risk Alert and the Naloxone Alert, for this initiative. AHC used the Six Sigma Define, Measure, Analyze, Design, and Verify (DMADV) methodology (outlined in the intervention section) to guide the project's design, implementation, and impact measurement. The alerts were integrated into the EHR prescribing workflow on May 2, 2022. Outcomes were evaluated monthly from May 2, 2022, through July 31, 2022, via the Quick Win Methodology. AHC implemented iterative design changes throughout this timeframe based on alerting data analysis, core project team evaluation, and stakeholder feedback.
Best Practices	At the close of the project, best practices were outlined for EHR-based co-prescribing CDS.
Practice Improvements	Recommendations were presented to the Opioid Stewardship Committee focused on improving the EHR-based CDS for future initiatives.

Intervention

As previously mentioned, AHC used the Six Sigma DMADV methodology to guide the iterative design, implementation, and impact measurement of Oracle Cerner's Opioid High Risk Alert and Naloxone Alert. According to Sunder M and colleagues (2020),

> *...DMADV methodology reveals its fundamental alignment with Design thinking (Brown 2008) that provides a more powerful approach to solve complex realtime problems project management. Design thinking is a non-linear, iterative process which seeks to understand customers, challenge assumptions, redefine problems and create innovative solutions to prototype and test (p. 516).*

The following summarizes how the AHC DMADV process was structured and followed during the project.

Project Method Phase – Define

The "Define" phase steps, focused on whether or not a problem existed (Sunder M et al., 2020), are noted below.

Table 10: Define Phase Steps

PROJECT METHOD PHASE	STEP	ACTIVITY
DEFINE (DMADV)	1	Assemble team
DEFINE (DMADV)	2	Develop consensus around the goal
DEFINE (DMADV)	3	Charter project
DEFINE (DMADV)	4	Create a project plan and timeline
DEFINE (DMADV)	5	Complete focused literature and evidence-based resource review - best practices
DEFINE (DMADV)	6	Listen to the voice of the customer (VOC)/collect VOC data
DEFINE (DMADV)	7	Understand and analyze customer requirements and translate them into measures (CTQs)

Taken from Adventist HealthCare Maryland's Performance Improvement Documentation

Assemble Team.

A team was assembled to provide the needed expertise in opioid use and management, prescribing, pharmacy, patient quality and safety, performance improvement, data analysis, EHR design, and CDS design during the project. A doctoral fellowship advising committee also guided the Doctoral Fellow and Project Manager from an academic rigor perspective. The Doctoral Fellow and Project Manager, CDS Rules Designer/Builder, and IT Pharmacist served as members of the Core Project Team that met weekly to discuss:

1) alerting design and issues,

2) data analysis, and

3) recommendations and follow-up items for committees and other relevant stakeholders.

Table 11: Opioid CDS Team

Team Member	Role
Monica Coley, MPH	Doctoral Fellow & Project Manager
Bonnie Arze, MD, PMP	Executive Sponsor & VP, Physician Quality & Performance Excellence Services
Debora Simmons, PhD	Chair, Advising Committee
Tiffany Champagne-Langabeer, PhD, MBA	Advising Committee
John Glaser, PhD	Advising Committee
Angela Ross, DNP, MPH, PMP, PHCNS-BC	Advising Committee
Mary Gillett	CDS Designer/Builder
Ryan Thelin	IT Pharmacist
Anne Tinker	Physician Survey Coordinator
Joy Gill, RN, MBA, CPHQ	Director, Quality Regulatory Programs and Analytics
Danielle Blair, MS	Quality Analyst
Sara Ehrlich	Quality Analyst
Emily Solomon, BS	Quality Analyst
Wayne Meyer, MD – Internal Medicine	Chair, Opioid Stewardship Committee
Barry Aron, MD – Urologist	Opioid Stewardship Committee
Mindi Cohen, MD – Family Medicine	Opioid Stewardship Committee
John Dunkle, MD – Palliative Care	Opioid Stewardship Committee
Norton Elson, MD – Pulmonology	Opioid Stewardship Committee
Kenneth Fisher, MD – Anesthesia/Chief Medical Officer	Opioid Stewardship Committee
Stuart Hough, MD – Anesthesia/Pain Medicine	Opioid Stewardship Committee

Team Member	Role
Mary Jacob, MD – Emergency Medicine	Opioid Stewardship Committee
Marissa Leslie, MD – Psychiatry	Opioid Stewardship Committee
Robert Linton, MD – Emergency Medicine/Chief Medical Officer	Opioid Stewardship Committee
Patsy McNeil, MD – Emergency Medicine/Chief Medical Officer	Opioid Stewardship Committee
James Rost, MD – Neonatology/Chief Medical Officer	Opioid Stewardship Committee
Terry Sheehan, MD – Physiatry/Chief Medical Officer	Opioid Stewardship Committee

Develop Consensus Around Goal.

The project team gained consensus to implement the CDS during the Opioid Stewardship Committee monthly meeting held on August 4, 2021. To support the approval-seeking effort, the team presented national opioid concurrent prescribing and fatal overdose death statistics that implicated the presence of opioid and benzodiazepine medication groups. The committee also discussed the requirement to report co-prescribing data related to opioids and benzodiazepines to Maryland's Health Services Cost Review for the entire 2022 calendar year. The project team proceeded to present the EHR-based alerting qualifications for Oracle Cerner's Opioid High Risk Alert, highlighting the interruptive nature within the clinician's prescribing workflow when:

1. an active opioid or benzodiazepine prescription existed on the patient's chart, and
2. the incoming opioid or benzodiazepine prescription would result in an unsafe medication combination.

With these details firmly presented to the committee, the project team moved forward with recommending the implementation of the Opioid High Risk Alert as an attempt to decrease the co-prescribing rates for the health system. The committee approved the implementation of the alert during this meeting.

The Core Project Team discovered that the Opioid High Risk Alert did not account for scenarios in which

1) two (2) or more new prescriptions for opioids and benzodiazepines were coming into the system simultaneously, and
2) an existing prescription for an opioid or benzodiazepine did not exist on the chart to trigger an alert for this unsafe prescribing scenario.

The team discussed the concurrent opioid prescription issue with Oracle Cerner's solution design team, which recommended the implementation of the Naloxone Alert to trigger in response to this unsafe scenario upon signing the order. The project team sought consensus for implementing this secondary, precautionary alert during the Opioid Stewardship Committee meeting held on April 6, 2022. The need for the Naloxone Alert, due to the gaps with the Opioid High Risk Alert, was discussed with the committee to gain buy-in for this additional implementation. The committee approved the implementation of this secondary alert on May 2, 2022.

The following table clarifies the triggering scenarios for each alert.

Table 12: Alerting Rules Triggering Scenarios

Rule	Triggering Action	Triggering Criteria
Opioid High Risk Alert	**Triggering Action:** Add to Scratchpad **Meaning:** The prescription orders were being added to the electronic prescription pad in the EHR before being signed	The incoming prescription order for an opioid or benzodiazepine AND either an opioid or benzodiazepine already existed on the patient's chart.
Naloxone Alert	**Triggering Action:** Sign Order **Meaning:** The prescription orders had been electronically written and were now being processed for electronic signature within the EHR.	The incoming prescription order for an opioid or benzodiazepine was being evaluated at the point of electronic signature processing.

Charter Project.

The detailed project charter can be found in Appendix A. The project team submitted the required project charter data elements via the AHC performance improvement system per the standard process.

Create Project Plan and Timeline.

Components of the project management plan are embedded within DMADV project steps of the methodology section. The project timeline can be found in Appendix C.

Complete Focused Literature and Evidence-Based Resource Review - Best Practices.

The evidence-based literature review comprises section 2 of this paper.

Listen to the Voice of the Customer (VOC)/Collect VOC Data.

The Voice of the Customer (VOC) is a process that identifies customer needs and what the customer is seeking as a solution to their problem (Daly et al., 2021). During the AHC project, the team engaged various stakeholder groups to:

- make and approve design decisions,
- provide iterative CDS feedback via a 1) series of Microsoft Forms surveys and 2) monthly Opioid Stewardship Committee, Physician Advisory Board, and Clinical Informaticist forums, and
- gain insights into current prescribing practices, environment, and perspectives related to alerting, and recommended paths for effective opioid stewardship

The following tables outline how the VOC was integrated into the project, as well as the planned feedback cycles.

Table 13: Pre-Launch Engagement

Stakeholder Group	Meeting	Focus/Outcomes
Opioid Stewardship Committee	August 2021 Monthly Meeting	• Discussed national co-prescribing statistics and associated mortality rates • Discussed the requirement to report co-prescribing data to Maryland's Health Services Cost Review for the calendar year 2022 • Reviewed the Opioid High Risk Alert triggering actions for co-prescribing • Approve the implementation of the Opioid High Risk Alert
Opioid Stewardship Committee	October 2021 Monthly Meeting	• Reviewed AHC co-prescribing statistics for 2021 year-to-date (YTD)
Opioid Stewardship Committee	January 2022 Monthly Meeting	• Presented a visual example of the standard (out-of-the-box) Opioid High Risk Alert • Presented design decisions for AHC customization • Finalized and gained approval for design decisions and AHC customization
Physician Advisory Board	January 2002 Monthly Meeting	• Presented on the co-prescribing initiative • Discussed 2021 YTD statistics • Reviewed approved design decisions
Opioid Stewardship Committee	February 2022 Monthly Meeting	• Provided responses to follow-up questions • Proposed additional design decisions • Finalized and gained approval for additional design decisions and AHC customization

Stakeholder Group	Meeting	Focus/Outcomes
Opioid Stewardship Committee	March 2022 Monthly Meeting	• Discussed alerting issues with simultaneous prescriptions on "add to scratchpad." • Introduced the Opioid Naloxone Alert rule as a precautionary measure to capture simultaneous prescriptions on "sign order." • Introduced the concept of a pilot test with hospitalists and surgeons
Opioid Stewardship Committee	April 2022 Monthly Meeting	• Approved the implementation of the Naloxone Alert • Finalized the decision to launch house-wide without leveraging a pilot • Approved open-ended stakeholder survey feedback questions • Approved schedule for iterative design feedback, change control approvals and deployments • Confirmed authority for changes • Approved measurements and analysis • Deferred target goal decision for further research • Approved the Quick Wins methodology for measurement review and feedback cycles • Approved training approach • Approved IRB Submission

Table 14: Iterative Microsoft Forms Survey Feedback

Stakeholder Group	Focus/Outcomes	Survey Windows
Prescribing Clinician E-Mail Distribution	• Gathered open-ended feedback related to the CDS alerts to inform necessary design changes	• May 13, 2022 – May 27, 2022 • June 20, 2022 – July 1, 2022 • July 18, 2022 – July 29, 2022

Table 15: Clinical Informaticist Feedback

Stakeholder Group	Focus/Outcomes	Feedback Forum
Clinical Informaticists	• Gathered open-ended feedback related to the CDS alerts to inform necessary design changes	• May 2022 Targeted Meeting • June 2022 Targeted Meeting • July 2022 Targeted Meeting

Table 16: Physician Advisory Board Feedback

Stakeholder Group	Focus/Outcomes	Feedback Forum
Physician Advisory Board Feedback	• Gathered open-ended feedback related to the CDS alerts to inform necessary design changes	• May 2022 Monthly Meeting • June 2022 Monthly Meeting • July 2022 Monthly Meeting

Table 17: Opioid Stewardship Committee Feedback

Stakeholder Group	Focus/Outcomes	Feedback Forum
Opioid Stewardship Committee	• Gathered open-ended feedback related to the CDS alerts to inform necessary design changes	• May 2, 2022, Monthly Meeting • June 2022 Monthly Meeting • July 2022 Monthly Meeting

Understand and Analyze Customer Requirements and Translate them Into Measures (CTQs).

The agreed upon design and implementation requirements to satisfy the critical to quality (CTQs) performance improvement goals are outlined under "Design" for the DMADV to follow. The "Performance Initiative Criteria" section reflects the eCQM population requirements. The agreed upon measurements and targets to meet the CTQs for performance improvement are outlined under the "Data Analysis" section of the methodology to follow.

Project Method Phase – Measure

The "Measure" phase steps for the project focused on how the process was measured and performed (Sunder M et al., 2020). During this phase, it was imperative to identify the factors critical to quality (CTQ), which translated the VOC into quantifiable metrics that were key to assessing the initiative's outcomes (Daly et al., 2021).

Table 18: Measure Phase Steps

PROJECT METHOD PHASE	STEP	ACTIVITY
MEASURE (DMADV)	8	Prioritize CTQs
MEASURE (DMADV)	9	Measure baseline performance on CTQs
MEASURE (DMADV)	10	Set performance targets for CTQs

Taken from Adventist HealthCare Maryland's Performance Improvement Documentation

Though noted below, the prioritized CTQs, baseline measurement performance, and performance targets are detailed in the data analysis section.

Prioritize CTQs.

The prioritized CTQ for measurement was the health system average eCQM co-prescribing from May 2, 2022, through July 31, 2022.

Measure Baseline Performance on CTQs.

The April 2022 baseline co-prescribing rates for the facilities and overall health system were the following:

Table 19: April Baseline Co-Prescribing Rates

Facility	Baseline Co-Prescribing Rate
Fort Washington	3.8%
Shady Grove	12.4%
White Oak	13.40%
Aggregate Health System Average	**12.2%**

Set Performance Targets for the CTQs.

AHC established the World Class and Quality and Patient Safety Council targets as 2% and 5%, respectively.

Project Method Phase – Analyze

The "Analyze" phase steps used by the project team, shown below, focused on addressing customer problems (Sunder M et al., 2020) via a macro design process.

Table 20: Analyze Phase Steps

PROJECT METHOD PHASE	STEP	ACTIVITY
ANALYZE (DMADV)	11	Link CTQs to design features, informed by literature search
ANALYZE (DMADV)	12	Create the macro design
ANALYZE (DMADV)	13	Review and optimize the macro design

Taken from Adventist HealthCare Maryland's Performance Improvement Documentation

Link CTQs to Design Features, Informed by Literature Search.

Oracle Cerner's standard (out-of-the-box) co-prescribing alerts were designed to notify clinicians of unsafe opioid and benzodiazepine combinations at the point of the "add to scratchpad" and "sign order" actions. These alerts aligned with the evidence-

based literature review and findings outlined in section 2. The eCQM Safe Use of Opioids: Concurrent Prescribing (out-of-the-box) reports were coded and certified according to CMS standards (eCQI, n.d.).

Create Macro Design.

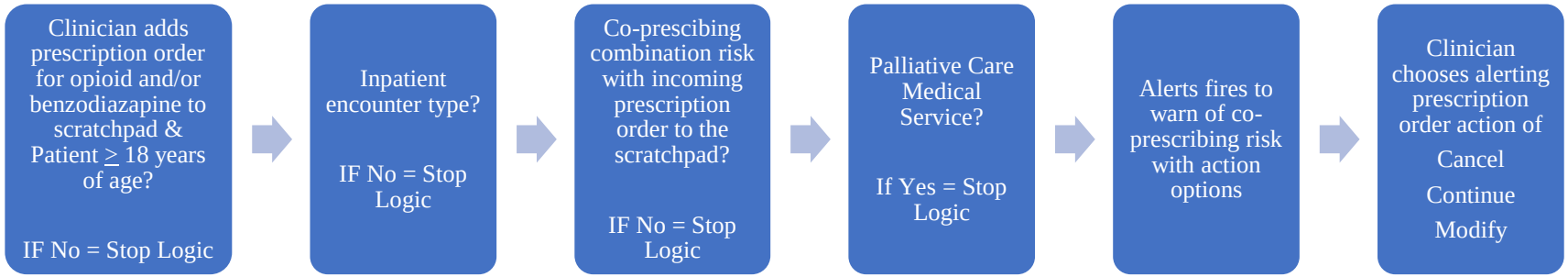
The macro design for the alerts was the standard (out-of-the-box) content provided by Oracle Cerner. AHC did not participate in the macro design with Oracle Cerner.

Review and Optimize Macro Design.

Opioid High Risk Alert.

The overarching logic concerning the Opioid High Risk Alert was the following:

Figure 3: Standard Opioid High Risk Alert Macro Design Logic



Modeled after the Oracle Cerner Opioid High Risk Alerting Logic

The standard order actions behaved in the following manner:

1) **Cancel Prescription** – The prescription was not completed nor written to the record, and the provider was returned to the ordering screen.
2) **Continue Prescription** – The alert was overridden and required an override reason to be provided. The default override reason provided by the EHR was "treatment plan requirement," with the option to add additional free text reasons if desired. Once the provider placed the prescription in the EHR, they were returned to the ordering screen.
3) **Modify Prescription** – The provider was returned to the ordering screen allowing modifications to the incoming prescription before processing.

