Comparison of 3 Surveillance Methods to Detect Potential Controlled Substance Diversion in an Academic Medical Center

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Abstract

Objectives: To compare 3 methods of detecting potential diversion of controlled substances (CS) by health care personnel from inpatient units in a large, academic medical center. **Methods:** Three different reports were retrospectively analyzed and evaluated to determine which employees are “high-risk” for diversion over a 30-day period using defined criteria. Reports were derived from automated dispensing machines (ADMs), purchased third-party software (TPS), and the electronic health record (EHR). The primary outcome was the percentage of employees in each report who were deemed to be high-risk for CS diversion (positive predictive value [PPV]). Secondary outcomes included the number of false positives and description of high-risk users on each report. Descriptive statistics were used to analyze differences between methods. **Results:** The PPV was highly variable between reports. The PPVs among the ADM, TPS, and EHR reports were 3.28%, 6.82%, and 23.88%, respectively. False positives were high among all reports (96.72%, 93.18%, and 76.12% for the ADM, TPS, and EHR reports, respectively). **Conclusions:** A report from the EHR has the highest PPV to detect high-risk employees who may be diverting CS. However, false positives were high for all reports, indicating that significant improvements are needed in the development of accurate and reliable software to detect potential and actual CS diversion.

Keywords

controlled substance, diversion, academic medical center, narcotic, theft, detection, policy, software, method, internal, surveillance, opioid

Introduction

Substance use disorders afflict approximately 10% to 15% of health care professionals,^{1–3} resulting in a 4-year loss of more than 19 million dosage units due to internal diversion of controlled substances (CS) by health care employees to supply an addiction of their own or a friend or family member.^{4–7} Internal drug diversion includes any activity whereby regulated pharmaceuticals are unlawfully channeled away from intended use,⁸ or more formally, “the unlawful taking of a patient’s medication by a healthcare professional for personal use.”⁹ The clandestine nature of diversion complicates the procurement of accurate, contemporary statistics, and while professionals of any discipline may divert CS, multiple studies and case series highlight nursing as the discipline at highest risk, potentially due to perceived poor workplace controls, ease of availability, and frequent interaction with CS.^{3,9–17} Recommendations for CS diversion prevention and detection have been provided,^{18–25} including comprehensive guidelines from the American Society for Health-System Pharmacists (ASHP),²⁶ and in a national survey of pharmacy directors, compliance with recommendations was variable.²⁷

Diversion has far-reaching impacts at many levels: (1) the patient, (2) the diverter, and (3) health care peers and institutions (Figure 1).²⁸ Patient and employee safety is put at risk with the possibility of acquiring and transmitting blood-borne pathogens, particularly if parenteral medication is being diverted. Patients may physically and emotionally suffer from delivery of substandard care from an impaired worker or poor pain control from undertreatment. Financially, patients may incur charges for medication that was not administered as a result of CS diversion, and the institution may experience direct costs of lost product and additional expense to replace

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Figure 1. Consequences of controlled substance diversion.

diverted product. Coworkers of the diverter have shared patient responsibilities and may interact with contaminated substances or unknowingly participate in fraudulent documentation. Health care systems have legal and regulatory duties to ensure appropriate use of CS throughout the medication use pathway and may experience legal and reputational repercussions if a lapse in oversight becomes apparent. Given the gravity and far-reaching consequences of diversion, The Joint Commission delegates responsibilities to institutions to prevent diversion via appropriate dispensing, storage, access, wasting, documentation, administration, and oversight of CS.²⁹ Legally, the Controlled Substances Act mandates appropriate prescribing, dispensing, and use of CS in the United States, which are then regulated and enforced by the Drug Enforcement Administration and other regulatory bodies such as state boards of pharmacy, medicine, and nursing.³⁰ Socially and ethically, institutions are obligated to protect patients against iatrogenic harms during the delivery of health care, which may include diversion of CS.

Although methods vary, options for diversion surveillance include manual chart audits based on reports, use of specifically designed software, or a combination of the 2.^{19,23,31} Reports may originate from automated dispensing machines (ADMs), third-party vendors, institution-built software, or electronic health records (EHRs). No literature exists to compare detection methods, which would allow institutions to appropriately invest time and resources into processes that are both effective and efficient. The objective of the described study was to compare 3 different reports that may aid in detection of potential CS diversion in a large, academic medical center setting.

