Development and implementation of autoverification standardization in the adult and pediatric emergency department

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Purpose: This project utilized the guidance of the American Society of Health-System Pharmacists (ASHP) autoverification toolkit to refine our health system's approach to autoverification and contribute to the literature regarding appropriate use of autoverification technology in a pediatric and adult emergency department (ED).

Summary: This single-center quality improvement study was conducted in an academic medical center ED that has 33 pediatric beds and 77 adult beds. A team consisting of clinical pharmacy specialists in emergency medicine, medication safety and informatics personnel, operational managers, and pharmacy leadership was identified to develop and implement autoverification best practices in the ED utilizing practices outlined within the ASHP autoverification toolkit. Before implementation of best practices, defined as the "preoptimization" state, autoverification took place for most medications available in the automated dispensing cabinets (ADCs). By anchoring the autoverification rule on ADC inventory, it was challenging to optimize both inventory practices and autoverification best practices. This project focused on redesigning the autoverification rules in the electronic health record, defined as the "postoptimization" state. In the postoptimization state, autoverification in the ED was updated to better align with regulatory standards. Autoverification metrics and the percentage of orders that autoverified vs required pharmacist verification were analyzed in the preoptimization and postoptimization states.

Conclusion: This project utilized the guidance from ASHP's autoverification toolkit to refine our health system's approach to autoverification. High-alert medications (eg, insulin, extended-release opioids, digoxin) were taken off autoverification following implementation. Optimization of autoverification rules allows more orders for high-alert medications to be reviewed by a pharmacist.

Keywords: autoverification, emergency medicine, medication management standards, medication safety, medication verification, pharmacy informatics

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Autoverification expedites the medication process by eliminating pharmacist review of medication orders. When a medication order is placed and simultaneously autoverified, a pharmacist does not review the medication order before removal of the medication from the automated dispensing cabinet (ADC) for patient administration. While this can expedite patient care and increase efficiency, bypassing pharmacist review of medication orders increases a patient's risk of adverse events through potential medication errors.[1] Pharmacists review medication orders before medication administration to ensure appropriate indication, dosing, timing, and route of administration while assessing for allergies or potential drug-drug interactions. Thus, omitting

pharmacist review of medication orders can lead to adverse events.

Regulatory bodies such as the Centers for Medicare and Medicaid Services (CMS) and The Joint Commission (TJC) emphasize the importance of pharmacist review of medication orders.[2,3] CMS states that "All medication orders (except in emergency situations) should be reviewed for appropriateness by a pharmacist before the first dose is dispensed." CMS also requires hospitals to have a process in place for reviewing medication orders to ensure safe and timely dispensing of medications.[2] TJC standard MM.05.01.01 requires pharmacists to review all medication orders except in 2 scenarios: (1) "if waiting for pharmacy review would create a delay that could result in patient harm" or (2) "a licensed independent practitioner (LIP) controls the ordering, preparation, and administration of a medication, such as in an ED [emergency department]."[3] TJC also states that organizations should limit autoverification technology to urgent scenarios and this should not be a standard of practice for convenience.[3]

Differing interpretations of CMS and TJC standards regarding autoverification technology exist due to the limited guidance by these governing bodies on autoverification implementation in health systems. Institutions may interpret TJC standard MM.05.01.01 differently, especially given the variable emergency medicine pharmacist (EMP) responsibilities surrounding order verification. For example, an institution might interpret this standard as exempting pharmacists from reviewing orders for "low-risk, high-volume" medications before patient administration to decrease verification volume while maintaining patient safety.[4] In contrast, our institution interprets the TJC standard as indicating that medications should be autoverified only if they meet the 2 criteria mentioned previously, where a delay in verification may cause harm to the patient or an LIP is present for the entire medication process. While many patients who present to the ED are high acuity in nature (eg, requiring advanced cardiac life support [ACLS] or rapid sequence intubation [RSI] or having acute agitation), many patients also present to the ED with lower acuities and receive high-risk medications such as insulin and long-acting opioids where pharmacist review of orders leads to optimized care. The limited literature regarding the appropriate use of autoverification technology within health systems makes implementing standardized autoverification practices challenging.