The Core Project Team reviewed the standard macro design to determine which customizations the team could make without Opioid Stewardship Committee feedback. The changes eligible for modification by the Core Project Team without committee approval were related to AHC-specific EHR configurations (e.g., facility location codes, patient types, orderable items, etc.). Based on the review, the CDS Rules Designer/Builder customized the following items to match the appropriate mappings for AHC's version of the Oracle Cerner EHR.

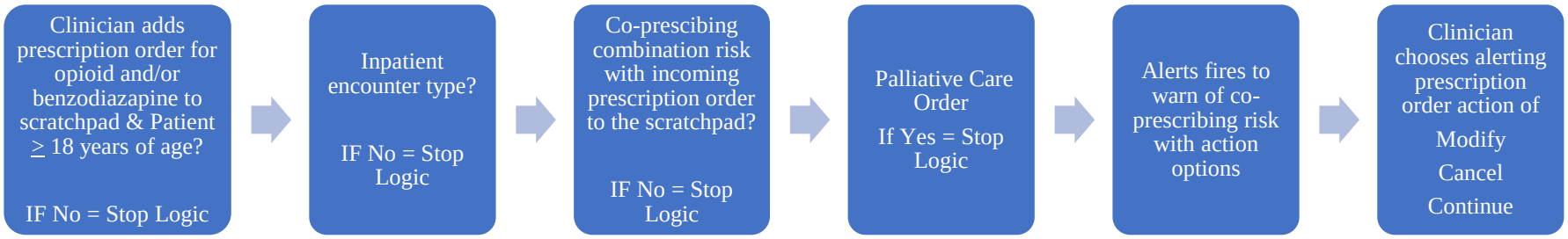
Table 21: Core Project Team Modifications

Design Change Modification
Triggering Actions
Design Change: Removed PharmNet Medication Manager Retail as an application. **Reason:** AHC does not use the retail pharmacy application.
Design Change: Added Naltrexone as a medication that should not trigger further evaluation. **Reason:** Naltrexone is an Opioid Use Disorder treatment drug.
Evaluation Criteria
Design Change: Replaced the Palliative Care medical service with the Palliative Care order. **Reason:** AHC utilizes Palliative Care instead of a medical service to identify these patients.
Prescription Order Actions
Design Change: Added override reason of "Treatment plan required." **Reason:** Certain clinical scenarios may call for co-prescribing. The default reason offered by the EHR to the provider when justifying the override of an alert was "Treatment plan required," an AHC standard response.

The intended design was to mirror the eCQM population qualifications and exclusions (i.e., excluding patients with a cancer diagnosis, receiving palliative or hospice care).

However, the localized design that was implemented was the following:

Figure 4: Localized and Implemented Opioid High Risk Alert Design Logic



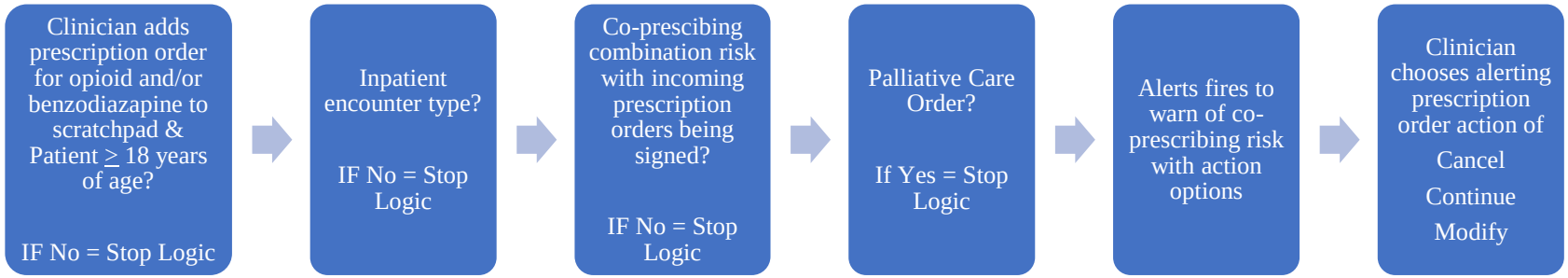
Modeled after the Oracle Cerner Opioid High Risk Alerting Logic

Naloxone Alert.

The team understood the Naloxone Alert's out-of-the-box design was to trigger on the "sign order" action. Furthermore, if the "sign order" action would lead to 1) multiple opioids or 2) an opioid-benzodiazepine combination, the EHR triggered the alert. The alert recommended that Naloxone be prescribed to the patient if the co-prescription was still going to be written, as Naloxone helps to prevent harm in these scenarios. The alert only provided a notification with no available order actions to select.

With the exception of triggering on the "sign order" action, the intended design for the Naloxone Alert was to mirror the Opioid High Risk Alert, subsequently utilizing the eCQM population qualifications and exclusions. The localized and implemented design solely offered the alert message with no action at the outset. Those options were later changed to mirror the order actions for the Opioid High Risk Alert. The localized and inferred implemented design is noted in the figure below.

Figure 5: Localized and Implemented Naloxone Alert Design Logic



Modeled after the Oracle Cerner Naloxone Alerting Logic

Project Method Phase – Design

The "Design" phase steps taken by the team are outlined below. This phase focused on "how to align customer's requirements with design specifications," as well as developing the prototype design (Sunder M et al., 2020, p. 516).

Table 22: Design Phase Steps

PROJECT METHOD PHASE	STEP	ACTIVITY
DESIGN	14	Develop detailed design
DESIGN	15	Review and optimize the detailed design

Taken from Adventist HealthCare Maryland's Performance Improvement Documentation

Develop Detailed Design & Review and Optimize Detailed Design.

The Opioid Stewardship Committee was not presented with the additional design decisions, as CMS measurement guidelines designate the patient population for inclusion. However, design decisions were presented to the committee as they related to maximizing clinical benefit for the AHC general patient population, which extended beyond the eCQM patient population. The following table outlines those design decisions and complexities that were out-of-scope for this project's evaluation.

Table 23: Opioid Stewardship Committee Design Decisions and Approval

Design Decisions & Modifications
Design Decision: Should the alert fire for ages other than those 18 years of age or older? **Design Change:** Age qualification changed to 12 years of age or older **Reason:** Problematic opioid use has been demonstrated in patients younger than 18 years of age, and the alert could enhance patient safety initiatives for this population group. **Measurement Complexity:** Evaluating the number of alerts firing and override reasons explicitly captured for the eCQM population versus the general population. **Measurement Mitigation:** A facility code for each location was included in the alerting data output, so that the data for the eCQM qualifying locations could be analyzed separately.
Evaluation Criteria
Design Decision: Should the alert fire for all facilities? **Design Change:** The team included all AHC facilities in the evaluation criteria. **Reason:** Including additional facilities alongside the qualifying eCQM facilities of Fort Washington, Shady Grove, and White Oak provided the potential for enhanced patient safety initiatives for all facilities. **Measurement Complexity:** Evaluating the number of alerts firing and override reasons explicitly captured for the eCQM qualifying facilities versus the expanded population. **Measurement Mitigation:** A facility code for each location was included in the alerting data output, so that the data for the eCQM qualifying locations could be analyzed separately.
Design Decision: Should the alert fire for all patient types? **Design Change:** All patient types were included in the evaluation criteria. **Reason:** Including additional patient types alongside the qualifying eCQM patient type of "inpatient" provided the potential for enhanced patient safety initiatives for all patient classifications. **Measurement Complexity:** Evaluating the number of alerts firing and override reasons explicitly captured for the eCQM qualifying patient type of "inpatient" versus the expanded population. **Measurement Mitigation:** The eCQM logic only qualifies "inpatients" in its population, which served as its own control for this risk. The team ran comparisons to determine if patients qualifying to be in the eCQM numerator also triggered an Opioid High Risk Alert or Naloxone Alert.
Prescription Order Actions
Design Change: No changes.

Project Method Phase – Verify

The "Verify" phase of the DMADV focused on answering the following questions: "Is the design meeting customer needs? Does the design solve the problem in hand?" (Sunder M et al., 2020, p. 516). AHC modified this phase by using the Quick Win methodology. The following were the Quick Win steps used to 1) gather feedback for analysis and 2) inform iterative design changes to improve the EHR-based CDS. The details of how the team incorporated the Quick Win methodology into the project, from May 2, 2022, through July 31, 2022, is outlined in the following "Data Analysis" methodology section.

Table 24: Quick Wins Phase Steps

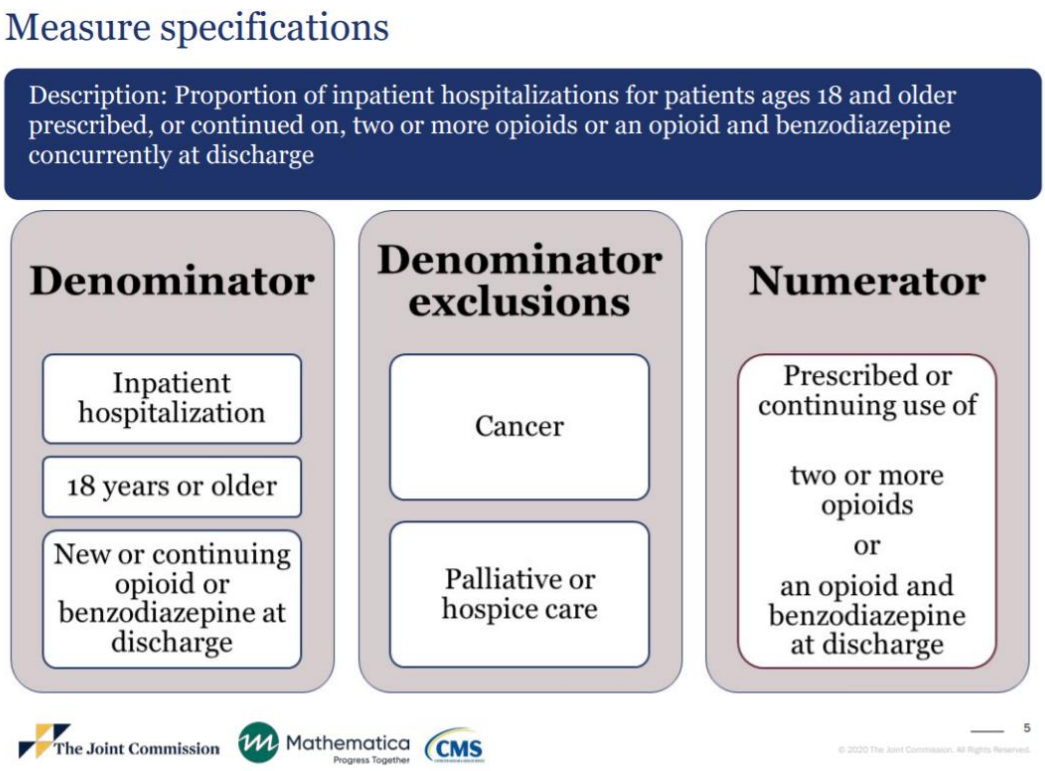
PROJECT METHOD PHASE	STEP	ACTIVITY
QUICK WIN	6	Determine a good next step to move you in the right direction and set a measurable goal and timeline (Improvement Initiative and Target)
QUICK WIN	7	Take the next step
QUICK WIN	8	Measure, assess, and document your progress (Current Improvement)
QUICK WIN	9	Reflect on and document what you learned with your last step (Lessons Learned)
QUICK WIN	10+	Until you reach your goal, ***repeat steps 6-9***: ensure you still understand the direction you need to head with the change and that the effort required to make the change is still easy and/or low effort (if not, need to change methodology)

Taken from Adventist HealthCare Maryland's Performance Improvement Documentation

Performance Initiative Criteria

The performance improvement initiative was conducted at AHC from May 2, 2022, through July 31, 2022. Patients seen during this timeframe that met the eCQM measure qualifications for the patient population, denominator, denominator exclusions, and numerator in the figure below served as the eligible patient population for evaluation.

Figure 6: eCQM Safe Use of Opioids Measure Specifications



Taken from the Joint Commission webinar co-sponsored by The Joint Commission, Mathematica, and the Center for Medicare and Medicaid Services.

Data Analysis

This performance improvement initiative was a mixed methods design that incorporated both quantitative and qualitative analyses. From a quantitative perspective, the primary outcome comparison of pre-CDS and post-CDS co-prescribing monthly data were analyzed utilizing Oracle Cerner's electronic clinical quality (eCQM) Safe Use of Opioids Current Prescribing report. The goal was to assess the impact of the CDS implementation on co-prescribing rates for 1) multiple opioids and 2) opioid-benzodiazepine combinations. The data presented in the report were extracted from the

EHR via load jobs and transferred to a business object reporting database. The file output included identifiers that were utilized for data comparisons for secondary data outcomes analyses. The data was de-identified when presented for data analysis review, committee meetings, and presentation of the results. The aggregate health system average was calculated across facilities, using eCQM reports, to assess AHC's percentage change during the project period.

Secondary data analysis focused on metrics aimed at providing insights regarding the alerting design, configuration, and adoption. Those metrics and their definitions are the following:

- **Alerting Gap:** percentage of patients in the eCQM numerator who did not trigger an Opioid High Risk Alert nor Naloxone Alert as expected.
- **Appropriateness of Alerts**: percentage of Opioid High Risk Alerts and Naloxone Alerts that fired as expected
- **Provider Interactions:** percentage of alerts that providers chose to
    1) cancel,
    2) continue,
    3) modify, or
    4) return to chart.

Patients with a cancer diagnosis, receiving palliative or hospice care, or not otherwise qualifying for the eCQM population were excluded from these calculations.

These insights aligned with the 1) people, 2) clinical content, and 3) system measurement and monitoring dimensions of the Socio-Technical Model, which is a

model comprised of eight (8) dimensions "specifically designed to address the sociotechnical challenges involved in design, development, implementation, use and evaluation of HIT within complex adaptive healthcare systems" (Sittig & Singh, 2010, p. 68). The people, clinical content, and system measurement and monitoring dimensions, more specifically, related to the following:

- **People Dimension:** effectiveness of the individuals designing, building, implementing, and interacting with the alerts
- **Clinical Content Dimension:** logic generating the alerting triggers is working appropriately
- **System Measurement and Monitoring Dimension:** actions taken when interacting with the alerts (e.g., overriding alerts, etc).

(Sittig & Singh, 2010, p. 68).

The 1) eCQM output files and 2) alerting data queried from the Oracle Cerner EHR database were analyzed. Microsoft Access and Microsoft Excel were leveraged to run relational database queries and calculate statistics, respectively.

Baseline Data

The following was an example of the report with 2022 YTD baseline reporting data for the eCQM qualifying populations at Fort Washington Medical Center, Shady Grove Medical Center, and White Oak Medical Center, respectively.

Figure 7: AHC April 2022 Baseline Co-Prescribing Rates

Report:	**Opioids 2022 Performance Summary**
Prompt CCN(s):	Fort Washington Medical Center (210060) Shady Grove Adventist Hospital (210057) White Oak Medical Center (210016)
Filters Applied During Drill:	None
Report Date Range:	04/01/2022 00:00:00 - 04/30/2022 23:59:59
Last Refresh Date:	05/10/2022 07:00:22
Page Number / Total Pages:	1 / 1

	Safe Use of Opioids				
	Performance Score	Initial Patient / Denominator Population	Denominator Exclusions	Numerator Population	Performance Denominator
Health System Average	12.2%	537	103	53	434
Fort Washington Medical Center (210060)	3.8%	30	4	1	26
Shady Grove Adventist Hospital (210057)	12.4%	315	56	32	259
White Oak Medical Center (210016)	13.4%	192	43	20	149

The Oracle Cerner Business Objects reporting system implemented at Adventist HealthCare Maryland generated the report shown in Figure 7.

From these baseline data, the YTD co-prescribing rates for qualified reporting locations were as follows:

- Fort Washington Medical Center – 3.8%
- Shady Grove Medical Center – 12.4%
- White Oak Medical Center – 13.4%
- Aggregate Health System Average – 12.2%

These rates were currently within the national averages associated with high fatal opioid overdose rates (i.e., 5%-20%).

As no national benchmark existed for co-prescribing rates, AHC's Quality and Patient Safety Council (QPSC) established a target goal of 14.9% for calendar 2022 (D. Blair, personal communication, April 6, 2022). This goal was based on their best-performing percentage for 2021 (D. Blair, personal communication, April 6, 2022). The World-Class goal for 2022 was 14.2% (D. Blair, personal communication, April 6, 2022). This goal did not account for a CDS implementation.