Methods

Current Process for Diversion Detection

This study was performed at The Ohio State University Wexner Medical Center (OSUWMC; Columbus, Ohio). At OSUWMC, the diversion detection process focuses on identifying discrepancies within individual user dispensing and administration patterns as interpreted from ADM and EHR data,²³ as recommended by the ASHP Guidelines on Preventing Diversion of Controlled Substances.²⁶ Briefly, 3 narcotics managers run monthly reports from ADM software (Pyxis C^{II} Safe; BD, San Diego, California), which list users in excess of 3 or more standard deviations (SD) of CS transactions compared with peers who care for similar patient populations. A narcotics manager will manually review each time a user accesses CS (termed a “transaction”) and search the EHR to find appropriate documentation of the full dose. Several “high-risk” behaviors that indicate the potential for CS diversion may be identified in manual chart review (Table 1). The manual review is necessary given that CS diversion may be interpreted by the ADM as a normal transaction without any obvious discrepancy (Table 2), and hidden discrepancies are often found with further investigation into the medical record. Conversely, the ADM may identify a health care user who was simply caring for a patient with large opioid demands.

Narcotic managers then meet with nurse managers to further review the high-risk users, which allows the nurse manager to provide insight regarding any suspicious behaviors that may indicate potential diversion (eg, cognitive dysfunction, preoccupation with opioid orders, volunteering for undesirable shifts, patient complaints).^{9,28,31,32} Three potential

Table 1. High-Risk Behaviors That May Indicate Potential Controlled Substance Diversion and Examples.

Category	Term	Definition	Example
Transactional	Not Charted	Dose dispensed from the ADM is not charted as given to the patient in the MAR.	User retrieves 2 oxycodone 5 mg tablets for a patient's oxycodone 10 mg dose but does not document these tablets as given to the patient.
	Waste All	Dose dispensed from the ADM is wasted in its entirety after the dispense.	User retrieves 2 oxycodone 5 mg tablets for a patient's oxycodone 10 mg dose. After the dispense, he or she documents these 2 tablets as "waste."
	Missing Waste	Dose dispensed from the ADM is not associated with a subsequent necessary waste transaction.	User retrieves 2 oxycodone 5 mg tablets for a patient's oxycodone 7.5 mg dose (1.5 tablets). He or she documents 7.5 mg as given to the patient but does not waste 2.5 mg (0.5 tablet).
	Override	Dose dispensed from the ADM prior to pharmacist verification or without a pursuant medication order from a provider in the EHR.	User retrieves 2 oxycodone 5 mg tablets without an order in the EHR and may or may not chart the medication as given to the patient.
	High Frequency	User's CS comprise a majority of CS dispenses for a unit or area of work.	User dispenses more controlled substances than his or her peers.
Timing	Late Waste	Dose dispensed from the ADM is associated with a subsequent necessary waste transaction 1 h or more after the given time.	User retrieves 2 oxycodone 5 mg tablets for a patient's oxycodone 7.5 mg dose (1.5 tablets). He or she documents 7.5 mg as given to the patient at 13:00 but documents 2.5 mg (0.5 tablet) as waste at 17:00.
	Early Dispense	Dose dispensed from the ADM is 1 h or more before the given time.	User retrieves 2 oxycodone 5 mg tablets for a patient's 10 mg dose at 13:00 but does not give the medication to the patient until 17:00.
	Dispense After Given	Dose dispensed from the ADM any time after the dose was documented as given to the patient in the MAR.	User documents that he or she gave the patient 10 mg of oxycodone and then subsequently retrieves 2 oxycodone 5 mg tablets from the machine.
	Late Recorded Time	Dose documented as given to the patient 1 h or more after the medication was actually given.	User documents at 17:00 that he or she gave the patient 10 mg of oxycodone at 13:00.

Note. ADM = automated dispensing machine; MAR = medication administration record; EHR = electronic health record; CS = controlled substances.

Table 2. Examples of Transactions That May Not Flag as a Discrepancy by the Automated Dispensing Machine But May Indicate Controlled Substance Diversion Upon Further Inspection Using the Electronic Health Record.