KEY POINTS

- Multidisciplinary collaboration is necessary to incorporate autoverification processes in the emergency department.
- Following guidance in the ASHP autoverification toolkit, autoverification rules in the pediatric and adult emergency departments were redesigned to align with best practices from The Joint Commission and Centers for Medicare and Medicaid Services.
- Optimization of autoverification rules allowed for more medication orders to be reviewed by a pharmacist, which may enhance patient safety.

Background

Pharmacists have been increasingly incorporated into the ED setting for a variety of reasons, including a desire to reduce medication errors via reviewing medication orders. The American Society of Health-System Pharmacists (ASHP) created a guideline outlining the role of the EMP, stressing the importance of pharmacists maintaining an environment conducive to medication and patient safety, due to the high-risk nature of the ED, which creates ample opportunities for medication errors and adverse events.[5] One study found that the rate of medication errors in the ED was significantly reduced by 66.6% when an EMP was present.[5] A systematic review examining the impact of interventions provided by pharmacists found that EMPs reduced the number of medication errors by a mean of 0.33 per patient.[6] These studies show the benefit of having an EMP review medication orders.[5,6]

Previous studies have stressed the significance of EMP review of medication orders to reduce medication errors.[5,6] However, health systems will continue to utilize autoverification technology to increase patient throughput and efficiency during emergent situations while balancing patient safety. In the ED, medications need to be administered quickly in specific situations, such as to increase throughput to counteract crowding and long durations of boarding.[7] Thus, organizations may opt to utilize autoverification technology to bypass the pharmacist verification step and expedite medication delivery to patients, with medication orders automatically verified in the electronic health record (EHR). Given the increasing use of artificial intelligence (AI) in healthcare systems, the ASHP Forecast provides insight on emerging issues and trends such as how AI may replace pharmacist order review and verification of medication orders.[8] Utilizing AI technology for order verification allows pharmacists more time for direct patient care actions while also relieving the strain caused by current pharmacist shortages.[8] Computer software for medication order entry can allow for autoverification if the medication order meets certain predefined criteria. If the medication order falls outside the set parameters, it is sent to the pharmacist verification queue to be reviewed and verified by a pharmacist before the medication is administered to the patient. In a recent survey, 62.2% of hospitals reported that their health systems utilize autoverification systems, and use has been increasing since 2016.[9] Therefore, the ASHP Section of Pharmacy Informatics and the Section Advisory Group on Medication Safety of the ASHP Section of Inpatient Care

Practitioners collaborated on a joint task force to develop a toolkit for implementation of autoverification.[9] With the increasing use of autoverification technology, the ASHP toolkit provides guidance for institutions to implement autoverification technology without compromising patient safety.

Analysis

This project aimed to utilize the guidance of ASHP's autoverification toolkit to refine our health system's approach to autoverification and add to the limited literature regarding appropriate use of autoverification technology in a pediatric and adult ED.

Gaps identified. ***Development of autoverification.*** To assess our institution's ED autoverification practices, a team consisting of clinical pharmacy specialists in emergency medicine, medication safety and informatics personnel, operational managers, and pharmacy leadership was tasked with developing and implementing autoverification best practices in the adult and pediatric EDs. The existing autoverification rules allowed orders for the majority of medications stocked in the ED ADCs to be autoverified. The existing ordering process was defined as the "preoptimization" state. The rules following redesign were defined as the "postoptimization" state.

The framework for implementing these changes to autoverification was based on the checklist from the ASHP autoverification toolkit.[9] This quality improvement study was conducted in a 1,000-bed academic level 1 pediatric and adult trauma center, pediatric accredited burn center, and comprehensive stroke center with 33 pediatric ED beds and 77 adult ED beds. From Monday through Friday, the institution has 24-hour adult ED pharmacist coverage and pediatric ED pharmacist coverage from 7:30 AM to 4:00 PM. In the adult ED, 82% of medications dispensed come from an ADC. Autoverification metrics were analyzed, including the number of medication orders that autoverified and the number that required pharmacist verification, within a 30-day period before vs after optimization. This study was exempt from institutional review board review as the project was considered quality improvement and did not meet the definition of research in 45 CFR 46.102(d).