Post-Baseline Analyses – Open-Ended Feedback

As previously mentioned, the Opioid Stewardship Committee approved the collection of open-ended Quick Win feedback cycles. Three (3) feedback cycles were conducted. The plan for these monthly cycles was to focus on

1) measuring the health system's monthly co-prescribing average to determine if the performance target was met,
2) gaining insights from key stakeholder groups to determine necessary CDS changes, and
3) implementing those CDS changes, where applicable and appropriate, into the EHR system.

The stakeholder groups engaged in the feedback cycles were the

1) Opioid Stewardship Committee,
2) Physician Advisory Board, and
3) Clinical Informaticists.

Additional open-ended feedback was collected from

1) prescribing providers via Microsoft Forms surveys,

2) a prescribing provider interview, and

3) interviews with various team members

to gain insights into current prescribing practices, the environment, perspectives related to alerting, and recommended paths for effective opioid stewardship.

The feedback was evaluated monthly by the project team, utilizing the Quick Win methodology. The following figure demonstrates the Quick Win tool to guide the process.

Figure 8: Quick Win Tool

Taken from Adventist HealthCare Maryland's Performance Improvement Documentation

Based on the feedback, recommended CDS changes were reviewed by and submitted to the Opioid Stewardship Committee for a final decision. The approval schedule and implementation change dates are noted below.

Table 25: CDS Approval & EHR Change Implementation Schedule

Opioid Stewardship Approval Date	EHR Change Implementation Date
June 1, 2022	June 5, 2022
July 6, 2022	July 10, 2022
August 3, 2022	August 7, 2022

The Chief Medical Information Officer (CMIO) also approved moving forward with interviewing four (4) physicians to assess factors behind why providers did or did not co-prescribe. The feedback from the interview process was collected by the team and de-identified in terms of patients and providers. The planned focus of the interviews was to:

- summarize the CDS co-prescribing initiative,
- ask providers about what led to their decision to co-prescribe for two (2) patients that qualified to be in the eCQM numerator,
- ask providers about what led to their decision not to co-prescribe for two (2) that qualified to be in the eCQM denominator, but not the numerator, and
- gather data regarding the CDS to provide insight into the providers' prescribing practices and lessons learned.

Performance Target

As aforementioned, no national benchmark existed for acceptable co-prescribing rates. AHC established World-Class and QPSC targets for the CDS implementation as follow:

- World Class Target – Decrease the health system's co-prescribing rate to 2% or less for the eCQM population by July 31, 2022
- QPSC – Decrease the health system's co-prescribing rate to 5% or less for the eCQM population by July 31, 2022

AHC selected the 5% target because fatal overdoses are significant with co-prescribing rates ranging from 5%-20% (Dasgupta et al., 2015; Dowell, Haegerich, & Chou, 2016; Jones & McAninch, 2015; Lui et al., 2013; Mack et al., 2015; Park et al., 2015) (as cited in eCQI, n.d.), so the goal was to target falling below the 5% mark. A target of 0% co-prescribing was considered unachievable, due to long-acting and short-acting opioid and benzodiazepine drug interactions that providers must account for during prescribing (B. Arze, personal communication, 2022).

Project Team

The project team is listed in the DMADV Define Phase above.

Stakeholder Analysis

The stakeholders for this project were wide-ranging. Patients seen during the performance period were the primary stakeholders. The goal was to ensure that patients were not co-prescribed 1) multiple opioids or 2) an opioid-benzodiazepine combination at discharge, which could lead to harmful morbidity and mortality outcomes. AHC physicians utilizing the CDS were also key stakeholders, as the alerts could potentially

impact their prescribing workflows and practice of medicine. The national medical community, policymakers, and organizations (e.g., CMS and The Joint Commission) could also benefit from the lessons learned from this project and apply those learnings to industry practices and policy. Finally, society at large was considered an interested party, due to opportunities to influence harm reduction.

Project Management (Project Plan & Project Schedule)

The project management documentation can be found in appendices A through C.

Return on Investment (ROI)

A cost-benefit analysis was not utilized as a means of calculating an ROI. As aforementioned, AHC sought a reduction in health system's average co-prescribing rate to fall between 2% to 5% as its quantitative ROI. The qualitative ROI focused on the summary of lessons learned regarding co-prescribing CDS. Those questions were the following:

1) Tell me about your overall experiences with using the alerts? What are your thoughts and feedback?
2) Tell me about your experiences with the alerts you receive during prescribing of opioids and/or benzodiazepines?
3) What are some benefits you have found from the use of the prescribing alerts?
4) What are some opportunities to improve upon the prescribing alerts?
5) What other feedback would you like to share regarding the prescribing alerts?

Additionally, provider interviews were conducted to

1) assess their decisions to or not to co-prescribe,
2) gain insights into providers' prescribing practices, and

3) determine lessons learned from implementing the CDS.

The overall results from the data analyses are to follow.

Section 4: Results

As noted in the methodology section, the project's goal was to implement EHR-based CDS at AHC that interrupted the opioid prescribing workflow. The project team designed this EHR workflow interruption to decrease the health system's average co-prescribing rate for 1) multiple opioids and 2) opioid-benzodiazepine combinations to fall between 2% to 5% as measured from May 2, 2022, through July 31, 2022. The change in the co-prescribing rate, from baseline through the project period, was the primary outcome of interest. Secondary data analysis focused on providing deeper alerting insights into the eCQM co-prescribing rates by assessing the

1) alerting gaps,
2) appropriateness of alerts,
3) provider interactions with alerts,
4) the potential to reach performance targets, and
5) the top 80% of co-prescribing roles.

Open-ended feedback was requested from various stakeholder groups to support the Quick Win cycles. The plan for these monthly cycles was to focus on

4) measuring the health system's monthly co-prescribing average to determine if the performance target was met,
5) gaining insights from key stakeholder groups to determine necessary CDS changes, and
6) implementing those CDS changes, where applicable and appropriate, into the EHR system.

The stakeholder groups were the

4) Opioid Stewardship Committee,
5) Physician Advisory Board, and
6) Clinical Informaticists.

Additional open-ended feedback was collected from

4) prescribing providers via Microsoft Forms surveys,
5) a prescribing provider interview, and
6) interviews with various team members

to gain insights into current prescribing practices, the environment, perspectives related to alerting, and recommended paths for effective opioid stewardship. The following were the results of the analysis.

Descriptive Statistics

Opioid and Benzodiazepine Prescriptions

From January 1, 2022, through July 31, 2022, which covered both the baseline and project timeframes, the following were the number of opioid and benzodiazepine prescriptions written for Fort Washington Medical Center, Shady Grove Medical Center, and White Oak Medical Center per the IT Pharmacist's data.

Table 26: Opioid and Benzodiazepine Prescription Counts by Facility

Facility	Opioid Prescriptions	Benzodiazepine Prescriptions
Fort Washington Medical Center	1064	115
Shady Grove Medical Center	4272	657
White Oak Medical Center	3221	410
Total	***8557***	***1182***

According to the eCQM report, the number of unique encounters evaluated for opioid or benzodiazepine prescribing combinations (i.e., the aggregate denominator), from January 1, 2022, through July 31, 2022, by facility, were the following.

Table 27 eCQM Unique Encounters Evaluated for Opioid or Benzodiazepine Combinations

Facility	Unique Encounters Evaluated
Fort Washington Medical Center	181
Shady Grove Medical Center	1723
White Oak Medical Center	1140
Total	***3044***

eCQM Co-Prescribing Numerators and Denominators

April 2022 served as the baseline when evaluating changes to the co-prescribing rates. The baseline eCQM numerators for Fort Washington Medical Center, Shady Grove Medical Center, and White Oak Medical Center were 1, 32, and 20, respectively. The baseline eCQM denominators, in the same listed order, were 26, 259, and 149. The eCQM numerator and denominator counts from May 2, 2022, through July 31, 2022, by facility and month, as well as the overall total, are listed in the figures to follow.

Figure 9: Fort Washington eCQM Population Statistics

Fort Washington	eCQM Initial Population	eCQM Final Population (Denominator)	eCQM Numerator
May	32	28	2
June	51	29	6
July	35	25	1
Total	*118*	*82*	*9*

Figure 10: Shady Grove eCQM Population Statistics

Shady Grove	eCQM Initial Population	eCQM Final Population (Denominator)	eCQM Numerator
May	285	237	22
June	297	265	25
July	336	293	29
Total	*918*	*795*	*76*

Figure 11: White Oak eCQM Population Statistics

White Oak	eCQM Initial Population	eCQM Final Population (Denominator)	eCQM Numerator
May	217	176	14
June	209	165	27
July	230	182	23
Total	*656*	*523*	*64*

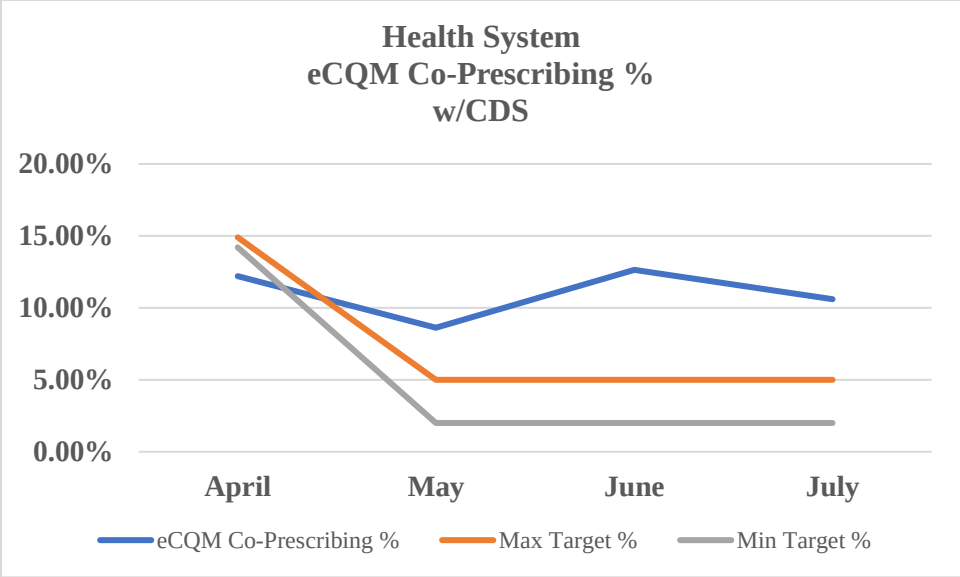
Figure 12: Total eCQM Population Statistics

Totals	eCQM Initial Population	eCQM Final Population (Denominator)	eCQM Numerator
May	534	441	38
June	557	459	58
July	601	500	53
Total	*1692*	*1400*	*149*

Pre- and Post-Comparison of Co-Prescribing Rates

The health system's average co-prescribing rate did not reach the 2% to 5% targeted range between May 2, 2022, and July 31, 2022. The April 2022 baseline average for the organization was 12.2%. The health system's average co-prescribing rates for May, June, and July of 2022 were 8.62%, 12.64%, and 10.6%, respectively. The overall average co-prescribing rate was 10.64%. These data demonstrated a 1.56% decrease in the health system's average co-prescribing rate from baseline, which trended positively.

Figure 13: Health System eCQM e-Prescribing Percentage with CDS

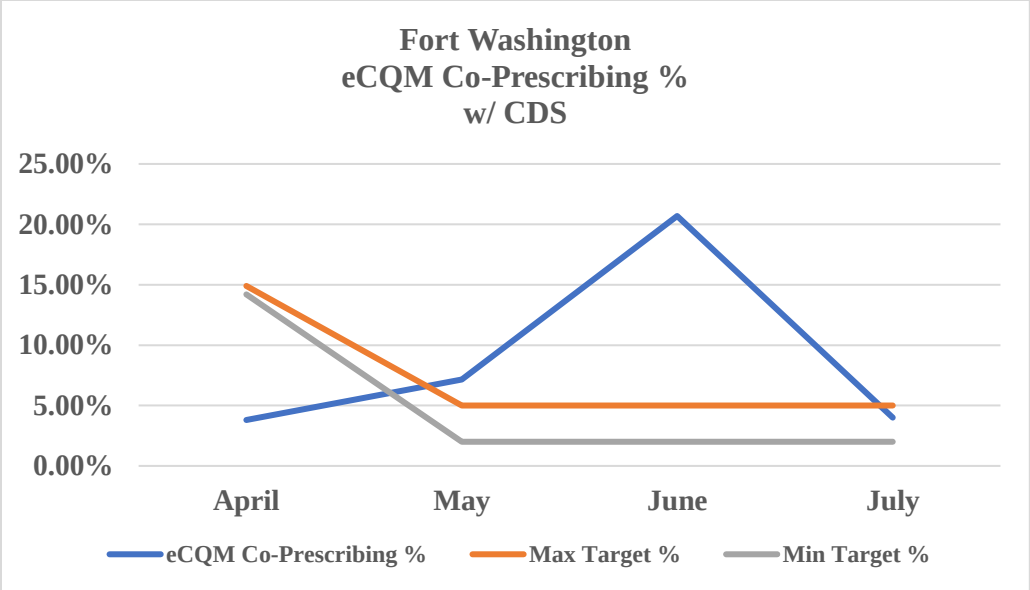


When stratified by facility, the trending patterns from the baseline differed. Those stratified results are to follow.

Fort Washington Medical Center

The co-prescribing target was met solely for Fort Washington in July 2022 at 4%. Though the co-prescribing rate fell within the targeted percentage range for July 2022, this was a slight increase from the facility's April 2022 baseline of 3.8%. Furthermore, the facility's rate increased in May and June of 2022 to 7.14% and 20.69%, respectively, before attaining a 4% rate in July 2022.

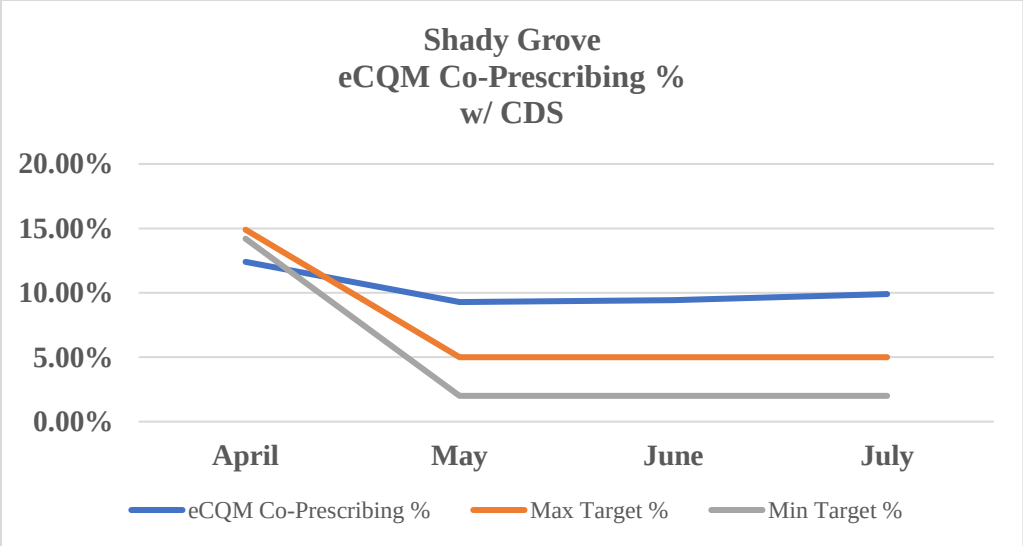
Figure 14: Fort Washington eCQM e-Prescribing Percentage with CDS



Shady Grove Medical Center

The co-prescribing percentage for Shady Grove Medical Center fell from the April 2022 baseline of 12.4% to 9.28% in May yet rose slightly to 9.43% and 9.90% in June and July of 2022, respectively. Though the facility's rates did not meet the 2% to 5% targeted range, a sustained decrease of approximately 3% from the April 2022 baseline demonstrated improvement.