Description	Example
Removing a dose for a PRN order when the patient is not reflecting a need for pain medication	User removes an oxycodone 10 mg tablet for a patient who has a pain score of 1 out of 10.
Removing a dose for a PRN order as often as allowed per the order when the patient is not reflecting a need for pain medication	User removes oxycodone every 4 h on a PRN order without the patient requesting pain medication.
Removing larger vial sizes/tablet strengths than necessary to complete an order	User retrieves a 10-mg morphine vial to fulfill a 2-mg order instead of using the 2-mg vial. User must then document 8 mg of waste.
Removing doses per a "verbal order" repeatedly	User continually orders and retrieves oxycodone 10 mg "once" orders and documents that he or she was given a verbal order from a physician.
Multiple canceled transactions	User frequently interacts with the ADM as if he or she is going to retrieve an oxycodone 10 mg tablet but cancels the transaction.
Removing multiple orders and documenting waste at the end of the shift	User removes morphine 2 mg vials for 1 mg order scheduled every 4 h. Throughout his or her 12-h shift, he or she removes 3 vials to complete the administrations but does not document 3 mg of waste until the end of his or her shift.

Note. PRN = as needed; ADM = automated dispensing machine.

outcomes may result: (1) practice issues will be addressed with the nurse, (2) they will be placed on an "active watch" list to review monthly, or (3) a "Code Narcotic" (also known as "Code N") is initiated.^{20,24} If a Code N occurs, the user is

given the opportunity to discuss the identified diversion behaviors, which may result in resignation from the organization or rehabilitation with the potential opportunity to return with restricted job activities.

Table 3. Differences Between RxAuditor and Pandora Software for Controlled Substance Diversion Detection.

Characteristic	RxAuditor®	Pandora®
ADM manufacturer accessibility	Any ADM	Omniceil, Pyxis, AcuDose-Rx
Platform	Web-based	Facility hardware
Price	Based on licensed beds per facility	Based on number of ADMs
% Use by UHC organizations	19%	23%
Integration with the MAR	Yes—RxAuditor 360 module	No

Note. ADM = automated dispensing machine; UHC = University Health Consortium; MAR = medication administration record.

Figure 2. Diversion surveillance continuum and study design.

Note. ADM = automated dispensing machine; TPS = third-party software; EHR = electronic health record.

Other Diversion Detection Methods

Some institutions elect to develop software for diversion surveillance or utilize third-party software (TPS) products. Two commonly used TPS include Omnicell Analytics (Omnicell, Mountain View, California) and RxAuditor (Medacast, Cheshire, Connecticut); key differences are highlighted in Table 3.

Additional reporting capabilities are available through OSUWMC’s EHR (Epic Systems Corporation, Verona, Wisconsin) using the “Unreconciled Dispenses” report, which can be customized to find dispenses of CS without a subsequent administration in the medication administration record (MAR).

Study Design and Setting

OSUWMC’s health system has 59 CS on formulary in various formulations and strengths, employs over 4000 nursing staff, maintains 250 ADMs, and administered more than 1.3 million CS doses in 2015. With over 1300 combined

inpatient beds, the 7-hospital medical center cares for many patient populations with significant CS needs, including an inpatient physical rehabilitation facility; surgery, burn, and trauma intensive care units; a premier Comprehensive Cancer Center; inpatient psychiatric facility; 100-bed emergency department; and inpatient detoxification and drug rehabilitation center.

The OSUWMC procured TPS (RxAuditor) in 2016, prompting this retrospective cohort study to compare 3 reports to detect potential CS diversion: (1) ADM reports (the current process for CS detection), (2) TPS, and (3) EHR reports. Each report was run over the same 30-day period in 2016, and one author (C.G.D.) manually reviewed each user’s CS transactions to identify “high-risk” behaviors (Table 1) and categorize whether each was a “potential” diverter or not (Figure 2; see Supplemental Methods for details on data query and analysis of each report). The time period of 30 days was selected to align with the ASHP Guidelines on Preventing Diversion of Controlled Substances, which recommends surveillance review every 30 days.²⁶ Users on each report were assigned a random case

ID for anonymity, and user CS transactions were only audited using the medical record if they had either 3 or more SDs (for the ADM and TPS reports) or 4 or more unreconciled dispenses (for the EHR report). Transactions and users were excluded from chart review if the CS access was associated with the maintenance of inventory by pharmacy personnel or occurred at external, affiliate hospitals or within operating rooms. Job description, time to analyze each user for each report, drug class, nursing unit, quantity of discrepancy, and total number of transactions per user were also collected. The study protocol was reviewed and approved by The Ohio State University Institutional Review Board with an approved waiver of informed consent (Protocol Number 2016H0415).