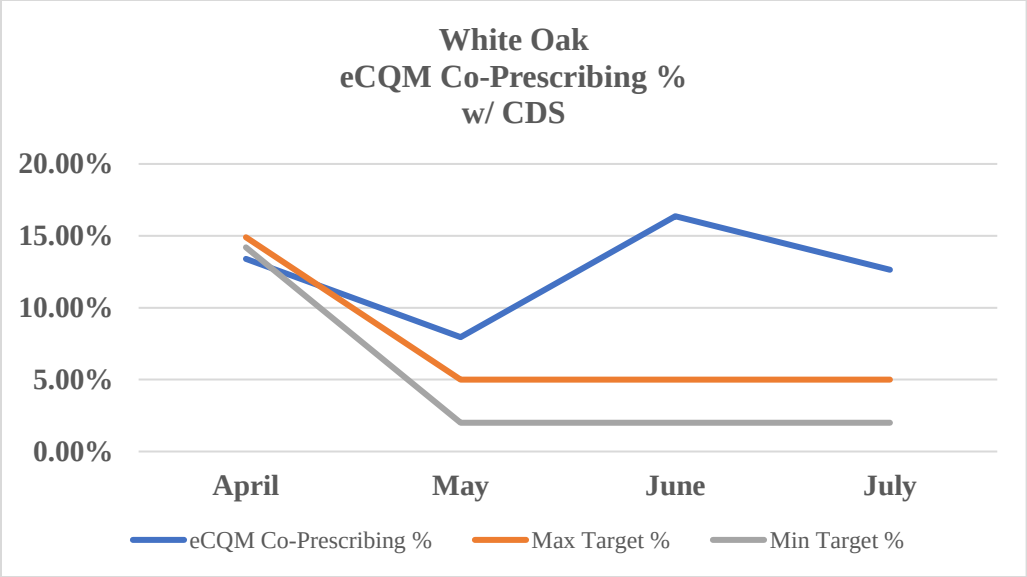
Figure 15: Shady Grove eCQM e-Prescribing Percentage with CDS



White Oak Medical Center

White Oak Medical Center's co-prescribing rate decreased from 13.40% to 7.95% between April and May of 2022. However, the percentage increased to 16.36% in June 2022, and subsequently decreased to 12.64% in July 2022. The significant fluctuation from month to month does not provide confidence in positive and sustained improvement.

Figure 16: White Oak eCQM e-Prescribing Percentage with CDS



In summary, though the trending from baseline differed for each facility, the co-prescribing rate increased for all facilities, at varying degrees, from May to June of 2022. The June 2022 trend could not be explained and needs further investigation. Understanding the co-prescribing rates was significant but understanding the "why" factors behind the rates was determined to provide valuable insights into prescribing practices and further warranted interventions. A deeper analysis of the "why," which are the alerting insights, is to follow.

Alerting Insights

Additional metrics were calculated to provide insights regarding the alerting design, configuration, and adoption. Those metrics and their definitions are the following:

- **Alerting Gap:** percentage of patients in the eCQM numerator who did not trigger an Opioid High Risk Alert nor Naloxone Alert as expected.
- **Appropriateness of Alerts**: percentage of Opioid High Risk Alerts and Naloxone Alerts that fired as expected
- **Provider Interactions:** percentage of alerts that providers chose to
    5) cancel,
    6) continue,
    7) modify, or
    8) return to chart.

Patients with a cancer diagnosis, receiving palliative or hospice care, or not otherwise qualifying for the eCQM population were excluded from these calculations.

These insights aligned with the 1) people, 2) clinical content, and 3) system measurement and monitoring dimensions of the Socio-Technical Model, which is a model comprised of eight (8) dimensions "specifically designed to address the sociotechnical challenges involved in design, development, implementation, use and evaluation of HIT within complex adaptive healthcare systems" (Sittig & Singh, 2010, p. 68). The people, clinical content, and system measurement and monitoring dimensions, more specifically, related to the following:

- **People Dimension:** effectiveness of the individuals designing, building, implementing, and interacting with the alerts

- **Clinical Content Dimension:** logic generating the alerting triggers is working appropriately
- **System Measurement and Monitoring Dimension:** actions taken when interacting with the alerts (e.g., overriding alerts, etc).

(Sittig & Singh, 2010, p. 68).

The results relating to these metrics are to follow.

Descriptive Statistics Related to the Opioid High Risk Alert

A total of 895 Opioid High Risk Alerts were triggered during the project period. These alerts were triggered by 776 patients. A total of 413 providers received the alerts. A one-to-one match between alerts, patients, and providers did not exist as some patients triggered multiple alerts, and subsequently some providers received multiple alerts for the same patients.

Opioid High Risk Alerting Gap Statistics.

The percentage of patients in the eCQM numerator who failed to trigger an Opioid High Risk Alert was referred to as an alerting gap. When initially analyzing the data, it appeared that only 4.7% of eCQM patients triggered the alert. This meant that there was a 95.3% failure rate for triggering the alert by patients that were co-prescribed 1) multiple opioids or 2) opioid-benzodiazepine combinations. The low overall percentage of eCQM numerator patients triggering alerts was problematic, as 100% of patients should have triggered an alert unless providers simultaneously prescribed an unsafe medication combination. As aforementioned, the Naloxone Alert was implemented to capture the simultaneous prescribing of medications.

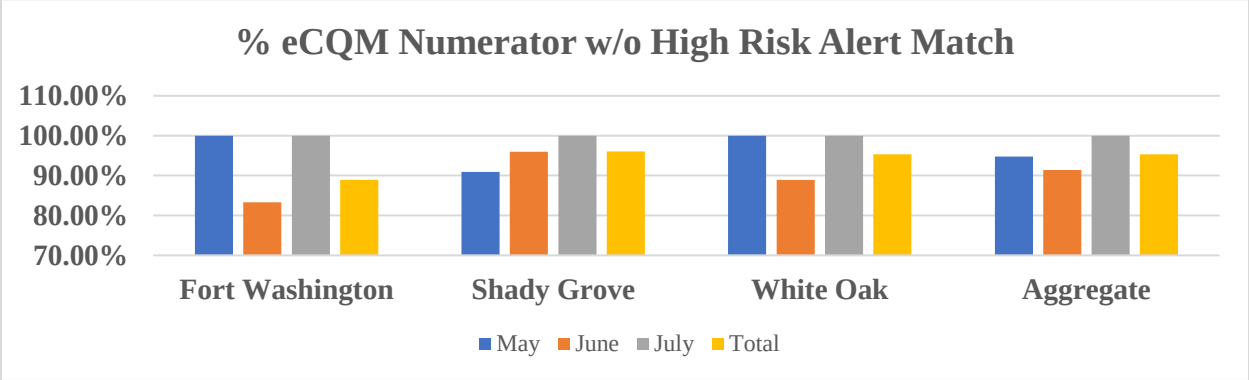
As previously mentioned, the overall average alerting gap was calculated at 95.3%. The gaps for May, June, and July of 2022 were calculated at 94.74%, 91.38%, and 100%, respectively. When assessing the gap across the facilities, the results were the following:

- Fort Washington Medical Center – 100%, 83.3%, and 100% (overall average of 88.89%)
- Shady Grove Medical Center – 90.91%, 96%, and 100% (overall average of 96.05%)
- White Oak Medical Center – 100%, 88.89%, and 100% (overall average of 95.31%)

Table 28: Percentage eCQM Numerator without High Risk Alert Match

	Fort Washington	Shady Grove	White Oak	Aggregate
May	100.00%	90.91%	100.00%	94.74%
June	83.33%	96.00%	88.89%	91.38%
July	100.00%	100.00%	100.00%	100.00%
Total	***88.89%***	***96.05%***	***95.31%***	***95.30%***

Figure 17: Percentage of eCQM Numerator Patients Not Receiving a High Risk Alert



Initially, the alerting gaps were calculated based on the patients that triggered the alerting message in Figure 18 (below).

Figure 18: Alert Message for Concurrent Prescribing of Opioids and Benzodiazepines

Reconstructed from Oracle Cerner's All About Opioid Management Package documentation

The concurrent opioid and benzodiazepine message only related to this specific medication combination. A similar alerting message was not always triggered when two

(2) or more opioids were prescribed. Instead, the provider would have received one (or more) of the following messages when the alert was triggered.

Figure 19: Alert Message for Opioid Rx MME Exceeding Recommended Thresholds

Reconstructed from Oracle Cerner's All About Opioid Management Package documentation

Figure 20: Alert Message Remaining Opioid Rx

Reconstructed from Oracle Cerner's All About Opioid Management Package documentation

Figure 21: Alert Message for Number of Opioid Prescriptions in Past 30 Days

Reconstructed from Oracle Cerner's All About Opioid Management Package documentation

These messages aligned with CDC guidelines for safely prescribing opioids. However, the EHR alerting did not codify these messages as co-prescribed medications in the data. As these medication combinations truly did relate to co-prescribed opioids, the project team expanded its definition of co-prescribing and included these message types in the next round of alerting gap calculations.

Based on the revised definitions and calculations of a co-prescribing alert message, it was determined that the Opioid High Risk Alert triggered for 41.61% of patients in the eCQM numerator. Each patient could have received multiple message combinations based on their current prescriptions and clinical conditions. However, when reviewing the additional alerting messages related to multiple opioid combinations, an average of 35.57% of patients triggered the MME greater than or equal to 50 messages, 5.37% triggered a greater than 50% remaining RX message, and 0% of patients triggered a message for three (3) or more prescriptions being written in the past 30 days. Unfortunately, even when factoring in these additional messages, the alerting gap was still 58.39%. The remaining gap called for the need for a deeper root-cause analysis. However, the triggering qualifications and disqualifications were not logged to the database tables for this specific alert, which prevented this additional layer of analysis.

Table 29: Co-Prescribing Opioid High Risk Alert Messages for eCQM Numerator Patients

Totals	% Receiving Alert	% With No Alert	% Co-Prescribe Opioid + Benzo	% MME ≥ 50	% > 50% Rx Remaining	% 3 or More Rx In 30 Days
May	55.26%	44.74%	5.26%	47.37%	5.26%	0.00%
June	34.48%	65.52%	8.62%	32.76%	3.45%	0.00%
July	39.62%	60.38%	0.00%	30.19%	7.55%	0.00%
Total	*41.61%*	*58.39%*	*4.70%*	*35.57%*	*5.37%*	*0.00%*

When evaluating data from each facility, the results showed that the percentage of patients receiving an alert ranged from 37.50% to 55.56%. MME alerts greater than or equal to 50 ranged from 32.81% to 55.56%, and greater than 50% remaining RX alerts ranged from 0% to 6.25%. The alerting gap ranged from 53.95% to 66.67%.

Table 30: Fort Washington Co-Prescribing High Risk Alert Messages for eCQM Numerator Patients

Fort Washington	% Receiving Alert	% With No Alert	% Co-Prescribe Opioid + Benzo	% MME ≥ 50	% > 50% Rx Remaining	% 3 or More Rx In 30 Days
May	50.00%	50.00%	0.00%	50.00%	0.00%	0.00%
June	16.67%	83.33%	16.67%	16.67%	0.00%	0.00%
July	100.00%	0.00%	0.00%	100.00%	0.00%	0.00%
Total	*55.56%*	*66.67%*	*11.11%*	*55.56%*	*0.00%*	*0.00%*

Table 31: Shady Grove Co-Prescribing High Risk Alert Messages for eCQM Numerator Patients

Shady Grove	% Receiving Alert	% With No Alert	% Co-Prescribe Opioid + Benzo	% MME ≥ 50	% > 50% Rx Remaining	% 3 or More Rx In 30 Days
May	54.55%	45.45%	9.09%	40.91%	4.55%	0.00%
June	28.00%	72.00%	4.00%	28.00%	0.00%	0.00%
July	55.17%	44.83%	0.00%	44.83%	10.34%	0.00%
Total	*46.05%*	*53.95%*	*3.95%*	*37.91%*	*4.96%*	*0.00%*

Table 32: White Oak Co-Prescribing High Risk Alert Messages for eCQM Numerator Patients

White Oak	% Receiving Alert	% With No Alert	% Co-Prescribe Opioid + Benzo	% MME ≥ 50	% > 50% Rx Remaining	% 3 or More Rx In 30 Days
May	57.14%	42.86%	0.00%	57.14%	7.14%	0.00%
June	44.44%	55.56%	11.11%	40.74%	7.41%	0.00%
July	17.39%	82.61%	0.00%	8.70%	4.35%	0.00%
Total	***37.50%***	***62.50%***	***4.69%***	***32.81%***	***6.25%***	***0.00%***

These data show that "%MME ≥ to 50" was the top reason for receiving an alert, not co-prescribing of opioids and benzodiazepines. The alerting gap could not be fully understood nor explained from the available EHR data. As previously mentioned, there was also a known issue when simultaneously prescribing multiple opioids or opioid-benzodiazepine combinations, which led to the implementation of the Naloxone Alert. The Naloxone Alert analysis is discussed later.

Appropriateness of Opioid High Risk Alerts.

Appropriate alerts are those triggered for patients not excluded from the eCQM denominator. As previously mentioned, the denominator exclusion was defined as patients with a cancer diagnosis or receiving palliative or hospice care. Additional patients that were not a part of the eCQM population, e.g., patients under 18, were also excluded. Upon assessment of the data, the alert fired appropriately at an overall average rate of 85.59%. This rate aligned with the specific facility averages ranging from 83% to 86.26%.

Table 33: Appropriate Alerting Rates for the Opioid High Risk Alert

Totals	Total Alerts	Total Alerts w/o Den Exclusion	% Appropriate Alerts
May	313	260	83.07%
June	343	294	85.71%
July	388	341	87.89%
Total	***1044***	***895***	***85.73%***

Table 34: Fort Washington Appropriate Alerting Rates for the Opioid High Risk Alert

Fort Washington	Total Alerts	Total Alerts w/o Den Exclusion	% Appropriate Alerts
May	34	28	82.35%
June	26	18	69.23%
July	40	37	92.50%
Total	***100***	***83***	***83.00%***

Table 35: Shady Grove Appropriate Alerting Rates for the Opioid High Risk Alert

Shady Grove	Total Alerts	Total Alerts w/o Den Exclusion	% Appropriate Alerts
May	166	140	84.34%
June	177	151	85.31%
July	210	186	88.57%
Total	***553***	***477***	***86.26%***

Table 36: White Oak Appropriate Alerting Rates for the Opioid High Risk Alert

White Oak	Total Alerts	Total Alerts w/o Den Exclusion	% Appropriate Alerts
May	113	92	81.42%
June	140	125	89.29%
July	138	118	85.51%
Total	***391***	***335***	***85.68%***

Approximately 14% noise (unnecessary triggering) existed with the alert.

Though the number of alerts was low, the team investigated the cause of the noise. One finding was that patients were excluded from the eCQM denominator if the discharge disposition in the registration system was flagged as an acute care facility, hospice, or expired. The team evaluated whether it would be valuable to incorporate the discharge order within the alert to exclude patients with these dispositions. However, discharge dispositions did not align between the orders and registration systems, and

discharge orders were typically placed by providers after prescribing had already taken place. It was not feasible for the team to eliminate the noise related to discharge orders. Similarly, the was designed by the team to exclude patients with palliative care orders, as that was the only way to determine if patients were receiving palliative care. However, this was a stop-gap as there was not palliative care medical service to utilize in the registration system, which could have still led to inappropriate alerting.

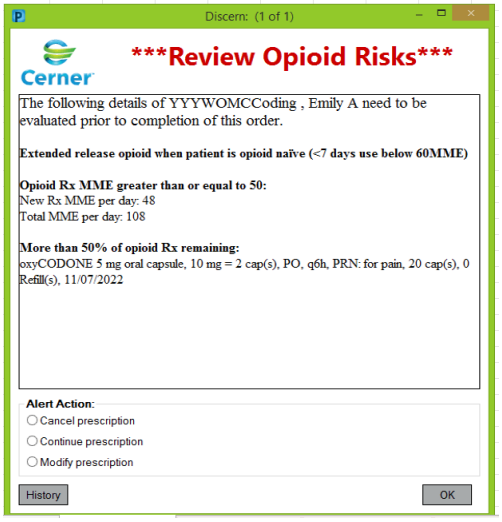
Though cancer diagnoses were not added to the alerting logic, the team did discuss whether it would be valuable to incorporate these codes into the exclusion logic. Upon evaluating the options for adding the diagnoses, the option to quickly add a "catch-all" to the exclusion logic for all primary and secondary cancer diagnoses was not feasible. The team was then left to determine if adding the codes individually to the alert was worthwhile, but that was a burdensome task. This noise was also not eliminated. When combined with inappropriate alerting for discharge dispositions and the uncertainty about the value of the palliative care order, the unnecessary alerting could have impacted physician adoption and adherence.

Provider Interactions with Opioid High Risk Alerts.