Outcomes

The primary outcome was the positive predictive value (PPV) of each report to detect “potential” diverters. Manual chart review was considered the gold standard to identify “potential diverters” as true positives. The definitions described in Table 1 were used to qualify each individual as a “potential diverter.” There is no nationally recognized consensus on exact patterns or behaviors that are guaranteed to signal CS diversion; however, the definitions listed in Table 1 follow recommendations from the ASHP Guidelines on Preventing Diversion of Controlled Substances, including tracking and trending of patient care usage, reports comparing dispensing device activity with prescriber orders and MARs, comparing activity with peers, transaction activity reviews, and MAR review for exact amount and quantity administered.²⁶

Secondary outcomes were the number of individuals on each report not considered to be potential diverters (false positives) and descriptive information about users on each report. Descriptive statistics were used to assess the results where applicable.

Results

Transactional and demographic information for each report is available in Table 4. The ADM report listed the least number of users ($n = 65$) compared with the TPS report ($n = 220$) and the EHR report ($n = 67$). Similarly, the ADM report had less total CS transactions for all users (3720) compared with the TPS report, which had the greatest (5937). The EHR report had the fewest total transactions (361). In total, the ADM report took 1830 minutes to analyze, less than the TPS report (2217 minutes), but more than the EHR report (403 minutes). The mean SD for the users on the ADM report was 3.44, whereas the mean SD for users on the TPS report was 3.75. The mean number of unreconciled dispenses for users on the EHR report was 6. Users were also identified as having a transactional discrepancy without being a potential diverter. In the ADM, TPS, and EHR reports, 28, 76, and 49

users, respectively, had at least one transactional discrepancy as defined in Table 1.

For the primary outcome (Table 5), the ADM and TPS reports had similar PPV (3.28% and 6.82%, respectively); however, the TPS report resulted in almost an 8-fold increase in high-risk users compared with the ADM report (15 and 2, respectively). The EHR report had the most potential diverters ($n = 16$), resulting in the highest PPV of 23.88%. Most users on the TPS and EHR reports were identified due to timing discrepancies (as described in Table 1) in addition to transactional discrepancies (as described in Table 1—14 and 10 users, respectively). The secondary outcome assessing false positives for each report was highest for the ADM report (96.72%), slightly lower for the TPS report (93.18%) and lowest for the EHR report (76.12%).

Information regarding specific drugs and patient populations is available in Table 5. Opioids were associated with the majority of discrepancies for all reports (25/47, 55/124, and 47/95 discrepancies for the ADM, TPS and EHR reports, respectively). Benzodiazepines ($n = 25$), pregabalin ($n = 2$), stimulants ($n = 1$), diphenoxylate/atropine ($n = 1$), and tramadol ($n = 5$) were also identified with limited discrepancies among all reports. There were few instances in which a nurse had discrepancies with multiple drug classes or more than one specific drug, although the EHR report revealed the most instances of both scenarios. As shown in Table 4, patient populations associated with users varied among reports; however, users with patients on medical/surgical nursing units comprised the majority of users on all reports (52/61, 147/220, and 45/67 users for the ADM, TPS and EHR reports, respectively).

Discussion

In this 30-day retrospective analysis of 30 diversion surveillance reports, very few users from each report were found to be potential diverters; the highest PPV of all 3 reports was 23.88% in the EHR report. This is likely because the EHR report provides crucial information about dose discrepancies (specifically “not charted” discrepancies) that is not generated from the other reports. False positives among all reports were high, indicating an overarching need for improvement in detection software and displaying the significant time and resource burdens required to investigate internal CS diversion. Investment in software that accurately detects CS diversion in a time-efficient and resource-sparing manner is crucial for successful, meaningful, and realistic implementation of CS diversion surveillance processes.