Provider interactions with the Opioid High Risk Alerts were assessed to determine behaviors, adherence, and adoption. The Opioid High Risk Alert guided the safe use of opioid prescribing while maintaining the providers' clinical decision-making autonomy. For this reason, no hard stops were incorporated into the alerting design. A provider had three (3) options to select from when receiving the Opioid High Risk Alert. Those options, and the corresponding behaviors, include:

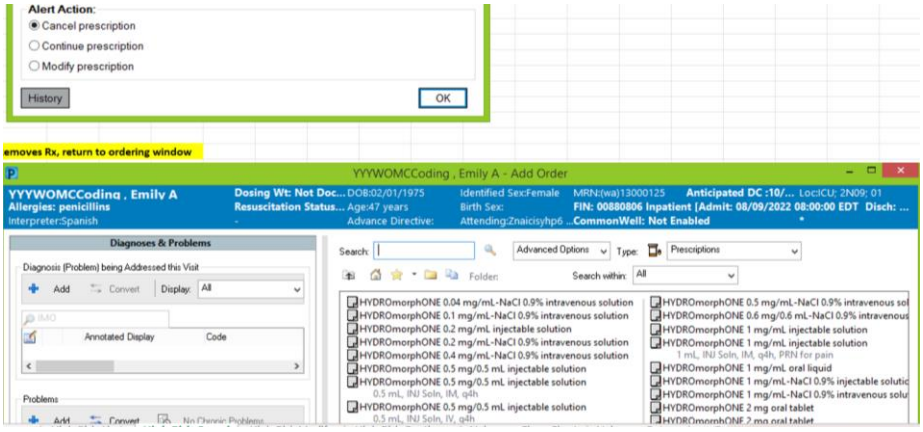
1) **Cancel Prescription** – The prescription was not completed nor written to the record, and the provider was returned to the ordering screen.
2) **Continue Prescription** – The alert was overridden and required an override reason to be provided. The default override reason provided by the EHR was "treatment plan requirement," with the option to add additional free text reasons if desired. Once the provider placed the prescription in the EHR, they were returned to the ordering screen.
3) **Modify Prescription** – The provider was returned to the ordering screen allowing modifications to the incoming prescription before processing.

Figure 22: Opioid High Risk Alert Example with Alert Actions



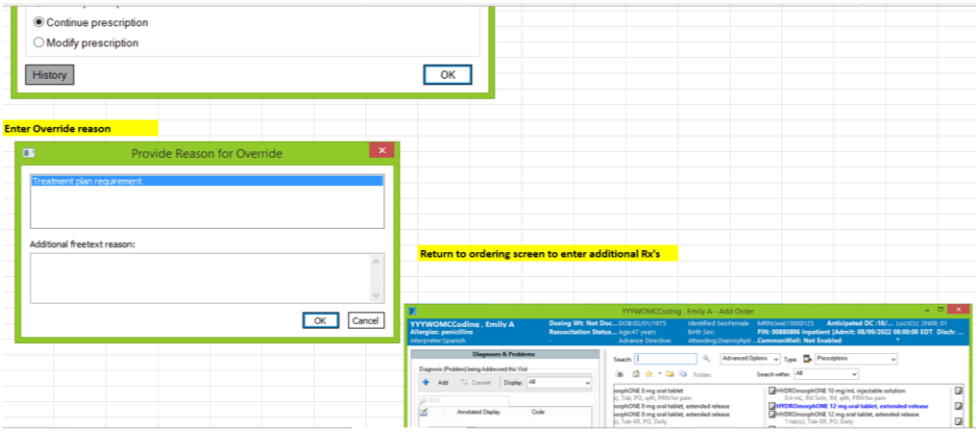
Generated from the Adventist HealthCare Maryland Oracle Cerner Electronic Health Record

Figure 23: Result When Selecting to Cancel Prescription for Opioid High Risk Alert



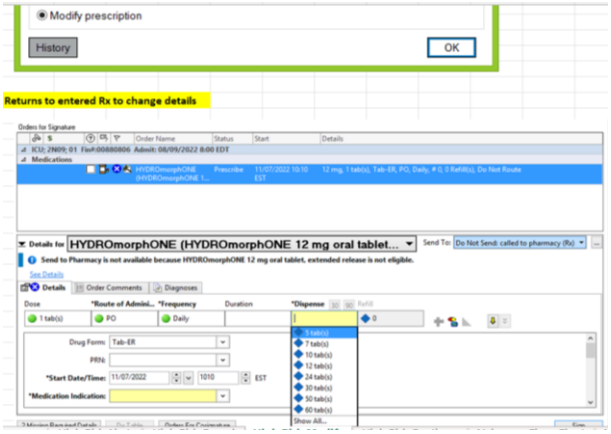
Generated from the Adventist HealthCare Maryland Oracle Cerner Electronic Health Record

Figure 24: Result When Selecting to Continue Prescription for Opioid High Risk Alert



Generated from the Adventist HealthCare Maryland Oracle Cerner Electronic Health Record

Figure 25: Result When Selecting to Modify Prescription for Opioid High Risk Alert



Generated from the Adventist HealthCare Maryland Oracle Cerner Electronic Health Record

The project team captured statistics regarding the selection of each alerting action to better understand provider interactions. As aforementioned, a total of 413 unique providers received the Opioid High Risk Alert, which were triggered by 776 unique patients. The “Continue prescription” action was the most selected, occurring 92.18% of

the time. As previously mentioned, the default selection for the override reason was "treatment plan requirement." The additional free text comments from the database were not individually analyzed. "Modify prescription" was chosen at an average rate of 7.82%, and providers never selected the "Cancel prescription" action. The individual facility rates for alerting actions mirrored the overall calculations, except for Fort Washington Medical Center. Fort Washington Medical Center's average override rate was 87.95%, with a "Modify prescription" rate of 12.05%.

Table 37: Opioid High Risk Alert Provider Actions

Totals	Unique Patient Alert Overrides w/o Den Exclusion	Unique Providers Receiving Alerts w/o Den Exclusion	% Continue Action w/o Den Exclusion	% Modify Action w/o Den Exclusion	% Cancel Action w/o Den Exclusion
May	216	125	89.62%	10.38%	0.00%
June	257	145	92.86%	7.14%	0.00%
July	303	143	93.55%	6.45%	0.00%
Total	*776*	*413*	*92.18%*	*7.82%*	*0.00%*

Table 38: Fort Washington Opioid High Risk Alert Provider Actions

Fort Washington	Unique Patient Alert Overrides w/o Den Exclusion	Unique Providers Receiving Alerts w/o Den Exclusion	% Continue Action w/o Den Exclusion	% Modify Action w/o Den Exclusion	% Cancel Action w/o Den Exclusion
May	25	11	85.71%	14.29%	0.00%
June	18	10	88.89%	11.11%	0.00%
July	32	14	89.19%	10.81%	0.00%
Total	*75*	*35*	*87.95%*	*12.05%*	*0.00%*

Table 39: Shady Grove Opioid High Risk Alert Provider Actions

Shady Grove	Unique Patient Alert Overrides w/o Den Exclusion	Unique Providers Receiving Alerts w/o Den Exclusion	% Continue Action w/o Den Exclusion	% Modify Action w/o Den Exclusion	% Cancel Action w/o Den Exclusion
May	112	68	94.29%	5.71%	0.00%
June	134	82	92.72%	7.28%	0.00%
July	160	79	91.40%	8.60%	0.00%
Total	*406*	*229*	*92.66%*	*7.34%*	*0.00%*

Table 40: White Oak Opioid High Risk Alert Provider Actions

White Oak	Unique Patient Alert Overrides w/o Den Exclusion	Unique Providers Receiving Alerts w/o Den Exclusion	% Continue Action w/o Den Exclusion	% Modify Action w/o Den Exclusion	% Cancel Action w/o Den Exclusion
May	79	46	83.70%	16.30%	0.00%
June	105	53	93.60%	6.40%	0.00%
July	111	50	98.31%	1.69%	0.00%
Total	***295***	***149***	***92.54%***	***7.46%***	***0.00%***

The reasoning behind the co-prescribing decisions cannot be fully explained solely from the data. However, provider feedback was collected regarding the alerts to assess perceptions and recommendations for changes, which will be discussed later in the results section.

Naloxone Alerting

As previously mentioned, the team implemented the Naloxone Alert to close EHR functionality gaps with the Opioid High Risk Alert. The Opioid High Risk Alert was triggered when an opioid or benzodiazepine was already present on the chart, and an incoming prescription for an opioid or benzodiazepine was added to the scratchpad. Unfortunately, the EHR functionality could not assess the scenario in which no prescription opioids or benzodiazepines were recorded in the chart, and two (2) new prescriptions in this combination were added to the scratchpad simultaneously. In speaking with the solution designer, the recommendation was to utilize the Naloxone Alert, triggered at the signing of the order, to address this scenario. The alert was implemented within the EHR at the outset of the project.

Descriptive Statistics Related to Naloxone Alerting.

A total of 179 Naloxone Alerts were triggered during the project period. These alerts were triggered by 163 patients. A total of 130 providers received the alerts. A one-to-one match between alerts, patients, and providers did not exist as some patients triggered multiple alerts, and subsequently some providers received multiple alerts for the same patients.

Naloxone Alerting Gap Statistics.

The data showed that the overall average rate of eCQM numerator patients triggering the Naloxone Alert was 28.86%. When reviewing the facility-specific statistics, the average rates were 33.3%, 27.63%, and 29.69% for Fort Washington Medical Center, Shady Grove Medical Center, and White Oak Medical Center, respectively.

Table 41: Naloxone Alerting Statistics for eCQM Numerator Patients

Totals	% Receiving Alert	% With No Alert
May	5.26%	94.74%
June	34.48%	65.52%
July	39.62%	60.38%
Total	***28.86%***	***71.14%***

Table 42: Fort Washington Naloxone Alerting Statistics for eCQM Numerator Patients

Fort Washington	% Receiving Alert	% With No Alert
May	0.00%	100.00%
June	50.00%	50.00%
July	0.00%	100.00%
Total	***33.33%***	***66.67%***

Table 43: Shady Grove Naloxone Alerting Statistics for eCQM Numerator Patients

Shady Grove	% Receiving Alert	% With No Alert
May	9.09%	90.91%
June	40.00%	60.00%
July	31.03%	68.97%
Total	***27.63%***	***72.37%***

Table 44: White Oak Naloxone Alerting Statistics for eCQM Numerator Patients

White Oak	% Receiving Alert	% With No Alert
May	0.00%	100.00%
June	25.93%	74.07%
July	52.17%	47.83%
Total	***29.69%***	***70.31%***

All eCQM numerator patients should have triggered an alert, so an alerting gap existed. Factors were assessed that may have contributed to the alerting gap. The first finding was that the EHR functionality was not coded to capture simultaneous prescriptions when signing orders, which rendered the Naloxone Alert no more effective than the Opioid High Risk Alert for this scenario. For this reason, the Opioid Stewardship Committee approved shifting the Naloxone Alert to trigger when closing the chart if 1) multiple opioids or 2) opioid-benzodiazepine combinations were present on the chart. The modified version of the alert went into the EHR production system on June 8, 2022.

Before the alerting change, the May 2022 trigger rate for eCQM numerator patients at Fort Washington Medical Center and White Oak Medical Center was 0%, and Shady Grove Medical Center's rate was 9.09%. After the alerting change, the June 2022 rates were 50%, 40%, and 25.93% for Fort Washington Medical Center, Shady Grove Medical Center, and White Oak Medical Center, respectively. The June 2022 rates were biased due to the seven (7) days of the month utilizing the prior version of the alert.

Logically, the seven (7) day gap should have explained why 100% of eCQM numerator patients did not trigger an alert in June 2022. However, when evaluating the numbers for July 2022, the rates did not reach 100%. Though the percentage of eCQM numerator patients triggering the alert increased significantly from June 22 to July 22, there was still an alerting gap. One theory was that the alert was not firing for opioid/opioid combinations. However, when spot-checking the eCQM data for patients that did not trigger an alert for July, there were opioid-opioid, opioid-benzodiazepine, and triplicate medication combinations that did not trigger the alert. The log data were not available for the alert to assess the failed triggers, which could have provided additional insights for mitigation.

Appropriateness of Naloxone Alerts.

As previously mentioned, appropriate alerts were defined as those triggered for patients who were not excluded from the eCQM denominator. The denominator exclusion was defined as patients with 1) a cancer diagnosis or 2) receiving palliative or hospice care. Additional patients that were not a part of the eCQM population (e.g., patients under 18) were also excluded. Upon assessment of the data, the alert fired appropriately at an overall average rate of 23.19%. This rate aligned with the specific facility averages ranging from 17.65% to 29.74%.

Table 45: Appropriate Alerting Rates for the Naloxone Alert

Totals	Total Alerts	Total Alerts w/o Den Exclusion	% Appropriate Alerts
May	35	16	45.71%
June	362	90	24.86%
July	375	73	19.47%
Total	***772***	***179***	***23.19%***

Table 46: Fort Washington Appropriate Alerting Rates for the Naloxone Alert

Fort Washington	Total Alerts	Total Alerts w/o Den Exclusion	% Appropriate Alerts
May	3	0	0.00%
June	44	13	29.55%
July	38	2	5.26%
Total	***85***	***15***	***17.65%***

Table 47: Shady Grove Appropriate Alerting Rates for the Naloxone Alert

Fort Washington	Total Alerts	Total Alerts w/o Den Exclusion	% Appropriate Alerts
May	3	0	0.00%
June	44	13	29.55%
July	38	2	5.26%
Total	***85***	***15***	***17.65%***

Table 48: White Oak Appropriate Alerting Rates for the Naloxone Alert

White Oak	Total Alerts	Total Alerts w/o Den Exclusion	% Appropriate Alerts
May	17	13	76.47%
June	119	36	30.25%
July	133	31	23.31%
Total	***269***	***80***	***29.74%***

These rates of accuracy were low. However, some bias existed in this alert, as it was intentionally designed to trigger for patients that were not a part of the eCQM patient population. The rule could have fired appropriately based on the intended design yet may also have some unknown failures. For this reason, further analysis is needed to determine which qualifications account for the noise. Evaluating the build configurations compared to the intended design, as well as assessing log files, would have provided additional insights. However, the log files were not available to review for this alert.

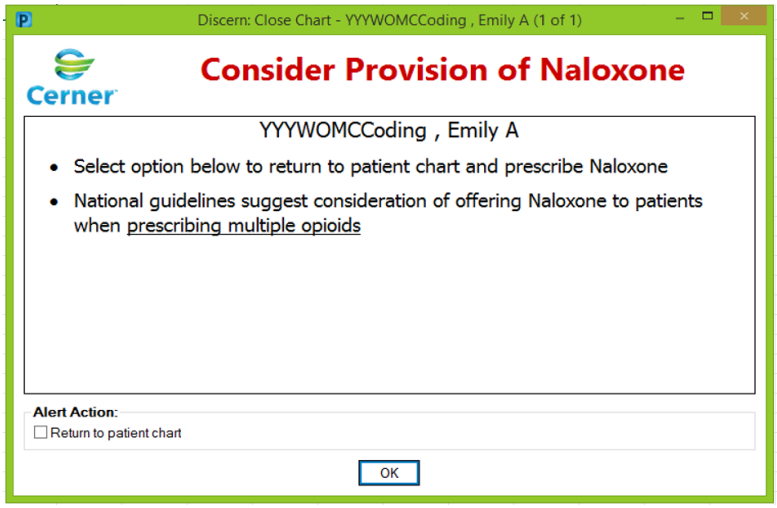
Provider Interactions with Naloxone Alerts.

The team designed the Naloxone Alert to guide safe opioid prescribing while maintaining the providers' autonomy during clinical decision-making. For this reason, no hard stops were incorporated into the alerting design. When the alert was initially launched on May 2, 2022, to trigger on "sign order," the provider only received an alert message related to co-prescribing. The alert message did not allow for further actions to be taken from the alerting screen. When the alert was modified on June 8, 2022, to trigger

on “close chart,” a provider had two (2) options to select. Those options, and the corresponding behaviors, were the following:

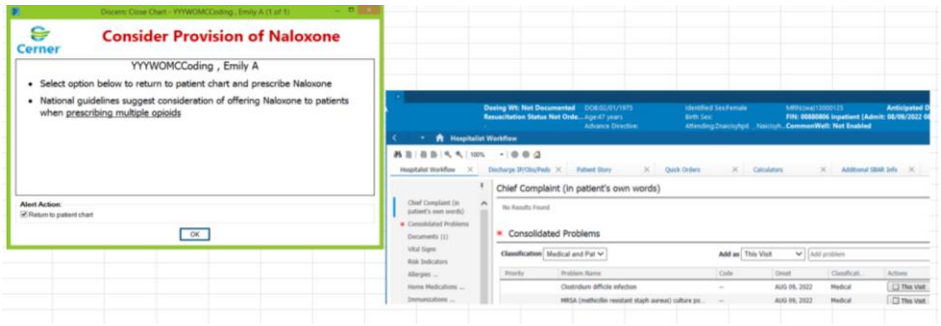
- **Return to Patient Chart** – This action would return the provider to the last screen they reviewed in the chart and was documented as a cancel action in the system but did not relate to the cancellation of an actual order.
- **OK** – This action allowed the provider to close the chart.