Our results also suggest that the reports that rely on the “standard deviation” method (ADM and TPS) are not enough to detect potential diverters and take the most time and resources to analyze. The EHR report, which identifies time discrepancies in relation to dose dispenses, is more useful to implement into busy workflows and detect potential diverters. Indeed, most high-risk users from the TPS and EHR

Table 4. Demographic Results for Each Report Across the 1-Month Reporting Period.

Characteristic	Report type		
	ADM report (n = 65)	TPS report (n = 220)	EHR report (n = 67)
Mean SD or UD	3	3.56	6.06
Median SD or UD	3.44	3.75	6
Transactions assessed (n)	3,720	5,937	361
User job department			
Nursing	64	220	67
Pharmacy	1	0	0
Average transactions per users (n)	60.98	26.99	5.39
Total approximate minutes analyzing reports	1,830	2,217	403
Average minutes per user	30	10.08	6.01
Users with at least one discrepancy	28	76	49
Total discrepancies	47	124	95
Users with more than 1 class of drug discrepancies	1	3	5
Users with more than 1 drug discrepancy	6	5	24
Users with opioid discrepancies ^a			
Total	25	49	47
Oxycodone	10	19	18
Oxycodone-acetaminophen	5	4	7
Hydrocodone-acetaminophen	1	3	4
Hydromorphone	6	12	31
Fentanyl	2	4	2
Morphine	2	6	7
Acetaminophen-codeine	1	0	0
Ketamine	1	0	0
Buprenorphine-naloxone	0	1	2
Users with nonopioid discrepancies ^a			
Total	4	23	7
Pregabalin	1	0	1
Benzodiazepine	1	19	5
Stimulant	1	0	0
Diphenoxylate-atropine	1	0	0
Tramadol	0	4	1
Primary nursing unit—all users			
Surgical	3	20	6
Medical	49	127	39
Intensive care	4	31	13
Rehabilitation	1	6	1
Emergency department	2	25	3
Psychiatric	0	5	0
Progressive care	1	6	5
Other ^b	1	0	0

Note. ADM = automated dispensing machine; TPS = third-party software; EHR = electronic health record; UD = unreconciled dispenses.

^aUsers may have discrepancies with multiple drugs; therefore, "total" may not equal the sum of the number of users with each drug discrepancy.

^bIncluded one user who was not a nurse.

reports were deemed high-risk due to timing discrepancies rather than specific types of transaction discrepancies. Anecdotally, one of the most time-consuming steps in the process of auditing a user's CS transactions rests in tracking of CS dispensing and administration in the MAR. While not performed in this study, aside from simple dispensing and administration data, further data from the patient record may

be needed, such as trending CS usage over a period of time or across nursing shifts, comparing pain scores with administration times, or accompanying events or disease states that may justify CS usage (eg, intubation, dressing changes, or physical therapy sessions). To comply with the ASHP Guidelines on Preventing Diversion of Controlled Substances and maximize resources, the CS diversion detection software

Table 5. Primary Outcome Data, Secondary Outcome Data, and Potential Diverter Data.

	Report type		
	ADM report (n = 65)	TPS report (n = 220)	EHR report (n = 67)
Primary outcome			
Total potential diverters (n)	2	15	16
PPV (%)	3.28%	6.82%	23.88%
Secondary outcome			
Total non-high-risk users (n)	59	205	51
False-positive rate (%)	96.72	93.18	76.12
Potential diverters with opioid discrepancies^a			
Oxycodone	1	2	7
Oxycodone-acetaminophen	1	4	5
Hydrocodone-acetaminophen	0	2	2
Hydromorphone	1	3	10
Fentanyl	0	0	1
Morphine	0	2	4
Acetaminophen-codeine	1	0	0
Buprenorphine-naloxone	0	0	1
Potential diverters with nonopioid discrepancies^a			
Pregabalin	0	0	1
Benzodiazepine	0	3	2
Tramadol	0	1	2
Potential diverter primary nursing unit^b			
Surgical	0	3	0
Medical	1	8	12
Intensive care	1	2	2
Rehabilitation	0	0	0
Emergency department	0	0	0
Psychiatric	0	2	0
Progressive care	0	0	2

Note. ADM = automated dispensing machine; TPS = third-party software; EHR = electronic health record; PPV = positive predictive value.