Figure 26: Naloxone Alert



Generated from the Adventist HealthCare Maryland Oracle Cerner Electronic Health Record

Figure 27: Naloxone Alerting Behavior on Return to Patient Chart



Generated from the Adventist HealthCare Maryland Oracle Cerner Electronic Health Record

Statistics were captured regarding the selection of each alerting action to assess the selections of the providers. "Continue" was the most common order action taken by the providers at a rate of 74.86%. Alert messages and cancels accounted for 15.64% and 9.50% of alerts, respectively. The alerts do not provide a direct correlation to an order

action, so there is no direct opportunity from the alert to interact with the triggering patient's order

Table 49: Naloxone Alert Provider Actions

Totals	%Alert Message Only w/o Den Exclusion	%Continue Action w/o Den Exclusion	%Modify Action w/o Den Exclusion	%Cancel Action w/o Den Exclusion
May	100.00%	0.00%	0.00%	0.00%
June	13.33%	73.33%	0.00%	13.33%
July	0.00%	93.15%	0.00%	6.85%
Total	***15.64%***	***74.86%***	***0.00%***	***9.50%***

Table 50: Fort Washington Naloxone Alert Provider Actions

Fort Washington	%Alert Message Only w/o Den Exclusion	%Continue Action w/o Den Exclusion	%Modify Action w/o Den Exclusion	%Cancel Action w/o Den Exclusion
May	0.00%	0.00%	0.00%	0.00%
June	30.77%	61.54%	0.00%	7.69%
July	0.00%	100.00%	0.00%	0.00%
Total	***26.67%***	***66.67%***	***0.00%***	***6.67%***

Table 51: Shady Grove Naloxone Alert Provider Actions

Shady Grove	%Alert Message Only w/o Den Exclusion	%Continue Action w/o Den Exclusion	%Modify Action w/o Den Exclusion	%Cancel Action w/o Den Exclusion
May	100.00%	0.00%	0.00%	0.00%
June	4.88%	78.05%	0.00%	17.07%
July	0.00%	95.00%	0.00%	5.00%
Total	***5.95%***	***83.33%***	***0.00%***	***10.71%***

Table 52: White Oak Naloxone Alert Provider Actions

White Oak	%Alert Message Only w/o Den Exclusion	%Continue Action w/o Den Exclusion	%Modify Action w/o Den Exclusion	%Cancel Action w/o Den Exclusion
May	100.00%	0.00%	0.00%	0.00%
June	16.67%	72.22%	0.00%	11.11%
July	0.00%	90.32%	0.00%	9.68%
Total	***23.75%***	***67.50%***	***0.00%***	***8.75%***

Alerting Insights Summary

Overall, providers were not consistently receiving alerts when expected. Alerting was mainly appropriate for the Opioid Hight Risk Alert; however, the Naloxone Alert exhibited lower appropriate firing rates. Bias did exist regarding the alerting data. However, the alerts still need to be investigated further. The reasoning behind the co-prescribing decisions cannot be fully explained solely from the data. However, provider feedback was collected regarding the alerts to assess perceptions and recommendations for changes, which will be discussed later in the results section.

Potential to Reach Performance Targets

The project aimed to determine if implementing CDS at the point of prescribing within the EHR would lead to an overall health system co-prescribing rate falling within the 2% to 5% range. As the results demonstrate, the team did not achieve this in the timeframe of May 2, 2022, to July 31, 2022. Various factors could have contributed to missing the target, such as the 1) technical design of the alert differing from the intended design and 2) alerting gaps. However, the team assessed whether it would have been possible to reach the 2% to 5% co-prescribing performance target range if the providers

had mitigated co-prescribing for the appropriate alerting that did occur. First, the potential co-prescribing percentage differential was calculated for each facility, by month, by subtracting the number of patients in the eCQM numerator that received the alert from the actual eCQM numerator, and then dividing the difference by the final denominator population. Next, the potential co-prescribing target differential was calculated for each facility, by month, by subtracting the potential co-prescribing differential from 5%, with 5% being the higher end of the performance target range. These calculations were run for both the Opioid High Risk Alert and the Naloxone Alert. The results are to follow.

Opioid High Risk Alert Potential Performance Rates

Data calculated for the Opioid High Risk Alert showed a potential to achieve an overall average co-prescribing rate of 6.21% from the May 2, 2022, through July 31, 2022, timeframe. A potential rate of 3.85% for May 2022, 8.28% for June, and 6.40% for July 2022 were achievable. An overall 6.21% co-prescribing rate would have equated to an approximate 49% reduction from the 12.2% baseline co-prescribing rate. The 6.21% co-prescribing rate would have fallen within 1.21% of the 5% performance target.

Table 53: Potential Opioid High Risk Alert Co-Prescribing Rates

Totals	Potential Co-Prescribing Rate	Potential Co-Prescribing Target Differential (5%) w/o Den Exclusion
May	3.85%	-1.15%
June	8.28%	3.28%
July	6.40%	1.40%
Total	***6.21%***	***1.21%***

When reviewing the facility-specific results, Fort Washington could have had a co-prescribing rate of 0% in May 2022, as well as could have hit the performance target in July 2022 at 3.57%. Shady Grove Medical Center could have reached the target for May and July of 2022 at 4.22% and 4.44%, respectively. White Oak Medical Center could have only hit the target in May 2022 at a rate of 3.41%. Those results are noted in the tables below.

Table 54: Fort Washington Potential Opioid High Risk Alert Co-Prescribing Rates

Fort Washington	Potential Co-Prescribing Rate	Potential Co-Prescribing Target Differential (5%) w/o Den Exclusion
May	3.57%	-1.43%
June	17.24%	12.24%
July	0.00%	-5.00%
Total	***7.32%***	***2.32%***

Table 55: Shady Grove Potential Opioid High Risk Alert Co-Prescribing Rates

Shady Grove	Potential Co-Prescribing Rate	Potential Co-Prescribing Target Differential (5%) w/o Den Exclusion
May	4.22%	-0.78%
June	6.79%	1.79%
July	4.44%	-0.56%
Total	***5.16%***	***0.16%***

Table 56: White Oak Potential Opioid High Risk Alert Co-Prescribing Rates

White Oak	Potential Co-Prescribing Rate	Potential Co-Prescribing Target Differential (5%) w/o Den Exclusion
May	3.41%	-1.59%
June	9.09%	4.09%
July	10.44%	5.44%
Total	***7.65%***	***2.65%***

Naloxone Alert Potential Performance Rates

Data calculated for the Naloxone Alert showed that a 7.57% potential target rate could have been achieved, which would have yielded an approximate 38% reduction from the 12.2% baseline co-prescribing rate. A co-prescribing rate of 7.57% would have fallen within 2.57% of the 5% performance target.

Table 57: Potential Naloxone Alert Co-Prescribing Rates

Totals	Potential Co-Prescribing Rate	Potential Co-Prescribing Target Differential (5%)
May	8.16%	3.16%
June	8.28%	3.28%
July	6.40%	1.40%
Total	***7.57%***	***2.57%***

When evaluating data from each facility, Fort Washington would have been able to reach the performance target in July 2022 at 4%. Shady Grove and White Oak would

not have achieved the 5% performance target, although Shady Grove would have neared the 5% target in June 2022 at 5.66%. The results are noted in the tables below.

Table 58: Fort Washington Potential Naloxone Alert Co-Prescribing Rates

Fort Washington	Potential Co-Prescribing Rate	Potential Co-Prescribing Target Differential (5%)
May	7.14%	2.14%
June	10.34%	5.34%
July	4.00%	-1.00%
Total	***7.32%***	***2.32%***

Table 59: Shady Grove Potential Naloxone Alert Co-Prescribing Rates

Shady Grove	Potential Co-Prescribing Rate	Potential Co-Prescribing Target Differential (5%)
May	8.44%	3.44%
June	5.66%	0.66%
July	6.83%	1.83%
Total	***6.92%***	***1.92%***

Table 60: White Oak Potential Naloxone Alert Co-Prescribing Rates

White Oak	Potential Co-Prescribing Rate	Potential Co-Prescribing Target Differential (5%)
May	7.95%	2.95%
June	12.12%	7.12%
July	6.04%	1.04%
Total	***8.60%***	***3.60%***

Though the potential co-prescribing rates were trending in a positive direction, adherence to alerts may not have always been warranted. For example, multiple opioid prescriptions with different frequencies may have been utilized by providers to adjust for patient pain levels. Other factors that may have contributed to the lack of adherence to the alerting and co-prescribing decisions need evaluation. Provider feedback and analysis were evaluated to better understand the co-prescribing dynamics. Those results are to follow.

Provider Alerting Feedback

Provider feedback and analysis was a critical component of the CDS project. Multiple feedback mechanisms were utilized to assess provider perspectives and interactions with the alerts. The Opioid Stewardship Committee approved the collection of open-ended feedback regarding the CDS from the Physician Advisory Board, Clinical Informaticists, and Opioid Stewardship Committee monthly forums, as well as from prescribing clinicians via Microsoft Forms surveys. Three (3) feedback cycles were conducted, for May 2, 2022, through July 31, 2022. The analysis will follow.

Monthly Forums

The following is the aggregated outcome of the monthly forums regarding the co-prescribing alerts.

Table 61: Aggregated Monthly Forum Feedback

Forum	Feedback	Action Items
Opioid Stewardship Committee	The stakeholders provided no direct feedback regarding specific co-prescribing alert changes nor from physician peer groups regarding the alerts. A committee member requested details on how the EHR calculated MME, as the calculation appeared to be too sensitive.	Oracle Cerner was contacted to provide further details on the MME logic but received no response.
Physician Advisory Board	The stakeholders provided no direct feedback regarding specific co-prescribing alert changes nor from physician peer groups regarding the alerts.	No action items.
Clinical Informaticists Meetings	The stakeholders provided no direct feedback regarding specific co-prescribing alert changes nor from physician peer groups regarding the alerts. A clinical informaticist stated that providers typically write their prescriptions for patients in their office-based EHR system for post-procedures, not in the hospital EHR system.	No action items.

The feedback from these forums was either limited or not directly related to the co-prescribing of opioids and benzodiazepines. However, if providers felt that the MME alerting was too sensitive, this could have led to a decision to override the alert. The knowledge that providers write their prescriptions for post-procedures in their office-based EHR provided perspective in that patients may be receiving co-prescriptions that cannot be accounted for nor serve as a basis for alerting evaluation.

One factor to consider is that an Opioid Stewardship Committee and a Physician Advisory Board meeting were canceled during the feedback cycles. However, the observed feedback behavior noted in Table 61 was consistent. Anecdotally, providers at AHC did not provide alerting feedback unless they had strong concerns (M. Gillett, personal communication, November 11, 2022). Strong concerns yielded more targeted feedback (M. Gillett, personal communication, November 11, 2022).

Provider Microsoft Forms Surveys

The Microsoft Forms surveys sent to providers included the following questions.

1) Tell me about your overall experiences with using the alerts? What are your thoughts and feedback?
2) Tell me about your experiences with the alerts you receive during prescribing of opioids and/or benzodiazepines?
3) What are some benefits you have found from the use of the prescribing alerts?
4) What are some opportunities to improve upon the prescribing alerts?
5) What other feedback would you like to share regarding the prescribing alerts?

The data from the monthly provider Microsoft Forms Survey yielded limited results. A total of eight (8) surveys were returned, with the May, June, and July counts totaling three (3), zero (0), and five (5), respectively. As the survey results were cumulative, the August data also showed on the dashboard, with a total of two (2) responses, bringing the overall count at the time of this writing to ten (10). In summarizing the feedback, the following themes were meaningful:

- The alerts were helpful and triggered providers to think about what they were prescribing.
- Some providers did not experience the alerts.
- Some providers did not consider the alert to be a nuisance and felt the alert fired appropriately.
- Some providers found the alerts unhelpful, ignored them, or felt there were too many alerts.
- The alert fired when two orders for the same medication were made by a prescriber while responding to different pain levels and frequencies.
- One prescriber said the alerts were challenging to modify in a timely manner when prescribing a different or comparable drug.
- Education was inadequate, and patient education materials should have been available to attach to the alert.

In summary, the feedback was limited and varied across responses. However, the information helped to understand the 1) provider perspective related to the alerts and 2) potential adoption challenges to address during future interventions. From these data, evaluating the noise in the alerts and improving upon education were key findings that can guide future enhancements. Although the feedback regarding the alerts firing for the same medication with different frequencies for pain was valuable, adjusting this logic would have been problematic. The eCQM measure solely evaluates the number of prescriptions placed, not the frequencies prescribed, so alerting on duplicate medications was necessary. These results allude to challenges between the eCQM data, clinical

judgment, and guidelines for prescribing 1) multiple opioids or 2) opioid-benzodiazepine combinations.

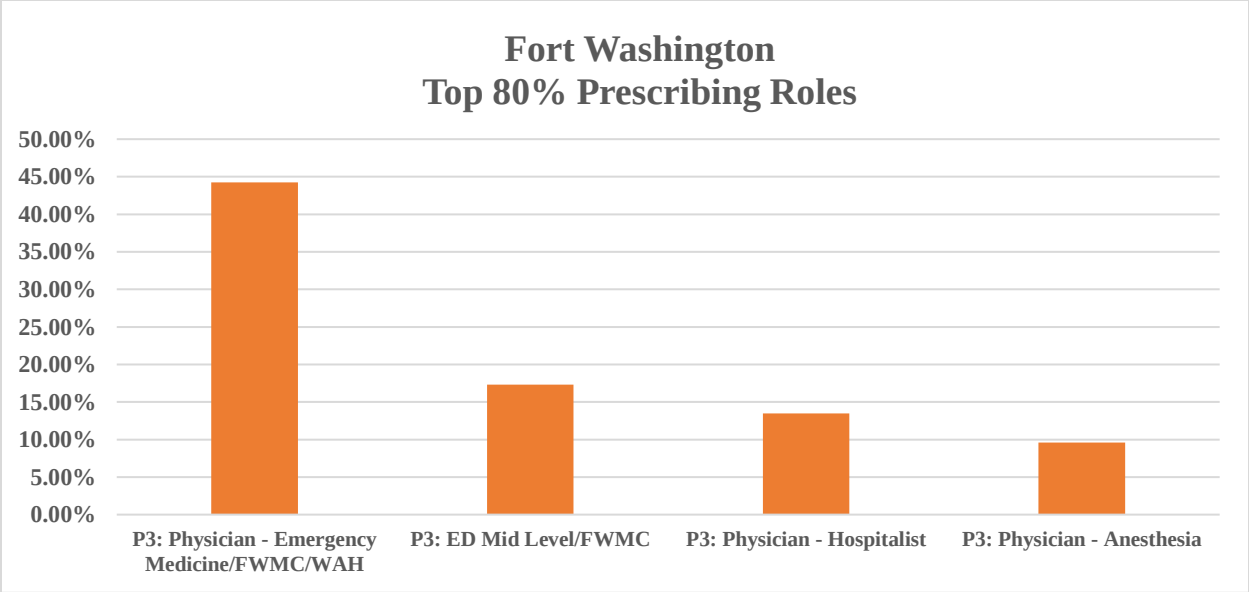
Additional Provider Alerting Analysis

Additional analyses were conducted to understand 1) the top provider roles that were triggering co-prescribing alerts and 2) specific decision-making for providers that did or did not co-prescribe for patients between May 2, 2022, and July 31, 2022. The results are to follow.