^aUsers may have discrepancies with multiple drugs; therefore, "total" may not equal the sum of the number of users with each drug discrepancy.

^b"Float" nurses were classified according to the primary nursing unit where they worked.

should optimally "have the ability to track waste, identify discrepancies, and pull data from technology systems into actionable reports, including, but not limited to, trending of information that supports diversion surveillance."²⁶ ASHP also recommends that these reports be tested to ensure accuracy, and to the best of our knowledge, our study is the first of its kind to justify this recommendation.

Furthermore, our results reveal information regarding the demographics of potential diverters. Across all reports, potential diverters predominantly worked on medicine and surgical nursing units rather than units dedicated to patient populations that may demonstrate higher CS usages, such as intensive care, emergency medicine, or psychiatric patients. Most of the medications attributed to

transactions with potential diverters were opioids; oxycodone and hydromorphone products were associated with the most number of discrepancies in users at high-risk for CS diversion.

The results of our study suggest many opportunities for improvement in the current state of CS diversion detection within inpatient health systems. While the initial aim of this study was to directly compare 3 different reports to detect potential diverters, there are a number of recognized limitations. The methodology was retrospective in nature and assessed a relatively short period of time. In addition, the analyzer auditing CS transactions may need to subjectively determine whether a user is a potential diverter depending on the number, severity, and combination of high-risk behaviors and documentation discrepancies. Questions to consider include the following: Should a user be considered high-risk if they have any "not charted" discrepancies? Should a threshold exist for every discrepancy and only consider users that cross these thresholds to be high-risk? How should these thresholds be quantified and determined? These questions have yet to be answered by current literature and are likely specific to each institution's size and practice model. Thus, there may be some degree of difference between the sensitivity of reports due to analyzer opinion in what ultimately deems a user to be a potential diverter or not. Similarly, many patterns of diversion exist, and not all diverters will divert using the same methods; the current technology does not allow perfect prediction of which employees are diverting CS. While we were not able to stratify high-risk behaviors in this study and only sought to define our institution's definitions of high-risk behaviors, further research in this area and use of predictive analytics technology may further advance diversion detection.

Of importance, users who divert small numbers of CS over an extended period of time or who divert non-CS to aid in abuse behaviors (eg, intravenous diphenhydramine) would not be detected via our methodology. Similarly, institutions may also rely on tips provided from employees who may witness or suspect diversion during daily work activities to prompt further investigation, a phenomenon that was not included in our methodology. All reports required a degree of manual auditing against the MAR, which leaves room for human error or bias. Reliance on nurse charting in the EHR may also present a limitation to detecting diversion, as a diverter who appropriately charts all doses as administered to patients but does not actually administer the medication would not be found through detection methods that solely rely on nurse charting or discrepancy data.

The ADM report lists users based on an aggregate number of CS dispenses for each user and does not provide specific medications or transaction types for assessment. In addition, while the ADM report uses the "standard deviation" method such that each user's transactions are compared with other

Table 6. Logical Limitations Within the EHR Report That Limit Its Use as a Diversion Detection Tool.

Limitation	Example
Inconsistent interpretation of time differences between days and months	A dose dispensed at 23:59 but administered at 00:02 may be reported as “unreconciled.”
Dispensing and administration of CS infusions or patient-controlled analgesia syringes	A fentanyl bag dispensed from a pharmacy to a nursing unit may be reported as “unreconciled.”
Transfer of patients throughout the institution	A dose dispensed to the patient in one unit of the hospital but administered at another unit in the hospital may be reported as “unreconciled.”
Dispensing of multiple strengths to achieve a total dose	A 5-mg oxycodone tablet will be reported as “unreconciled” if the user retrieved a 10-mg tablet and a 5-mg tablet to achieve the proper dose for a 15-mg order.
Dispensing errors	A user who accidentally dispenses one tablet when he or she needs 2 tablets for the whole dose will have an “unreconciled” dispense for the second dispense.
Dependence on perfect MAR documentation	A user documents an oxycodone scheduled dose as given on an oxycodone PRN order in the MAR, will be “unreconciled.”
Detecting false documentation	A user dispenses a drug from an ADM at 13:00 and documents in the MAR at 20:00 that he gave the dose at 13:15. This false documentation would not appear on the report.
Doses that are documented without a “given” action	A user dispenses a dose but subsequently discovers that the patient cannot take anything by mouth and charts the drug as “not given” in the MAR. He then returns the tablet to the machine, and the dispense will be “unreconciled.”

Note. EHR = electronic health record; CS = controlled substance; MAR = medication administration record; PRN = as needed; ADM = automated dispensing machine.

users’ transactions who work with similar patient populations, it does not compare users who work at different times of day and cannot precisely detect diverters within float nurse pools.

Institutions that utilize RxAuditor vendor services are familiar with the wide array of reports that are available in the software package. Our study as described used one of these reports and did not assess other reports or a combination of multiple reports available in the software package; thus, sensitivity or utility of these other reports within the context of CS diversion detection cannot be concluded from this study.

While the EHR report had the highest PPV to detect potential diverters, there are multiple inherent limitations and barriers to the utility of this report for realistic CS diversion detection. First, the report does not directly compare peers who work similar shifts with similar patient populations. Furthermore, the logic behind the report may report dispenses as unreconciled when no true discrepancy exists. Full descriptions of logic limitations are available in Table 6.

Conclusion

Safe patient care relies on health systems’ abilities to protect patients from iatrogenic harms such as undetected internal CS diversion. The current state of CS diversion detection will need to advance as technology and complexity of patient care continue to progress. Unfortunately, the literature has not identified the most sensitive and efficient method of detecting CS diversion, but the results of this study suggest that a report from the EHR to detect unreconciled dispenses may offer a reasonable solution to other academic institutions such as ours. While no report may ever perfectly detect CS diversion, future research may be able to prospectively

compare CS diversion detection methods over extended periods of time, validate reports that integrate dispensing and charting software, or provide anecdotal results from institution-built diversion detection software to determine national benchmarks for optimizing diversion detection resources to improve patient safety.

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References

1. Center for Behavioral Health Statistics and Quality. Behavioral health trends in the United States: results from the 2014 National Survey on Drug Use and Health. Rockville, MD. <http://www.samhsa.gov/data/>. Published 2015. Accessed November 27, 2018.