Top Co-Prescribing Roles

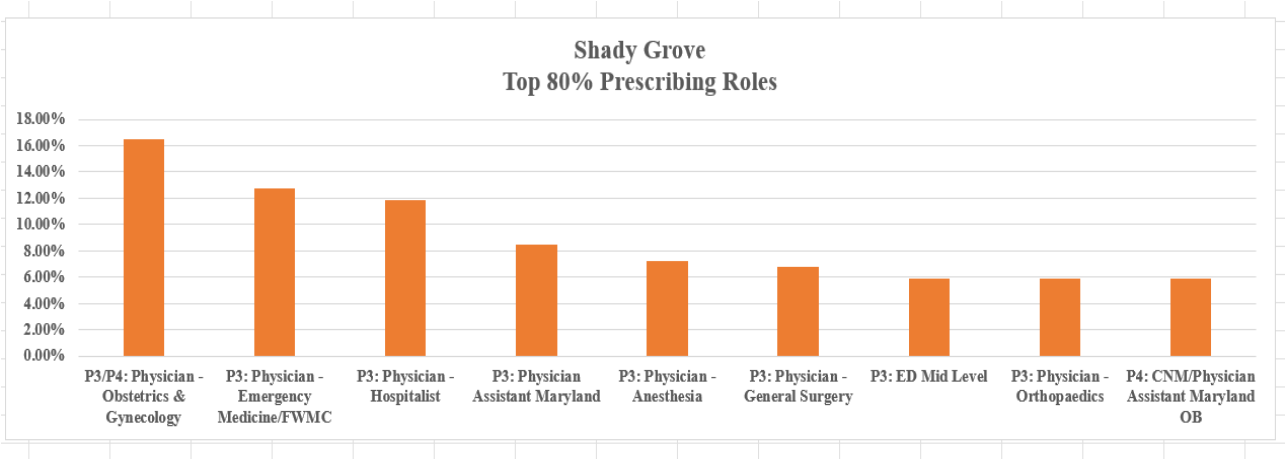
The number of unique providers receiving alerts were calculated in order to determine their specialties. The goal was to determine which specialties may need to be approached for 1) a deeper assessment of prescribing practices and 2) additional education related to co-prescribing. The top 80% of prescribing roles for each facility was assessed by calculating the roles with the highest count for the unique providers that were alerted. The top 80% of co-prescribing roles for Fort Washington were emergency medicine physicians (44.23%), ED mid-level providers (17.31%), hospitalists (13.46%), and anesthesia physicians (9.62%).

Figure 28: Fort Washington Top 80% of Prescribing Roles



The top 80% of co-prescribing roles for Shady Grove were related to obstetrics and gynecology (16.53%), emergency medicine physicians (12.71%), hospitalists (11.86%), physician assistants (8.47%), anesthesia (7.20), general surgery (6.78%), ED mid-level providers (5.93%), orthopedics 5.93%), and physician assistants in obstetrics (5.93%.

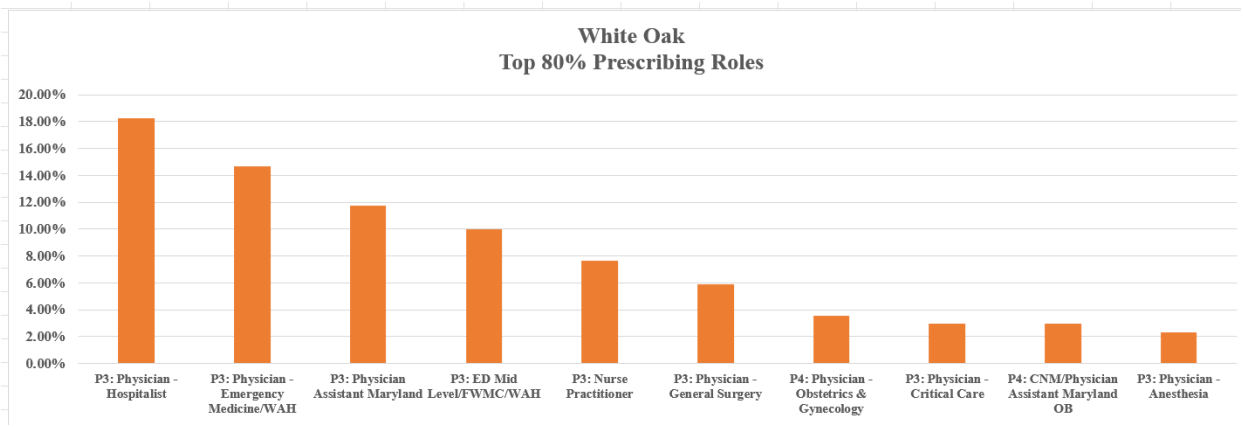
Figure 29: Shady Grove Top 80% of Prescribing Roles



The top 80% of co-prescribing roles for White Oak were hospitalists (18.24%), emergency medicine physicians (14.71%), physician assistants (11.76%), ED mid-level

providers (10%), nurse practitioners (7.65%), general surgery (5.88%), obstetrics and gynecology (3.53%), critical care (2.94%), physician assistants in obstetrics (2.4%), and anesthesia (2.35%)

Figure 30: White Oak Top 80% of Prescribing Roles



Across all facilities, emergency medicine physicians, ED mid-level providers, and hospitalists were among the top prescribing roles. Physician assistants and providers in obstetrics and gynecology were also high percentage prescribers, though not at all three (3) facilities. These data provide insights useful for future intervention strategies with the providers. The Naloxone Alert may have contributed to bias in these statistics, as the providers who may have received alerts while closing the chart alerts may not have been the provider responsible for the co-prescribing.

Provider Interviews

The Chief Medical Information Officer (CMIO) approved interviewing four (4) physicians to assess factors behind why providers co-prescribed, as well as why providers did not co-prescribe. One (1) provider agreed to be interviewed regarding their decision to co-prescribe. To protect the provider's identity, they are referred to as Provider #1. The summary of the interview is to follow.

Four (4) patients whose care triggered the Opioid High Risk Alert were reviewed with Provider #1. The overarching reason for overriding the alerts was that the patients were experiencing severe pain. Most patients had a complication, such as an existing injury or prior surgery, that resulted in ongoing or chronic pain. The provider was unfamiliar with MME calculations, so there was an opportunity to provide evidence about 1) MME overall and 2) appropriate MME ranges for safe opioid prescribing. The provider also mentioned that benzodiazepines work better for back sprains, and that he/she would prescribe a benzodiazepine instead of Ibuprofen.

Regarding thoughts around the CDS, the provider mentioned that the alerts did not generally influence his/her prescribing decisions but did make them think about the number of controlled substances they were prescribing monthly. The provider also mentioned that mid-level providers usually see pain patients and would more than likely receive than other providers. Finally, Provider #1 mentioned that the alerts needed to present a therapeutic alternative of what clinicians should prescribe, and recommended a project focused on incorporating therapeutic substitutions into the alerting design.

This information provides valuable insights into why providers might co-prescribe based on the patient's underlying medical conditions. Enhanced education regarding evidence-based opioid prescribing might have also been necessary. The statements related to mid-level providers caring for the most patients with pain align with the provider groups comprising the top 80% of prescribing roles. Finally, incorporating therapeutic substitutions into the alerts might be a beneficial enhancement to the co-prescribing alerts to further guide provider decision-making.

Open Ended Feedback

Throughout the project, the Core Team and CMIO provided valuable insights regarding alerting initiatives. A key area of feedback was around pharmacy perspectives related to medication ordering. The IT Pharmacist mentioned that medication alerting for 1) multiple opioids and 2) opioid-benzodiazepine combinations within the inpatient setting was set according to the standard content delivered through a partner of Oracle Cerner. AHC scaled back the alerts due to a significant increase in provider alerts (R. Thelin, personal communication, November 18, 2022). Though the medications for these alerts were inpatient orders and not discharge prescriptions, this information raised questions related to 1) multiple opioids and 2) opioid-benzodiazepine combination prescriptions being problematic within the overall health system. When asked if there was a pharmacy medication review process at discharge, the Medication Safety Officer (MSO) responded that inpatient medications were reviewed but that discharge prescriptions were not typically reviewed (E. Sidawy, personal communication, November 21 & 22, 2022). However, one of the Clinical Pharmacy Specialists, that serves as a part of the Transition of Care team at White Oak Medical Center, reviewed discharge medications at times (O. Davies Brony, personal communication, November 22, 2022). White Oak Medical Center data showed that providers prescribed few combinations of opioids and benzodiazepines at discharge. Patients prescribed these combinations were taking them upon admission and required as-needed doses until they could meet with their primary care physician (O. Davies Brony, personal communication, November 22, 2022).

The CDS Designer provided feedback that aligned with the aforementioned five (5) rights of CDS. The five (5) rights focus on presenting the right information, to the right person, using the right CDS intervention format (e.g., CDS alerts), leveraging the right channel (e.g., an electronic health record), and presenting at the appropriate time within the clinician's workflow (Sirajuddin et al., 2009, CDC, 2022b).

When questioning the value of hard stops for provider alerting, the CDS Designer expressed that a critical challenge with this approach was that the alerts did not always present to the appropriate provider that needed to make the decision (M. Gillett, personal communication, November 11, 2022). The appropriate attending physician being available also posed challenges with appropriate alerting within the environment (M. Gillett, personal communication, November 11, 2022). EHR functionality challenges were another area of discussion with the CDS Designer. In those discussions, the value of the alerts, particularly regarding simultaneously assessing two (2) or more incoming prescriptions that would be unsafe combinations, was curtailed (M. Gillett, personal communication, November 11, 2022). Placing alerts at the point of "close chart" were limited, as the action to return to the ordering screen within the patient's chart was not optimal for modifying prescriptions (M. Gillett, personal communication, November 11, 2022), which was also alluded to in the provider survey feedback.

As aforementioned, the CDS Designer noted that provider feedback regarding alerts was most often not shared unless there was a concern. However, reports from providers regarding overall alert fatigue were reported to and through the Physician Advisory Board (M. Gillett, personal communication, November 11, 2022). The CDS

Designer also noted that:

1) 161 alerts were active within the environment,
2) data were not typically analyzed regarding the alerts, and
3) alerts were rarely "turned off" if they were found ineffective or overridden

(M. Gillett, personal communication, November 11, 2022). These findings may have provided insight into the overall lack of

1) feedback from stakeholder groups,
2) adoption and adherence to the alerts, and
3) understanding of how alerts were truly functioning within the EHR environment.

The CMIO provided valuable insights about the context around alerting and perspectives for continued improvement. From an alerting insights perspective, the CMIO expressed hesitancy to force hard stops for alerts, as there were concerns regarding preventing providers from completing their workflow (B. Arze, personal communication, November 18, 2022). The CMIO shared a concern that alerts were not always optimal, yet there were so few options to support clinical decision-making outside of alerting (B. Arze, personal communication, November 18, 2022). The CMIO echoed the hesitancy in discontinuing alerts (B. Arze, personal communication, November 18, 2022). When asked about what environmental factors might have contributed to elevated co-prescribing rates in June 2022, there was not a clear understanding of the contributing factors. However, provider turnover was noted as a possibility (B. Arze, personal communication, November 18, 2022).

When discussing potential improvements, the CMIO noted that addressing the design and technical issues with the current alerts was a priority. Additionally, modification was needed to customize the alerts to trigger when two (2) opioids are prescribed (B. Arze, personal communication, November 18, 2022). Requiring providers to check the prescription drug monitoring program database (PDMP) before being able to prescribe an opioid or benzodiazepine was discussed with the CMIO. However, the current view into the PDMP via the health information exchange for the state of Maryland was considered sufficient (B. Arze, personal communication, November 18, 2022). Increasing provider awareness was another component of the conversation. Although there may have been some increased awareness around co-prescribing at the beginning of the project, reporting targeted provider-level data to hospital, and departmental leadership was needed to increase awareness regarding co-prescribing. More specifically, provider-level data were needed to intervene with those individuals who co-prescribed (B. Arze, personal communication, November 18, 2022). Provider-level report cards were currently under development for health system leadership and have been beneficial in the past (B. Arze, personal communication, November 18, 2022). An Opioid Stewardship Dashboard was already in place to assess the average count of prescriptions and prescription MME totals (B. Arze, personal communication, November 18, 2022). A final area of improvement was to involve pharmacists in the prescribing process (B. Arze, personal communication, November 18, 2022).

Summary

In summary, though the health system's average co-prescribing rate decreased slightly from baseline, the 2% to 5% performance target was not met. Various challenges

were discovered during the data analysis that could have impacted the achievement of the target. The limitations with EHR functionality, differences between the planned versus actual implementation of the alerts, alerting gaps (e.g., not alerting for eCQM patients), and noise (e.g., alerting unnecessarily) were all areas that needed to be improved to determine if the team could have met its performance target using CDS. Understanding prescribing perspectives, patterns, and decision-making, provider roles that are co-prescribing, more effectively leveraging provider-level data for reporting, and continued education of providers were also determined to be necessary components of co-prescribing. Some recommended paths forward were to

1) address the design and technical challenges associated with the co-prescribing alerts,
2) enhance provider-level reporting regarding opioid and benzodiazepine prescribing to hospital and departmental administration,
3) continue educational efforts around co-prescribing, particularly for the top co-prescribing roles, and
4) explore the consistent role of pharmacy in reviewing prescriptions during the discharge process.

These recommendations are outlined in the discussion section to follow.

Section 5: Discussion

As noted in the results section, various challenges throughout the project may have impacted the organization's ability to reach the 2% to 5% target performance goal. The following discussion outlines those findings and recommended paths forward as they relate to:

1) EHR functionality,
2) confirming the intended design,
3) assessing and closing alerting gaps,
4) reducing alerting noise,
5) enhancing provider interventions, and
6) advocating for eCQM Safe Use of Opioids measurement changes.

The recommendations were presented to the Opioid Stewardship Committee on December 7, 2022.

EHR Functionality

The EHR functionality could not evaluate simultaneous, incoming prescriptions for opioids and benzodiazepines. This capability was unavailable when 1) adding medications to the scratchpad or 2) signing incoming orders. For this reason, the decision was made to modify the Naloxone Alert to trigger when the chart was closed if 1) multiple opioids or 2) opioid-benzodiazepine combinations were active prescriptions on the chart. However, the "close chart" alert did not trigger within an optimal place within the workflow nor have the option to return providers to the ordering screen. The following were the recommendations for the path forward to address these issues.

Table 62: Recommendations for EHR Functionality

Recommendation 1:	Work with the EHR vendor to confirm that there are no other options for evaluating simultaneous incoming prescriptions. If not, submit an enhancement request for this functionality to be developed.
Recommendation 2:	Work with the EHR vendor to confirm that there are no other options for returning the provider to the ordering screen when closing the chart in order to review and address medication prescriptions. If not, submit an enhancement request for this functionality to be developed.

Questions were posed to the EHR vendor on current options, for which the team is awaiting feedback.

Confirming Intended Design

The need to ensure the alerts were implemented according to the approved, intended design was a critical lesson learned. Confirming a mutual understanding of the intended design for all team members would have also been beneficial. For the Opioid High Risk Alert, there was a design gap in that the goal was to trigger alerts for 1) multiple opioids and 2) opioid-benzodiazepine combinations. The data showed that multiple opioids did not trigger a co-prescribing alert message unless

1) a current and incoming opioid prescription would have resulted in MME greater than or equal to 50,
2) 50% of a current opioid prescription was remaining, and
3) prescribers had written three (3) or more opioid prescriptions in the past 30 days.

If a patient did not meet at least one (1) of these criteria, that could have contributed to the alerting gap. The language from the EHR vendor was also confusing with regard to

whether multiple opioid prescriptions would trigger the Opioid High Risk Alert under all circumstances.

Another finding was that the Naloxone Alert did not align with the approved, intended design in that it did not

1) provide the same alerting actions as the Opioid High Risk Alert during the "sign order" timeframe, nor
2) trigger for all multiple opioid and opioid-benzodiazepine combinations.

These challenges could have arisen due to a lack of 1) understanding related to the intended design and 2) clarity around the standard content design. Though testing was completed for various scenarios, the alerting gap was not found until the data analysis phase. The following were recommendations for a path forward to address these issues.

Table 63: Recommendations for Confirming the Intended Design

Recommendation 1	Confirm an understanding of the intended design with the project team to outline the necessary configuration changes for the alert modifications.
Recommendation 2	Make the necessary configuration and customization changes to the alert to align with the intended design.
Recommendation 3	Test specific scenarios related to the intended design more robustly to ensure that all scenarios are covered.
Recommendation 4	Gain project team sign-off before submitting to change control for implementation of the next iteration of the design.
Recommendation 5	Implement the modified alert and continue to monitor alerting data.
Recommendation 6	Communicate findings about the design to the EHR vendor and recommend enhancement requests where needed.

Assessing and Closing Alerting Gaps

Both the Opioid High Risk Alert and Naloxone Alert data showed that there were alerting gaps for eCQM numerator patients. These gaps could have been due to

1) simultaneous incoming prescriptions not triggering an alert,

2) multiple opioids not triggering an alert, or
3) other factors that could not be explained without capturing and reviewing the EHR's log files to assess failures.