2. Malatestinic WN, Jorgenson JA. Dealing with substance abuse in the workplace. *Hosp Pharm*. 1991;26:102-105.
3. Dunn D. Substance abuse among nurses: defining the issue. *AORN J*. 2005;82(4):573-582.
4. Drug Enforcement Administration. Drug theft prevention. https://www.deadiversion.usdoj.gov/mtgs/pharm_awareness/conf_2014/feb_2014/gallager.pdf. Published February 8 & 9, 2014. Accessed September 8, 2016.
5. Counts J. A nurse's death, a doctor's overdose and 16,000 missing pills. *MLive.com*. October 26, 2014. https://www.mlive.com/news/ann-arbor/2014/10/drug_thefts_at_u-m_hospital_a.html. Accessed April 3, 2019.
6. Nicholson K. Former UCH nurse suspected of stealing, swapping out drugs. *The Denver Post*. November 4, 2016. <https://www.denverpost.com/2016/11/04/former-cu-hospital-nurse-suspected-of-stealing-swapping-out-drugs/>. Accessed November 4, 2016.
7. Miller A. Years of large-scale drug thefts reported at an Emory hospital. *Georg Health News*. March 8, 2016. <http://www.georgiahealthnews.com/2016/03/years-large-scale-drug-thefts-reported-emory-hospital/>. Accessed October 10, 2018.
8. Tanga HY. Nurse drug diversion and nursing leader's responsibilities: legal, regulatory, ethical, humanistic, and practical considerations. *JONAS Healthc Law Ethics Regul*. 2011;13(1):13-16.
9. Fleming K, Boyle D, Lent WJB, Carpenter J, Linck C. A novel approach to monitoring the diversion of controlled substances: the role of the pharmacy compliance officer. *Hosp Pharm*. 2007;42(3):200-209. doi:10.1310/hpj4203-200.
10. Inciardi JA, Surratt HL, Kurtz SP, Burke JJ. The diversion of prescription drugs by health care workers in Cincinnati, Ohio. *Subst Use Misuse*. 2006;41(2):255-264. doi:10.1080/10826080500391829.
11. Trinkoff AM, Storr CL, Wall MP. Prescription-type drug misuse and workplace access among nurses. *J Addict Dis*. 2008;18(1):9-17. doi:10.1300/J069v18n01_02.
12. Schaefer MK, Perz JF. Outbreaks of infections associated with drug diversion by US health care personnel. *Mayo Clin Proc*. 2014;89(7):878-887. doi:10.1016/j.mayocp.2014.04.007.
13. Foltz-Gray D. Just say no: strict policies can help supervisors keep on-the-job drug abuse in check. *Contemp Longterm Care*. 1996;19(6):56-860.
14. Hastings J. Addiction: a nurse's story. *Am J Nurs*. 2007;107(8):75-79.
15. Griffith J. Substance abuse disorders in nurses. *Nurs Forum*. 1999;34(4):19-28.
16. Dunn D. Substance abuse among nurses: intercession and intervention. *AORN J*. 2005;82(5):777-782.
17. Trossman S. Nurses' addictions: finding alternatives to discipline. *Am J Nurs*. 2003;103(9):27-28.
18. O'Neal BC. Controlled substance diversion detection: go the extra mile. *Hosp Pharm*. 2004;39(9):868-870.
19. O'Neal B, Bass K, Siegel J. Prevention of controlled substance diversion: scope, strategy, and tactics: diversion in the operating room. *Hosp Pharm*. 2007;42(4):359-367.
20. Siegel J, O'Neal B. Prevention of controlled substance diversion: scope, strategy, and tactics: Code N: multidisciplinary approach to proactive drug diversion prevention. *Hosp Pharm*. 2007;42(3):244-248.
21. O'Neal B, Siegel J. Prevention of controlled substance diversion: scope, strategy, and tactics: diversion in the pharmacy. *Hosp Pharm*. 2007;42(2):145-148.
22. O'Neal B, Siegel J. Prevention of controlled substance diversion: scope, strategy, and tactics: use of diversion detection software. *Hosp Pharm*. 2007;42(6):564-571.
23. Siegel J, Wierwille C, O'Neal B. Prevention of controlled substance diversion: scope, strategy, and tactics: the investigative process. *Hosp Pharm*. 2007;42(5):466-469.
24. Siegel J, O'Neal B. Prevention of controlled substance diversion: scope, strategy, and tactics: Code N: the intervention process. *Hosp Pharm*. 2007;42(7):653-656.
25. Carlson GM, Castile JA, Janousek JP. Guidelines for the prevention and detection of controlled substance diversion. *Hosp Pharm*. 1988;23(12):1057-1059.
26. Brummond PW, Chen DF, Churchill WW, et al. ASHP guidelines on preventing diversion of controlled substances. *Am J Health Syst Pharm*. 2017;74(5):325-348. doi:10.2146/ajhp160919.
27. McClure SR, O'Neal BC, Grauer D, Couldry RJ, King AR. Compliance with recommendations for prevention and detection of controlled-substance diversion in hospitals. *Am J Health Syst Pharm*. 2011;68(8):689-694. doi:10.2146/ajhp100212.
28. Berge KH, Dillon KR, Sikkink KM, Taylor TK, Lanier WL. Diversion of drugs within health care facilities, a multiple-victim crime: patterns of diversion, scope, consequences, detection, and prevention. *Mayo Clin Proc*. 2012;87(7):674-682. doi:10.1016/j.mayocp.2012.03.013.
29. The Joint Commission. Medication management: countering drug diversion. Vol. 13. http://www.jcrinc.com/assets/1/7/Drug_Adversion_The_Source.pdf. Published 2013. Accessed July 11, 2017.
30. Drug Abuse Control and Prevention, 21 U.S.C. Chapter 13. Sect. 801-971 (2015).
31. Kahler S, Kelm M, Lay R, Meleis L, Rodriguez D, Wheeler T. *Controlled Substance Diversion Detection Technologies and Applications: Environmental Scanning and Review*. Vizient, Inc. Irving, TX. 2016.
32. Genaro BA, Replogle JH. Supporting rehabilitation for the impaired healthcare employee: a case study. *Hosp Pharm*. 1989;24(8):601-603.