An alerting assessment was needed in order to determine how to close those gaps within the design. The following were the recommendations for a path forward to address these issues.

Table 64: Recommendations for Assessing and Closing Alerting Gaps

Recommendation 1	Conduct a chart audit for a sampling of eCQM numerator patients that did not trigger alerts to assess which medications were prescribed and other factors related to alerts that might be relevant (e.g., demographics, facility registration information, and others.)
Recommendation 2	Conduct a test by recreating the scenarios that did not trigger an alert. Review the log files to determine where the qualification criteria failed to trigger alerts.
Recommendation 3	If possible, modify the alert to account for the failed alerting qualification criteria.
Recommendation 4	Test the specific scenarios related to the intended design to ensure they are covered.
Recommendation 5	Gain project team sign-off before submitting to change control for implementation of the next iteration of the design.
Recommendation 6	Implement the modified alert and continue to monitor alerting data.
Recommendation 7	Communicate findings about the design to the EHR vendor and recommend enhancement requests where needed.

Reduce the Noise from Inappropriate Alerting

The results showed that both the Opioid High Risk Alert and the Naloxone Alert inappropriately triggered for patients excluded from the eCQM denominator. The Opioid High Risk Alert was greater than 60% more accurate than the Naloxone Alert. CDS teams should strive to reduce the noise across the board, so that providers do not disregard the alerts. As previously mentioned, the approved patient qualification criteria

included age ranges outside of the eCQM population to allow for clinical benefit. This may have yielded some bias in the calculation. The recommended path forward was the following to address these issues.

Table 65: Recommendations for Reducing Alerting Noise

Recommendation 1	Test the specific scenarios related to the intended design (for both alerts) to ensure all necessary scenarios are covered.
Recommendation 2	Gain project team sign-off before submitting to change control for implementation of the next iteration of the design.
Recommendation 3	Implement the modified alert and continue to monitor alerting data.
Recommendation 4	Communicate findings about the design to the EHR vendor and recommend enhancement requests where needed.

Enhancing Provider Interventions

Provider interactions with the alerts provided valuable insights about the acceptance of and adherence to the alerts. Provider feedback from the survey and interview denoted mixed reviews on the value of the alert but did cause providers to pause and consider their prescribing decisions. Pain levels informed the prescribing choices. The need to re-educate providers on the opioid-related CDC guidelines was additionally brought to light. Finally, the need for therapeutic substitutions to be incorporated into the alerts for prescribing guidance, particularly for mid-level providers, was also considered essential for CDS success.

Other provider interventions centered on pharmacy engagement and provider-level data reporting. Pharmacy engagement with the discharge prescribing process has yielded some value at White Oak (O. Davies Brony, personal communication, November 22, 2022) with regard to recommending naloxone prescriptions when appropriate.

Extending this model may yield some value if expanded across all facilities. Distributing provider-level reporting data to executive and departmental leadership has also been effective at AHC for prior initiatives. The CMIO endorsed this for opioid-related prescribing as well. (B. Arze, personal communication, November 18, 2022).

Due to the

1) high alert override rates,
2) provider interactions with the alerts,
3) provider survey feedback,
4) data related to the top 80% of co-prescribing providers, and
5) open-ended discussions with the CMIO, pharmacy, and interviewed provider,

the following were additional recommendations for enhancing CDS interventions.

Table 66: Recommendations for Enhanced Provider Interventions

Recommendation 1	Incorporate therapeutic substitutions into the alert for providers to select.
Recommendation 2	Launch a co-prescribing re-education campaign related to the CDC clinical guidelines and CDS alerts for all providers once the intended design, therapeutic substitutions, alerting gaps, and noise are addressed.
Recommendation 3	Target more focused interventions towards the top 80% of prescribing roles at each facility.
Recommendation 4	Provide monthly, provider-level co-prescribing data to both hospital and departmental leadership to influence additional provider interventions
Recommendation 5	Consider the incorporation of a transition-of-care pharmacist at each facility to participate in the discharge prescribing process.

Advocating for eCQM Safe Use of Opioids Measurement Changes

Though the evaluation of the eCQM reporting and measurement developments were not the focus of the project, it was necessary to note that there was a disconnect between the eCQM reporting and clinical practice guidelines related to opioid prescribing. Before the start of the project, the team held anecdotal conversations regarding the fact that the eCQM Safe Use of Opioids solely measures whether

1. multiple opioids or
2. an opioid-benzodiazepine combination

was prescribed at discharge. During these conversations, the team noted that providers often prescribed the same opioid medication with different frequencies for patients to take based on their pain level. In the survey feedback, providers noted the CDS alerted for differing frequencies, which was inferred to mean that the alerting was unnecessary as this was a common clinical prescribing practice for pain patients. The eCQM guidelines and measurements did not concisely align with the CDC's 2016 clinical recommendations for safe opioid prescribing (Dowell et al., 2016). The CDC guidelines focused more on the total MME prescribed, the remaining amount of existing opioid prescriptions, and the total number of opioid prescriptions written within the last 30 days (Dowell et al., 2016). However, the Opioid High Risk Alert did account for these guidelines. The team mentioned that organizations had provided feedback to CMS and the Joint Commission about aligning their reporting and measurements to the clinical guidelines. However, the reporting specifications have still not been adjusted. Therefore, the recommendations for a path forward were the following.

Table 67: Recommendations for Advocating for eCQM Safe Use of Opioids Measurement Changes

Recommendation 1	Continue to advocate with CMS and the Joint Commission to change the eCQM reporting guidelines and measurements to mirror the CDC guidelines.
Recommendation 2	Pending a decision by CMS and the Joint Commission, work with the EHR vendor to develop eCQM reporting that evaluates the prescription orders from the perspective of clinical guidelines, and not purely a tally count.

Summary

In summary, implementing CDS to reduce co-prescribing rates for 1) multiple opioids and 2) opioid-benzodiazepine combinations presented numerous complexities, areas of success, and points of failure. CDS for co-prescribing needed to consider various factors, such as the

1) EHR functionality,
2) intended versus implemented design,
3) alerting gaps,
4) alerting noise, and
5) necessary provider interventions.

The project team proposed a set of recommendations as a path forward to reach the chosen performance targets. Once the recommendations are implemented in a future phase, the performance targets and factors influencing those targets should be reassessed. Enhancing the CDS to achieve optimal performance levels will require continuous 1) performance improvement cycles and 2) support from the Opioid Stewardship Committee

to achieve future success and ensure patient safety. Pairing down the 161 alerts will ensure that overall alert fatigue for AHC providers is addressed and may also impact adherence to the opioid prescribing CDS (M. Gillett, personal communication, November 11, 2022). Through continuous quality improvement initiatives, the alerts can more effectively adhere to the five (5) rights of CDS by

1) presenting the right information,
2) to the right person,
3) using the right CDS intervention format,
4) leveraging the right channel, and
5) presenting at the right time within the clinician's workflow

(Sirajuddin et al., 2009, CDC, 2022b).

Section 6: Performance Improvement Limitations

The CDS initiative at AHC focused on measuring the eCQM population. The population focused on patients within acute care facilities, who were over 18, not diagnosed with cancer, nor receiving hospice or palliative care services. For this reason, the findings from this initiative may not be generalizable for all patient populations at AHC. As previously mentioned, the design of the CDS allowed for alerts to trigger for non-eCQM patient populations, including rehabilitation, behavioral health patients at Shady Grove Medical Center, and stand-alone emergency medicine patients, as well as patients young as eleven (11) years old. This alerting aimed to ensure the overall maximum clinical benefit for patients. Therefore, alerting data can be analyzed for these patients and providers at a future date. Results were also not stratified by patient demographics, such as race, age, insurance type, etc., which did not provide the opportunity to assess prescribing disparities across various patient populations. These findings, however, could be generalized for organizations utilizing the Oracle Cerner EHR with the exact same design as AHC.

Section 7: Conclusions

In conclusion, this project demonstrated that implementing CDS is multi-faceted. Implementing standardized content delivered from EHR vendors may not successfully deliver accurate CDS, nor does EHR functionality always work optimally to achieve the organization's goals. The intended versus implemented design may differ, demonstrating the need for effective communication and review throughout the process. Initial testing rounds of CDS do not always find critical issues with alerting, and alerting data analysis is crucial to understanding how well CDS works to achieve the selected performance targets. Understanding provider perspectives and interactions with the CDS are also vital to any project, as their feedback can help to drive design considerations. CDS developers should also address provider perspectives and interactions with targeted interventions if analyzed data are available. Though this project did not meet the selected performance targets of falling within the 2% to 5% range, there was a slight 1.56% decrease in the co-prescribing rate. Notably, there was the potential to reduce the co-prescribing rate by approximately 49% with the Opioid High Risk Alert and 38% with the Naloxone Alert. However, adhering to CDS alerts may not always yield the best clinical decision-making for a particular patient, especially concerning pain management. As the CDS designer stated, "computers are not people," meaning provider decision-making and judgment are still required (Mary Gillett, personal communication, November 11, 2022).

These findings were valuable, can advance future CDS initiatives for Adventist HealthCare Maryland, and can help contribute to the healthcare industry's body of evidence related to co-prescribing CDS, particularly within the inpatient setting. The CDS opioid-related prescribing literature does not fully address the issues and

complexities with the design, implementation, and technical challenges that might impact the acceptance and adoption of the CDS. Limitations with the technology and the detailed analysis of the actual alerting insights themselves have also not been fully demonstrated in the published literature. These findings and recommended paths forward to develop effective CDS implementation processes contribute significantly to the return on investment.

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Appendix A

Revised Project Charter

Project Name:
Safe Use of Opioids – Clinical Decision Support to Reduce Co-Prescribing of Opioids and Benzodiazepines

Project Leader:
Monica Coley, MPH, Doctoral Fellow

Executive Sponsor:
Bonnie Arze, MD, PMP
VP, Physician Quality & Performance Excellence Services
Chief Medical Information Officer

PROGRESS & DATES

Status: Completed
Start Date: May 2, 2022
Duration (days): 91 Days
Due Date: July 31, 2022
Completion Date: July 31, 2022

PROJECT CLASSIFICATION

Entity: Adventist Healthcare System Wide
Department: Physician Quality & Performance Excellence Services

Methodology: Define Measure Analyze Design Verify (DMADV)
Advisor/Coach: Bonnie Arze, MD, PMP

PROJECT DEFINITION

Problem Statement:
Fatal overdose deaths that implicate opioids and benzodiazepines is an epidemic in the United States. Statistics show that:

- 31%-51% fatal opioid overdose deaths involved the concurrent use of opioids and benzodiazepine (Dowell, Haegerich, & Chou, 2016)
- Fatal opioid overdose deaths were 10 times higher when involving both an opioid and benzodiazepine (Dasgupta et al., 2015)
- From 2006-2011, there was a 14% average annual increase in the number of patients dying from an opioid overdose increased where benzodiazepine is implicated (Jones & McAninch, 2015)

(As cited in https://ecqi.healthit.gov/sites/default/files/ecqm/measures/CMS506v3.html)

When evaluating concurrent co-prescribing statistics, the data show that:

- 5%-15% of patients receive concurrent opioid prescriptions
- 5%-20% of patients receive concurrent opioid and benzodiazepine prescriptions

(Lui et al, 2013, Mack et al., 2015, Park et al., 2015) (as cited in https://ecqi.healthit.gov/sites/default/files/ecqm/measures/CMS506v3.html)

One of the initiatives developed by the Centers for Medicare and Medicaid Services (CMS) to curb this issue is the ***Safe Use of Opioids – Concurrent Prescribing*** Electronic Clinical Quality Measure (eCQM). The focus of this measure is to decrease the "proportion of inpatient hospitalizations for patients 18 years of age and older prescribed, or continued on, two or more opioids or an opioid and benzodiazepine concurrently at discharge." Maryland's Health Services Cost Review is requiring that health systems report on this measure for the full 2022 calendar year. The April 2022 baseline eCQM reports from the Cerner system show the co-prescribing rates for qualified reporting locations:

- Fort Washington Medical Center – 3.8%
- Shady Grove Medical Center – 12.4%
- White Oak Medical Center – 13.4%
- Aggregate Health System Average – 12.2%

These rates are currently within the national averages that are associated with high rates of fatal opioid overdose rates (e.g., 5%-20%).

Project Scope
In order to impact the co-prescribing rates, AHC will implement Oracle Cerner's ***Opioid High Risk Alert*** within the HER as a form of clinical decision support (CDS), which will be interruptive within the provider prescribing workflow. This alert seeks to prevent co-

prescribing situations when opioid and/or benzodiazepine is added to the scratchpad and an active opioid and/or benzodiazepine prescription already exists. As a precautionary safety measure, Oracle Cerner's ***Opioid Naloxone Alert***, another CDS tool, will also be implemented within the EHR that will alert providers of the unsafe co-prescribing scenario when orders are being signed. This precautionary safety measure is to account for scenarios in which an opioid and benzodiazepine are entered as new prescriptions at the same time, with no existing prescriptions for opioid and/or benzodiazepine on the chart. If no existing prescriptions are on the chart, and these medications are prescribed at the same time, the ***Opioid High Risk Alert*** will not fire when these are added to the scratchpad. However, the ***Opioid Naloxone Alert*** will fire when the orders are signed.

Providers and clinical informaticists will be queried for clinical decision support feedback via Microsoft Forms Surveys and meetings with the Opioid Stewardship Committee, Physician Advisory Board, and Clinical Informaticists. Iterative modifications to the clinical decision support, based on the feedback and approved by the Opioid Stewardship Committee, will be made on a monthly basis through August of 2022. Feedback from provider interviews will be conducted to gain insights related to co-prescribing decisions. Project Core Team and additional stakeholders will also be interviewed to gain insights into the environmental, cultural, and other factors related to co-prescribing.

The populations in-scope for the project are inpatients aged 18 years of age or older that have discharge prescriptions written for opioids and benzodiazepines between May 2, 2022, and July 31, 2022. The in-scope inpatient facilities are Fort Washington Medical Center, Shady Grove Medical Center, and White Oak Medical Center.

Expected Benefit:
The expected benefit is a decrease in the percentage of co-prescriptions for the eCQM population. As no benchmark currently exists, AHC will establish the following targets:

- Quality and Patient Safety Council – Decrease in percentage of co-prescriptions to 5% or less for the eCQM population.
- World Class Target Goal – Decrease in percentage of co-prescriptions to 2% or less for the eCQM population

A target of 0% co-prescribing is not achievable due to long-active and short-acting opioid and benzodiazepine scenarios that must be accounted for during prescribing.

Gaining insights related to CDS, from a perspective of what does and does not work well is also an expected benefit.

Project Risks

The following ae project risks and potential impacts. The project team will work with the executive sponsor to remove these barriers where possible.

Risks	Possible Impacts
Competing priorities and resource constraints	The health system has competing projects that may constrain resources to work on the project. Bringing a new hospital online with the EHR is one major competing project.
Provider perceptions regarding interruptive CDS	In general, providers have differing tolerance levels regarding alerting within the EHR workflow. Gaining buy-in from all providers to accept interruptive co-prescribing CDS may serve as a challenge.
COVID-19	Organizations are prioritizing initiatives and resources related to COVID-19 as their top priority, which may take away from resourcing and effort related to new initiatives.

Appendix B

SWOT Analysis

SWOT Analysis

- **Strengths**
  - Sr. level executive support
  - Focus on quality and safety
  - Engaged Opioid Stewardship Committee
  - Commitment to reducing co -prescribing of opioids and benzodiazepines

- **Weaknesses**
  - No current or prior implementation of co-prescribing CDS
  - Resource constraints (smaller team) for implementation and data analysis

SWOT Analysis

- **Opportunities**
  - Implementing a CDS framework aimed at reducing co-prescribing of opioids and benzodiazepines
- **Threats**
  - Competing projects
  - Potential prioritization shifts (e.g. regulatory, leadership, industry, organizational)
  - Physician perceptions and beliefs related to co-prescribing of opioids and benzodiazepines

Appendix C

Project Timeline

Key Milestones	Aug-21	Sep-21	Jan-22	Feb-22	Mar-22	Apr-22
Project Initiation						
Project Kick-Off						
Workflow Analysis & Mapping (Current State & Future State)						
KPI/Benefits Plan Development						
Translation of Future State Workflows into Systems Requirements						
Systems Build						
Systems Testing						
Training						
IRB Review & Approval						

Key Milestones	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
Go-Live								
Quick Win Cycles								
Data Analysis								
Finalize Project Results								
Finalize Translational Research Project								
Project Close-Out								