Checklist for implementation. ***Review of federal and state regulations for requirements for verification of medication orders.*** The first task accomplished within the ASHP autoverification checklist for implementation included reviewing federal and state regulations regarding requirements for verification of medication orders. Two governing bodies with guidance on autoverification best practices were identified: CMS and TJC.[2,3] Additionally, ASHP policy positions regarding autoverification of medication orders encourage organizations to "develop policies, procedures, and guidelines to determine which care settings, medications, and patient populations are appropriate candidates for autoverification of select medication orders in order to support the implementation of autoverification models for those circumstances" and "advocate for regulations and accreditation standards that permit autoverification of select medication orders in circumstances in which it has proven safe."[10]

Review of current literature related to autoverification. Current literature pertaining to optimization of autoverification in the ED was identified. A descriptive study described a process to design, implement, and measure the safety of autoverifying orders for low-risk, high-volume medication in the ED.[4] In this study, a total of 7,433 medication orders were reviewed, of which 3,057 orders (41%) were classified as being for low-risk, high-volume medications eligible for autoverification. EMPs would have verified 97.5% of these orders without changes, and only 0.07% were identified as inappropriate for autoverification. The authors concluded that using a risk stratification tool for potentially autoverifiable medication orders can provide a large decrease in verification volume without compromising patient safety.[4]

A retrospective study conducted in an academic pediatric ED aimed to identify and evaluate dose errors on medication orders that bypassed pharmacist verification.[11] The study found that, of the 46,185 medication orders placed, 32,928 (71%) bypassed pharmacist review. Altogether, 676 (2%) of the autoverified orders were outside standard dose ranges, which corresponds to a relatively low percentage but not insignificant number of dosage errors. The dosing errors reported in the study included errors ranging from 20-fold underdosing to 7-fold overdosing for intranasal midazolam as well as ibuprofen doses exceeding maximum adult doses. The medications with the highest error rates were ibuprofen, benzodiazepines, and corticosteroids. Although the overall percentage of orders with an error was low (2%), a high number of dosing errors occurred; any medication errors in a high-acuity setting such as the ED can lead to significant morbidity and even mortality.[11]

Another descriptive study conducted in an academic medical center evaluated prespecified high-risk medications (eg, antibiotics, electrolytes, fluids, insulin, sedatives, and antiepileptics) before and after removal of autoverification and addition of pharmacist review.[12] A total of 726 medication orders were evaluated (404 medication orders in the preintervention group and 322 medication orders in the postintervention group). The authors found that, with removal of autoverification for the prespecified high-risk ED medications, pharmacists verified 2,100 more medication orders with fewer medication errors (63 vs 53 medication orders).[12]

Define scope for autoverification. At our institution, a standardized process was recently created to manage autoverification use and ensure compliance with regulatory standards set by TJC and CMS in the inpatient setting. Our institution currently utilizes autoverification rules as stated in the pharmacy department's policy on autoverification.

This policy contains an algorithm to guide autoverification (Figure 1). This project utilized this algorithm to redesign autoverification in the adult and pediatric ED. The autoverification rules in the ED EHR before optimization are illustrated in Figure 2. In the preoptimization state, medication orders in the ED were eligible for autoverification if the medication was located in an ED ADC, if the user had security clearance permitting autoverification in the ED, and if the order did not trigger any high-severity alerts. High-severity alerts included alerts about medication allergies, drug-drug interactions, and duplicate orders. However, if an unidentified patient (eg, a trauma patient) presented to the ED, these high-severity alerts would not be available given that the patient's allergies would not be documented and the medication order would autoverify. Orders for select medications were designated not to autoverify in the ED. However, these select medications did not have a formalized process for continued assessment and optimization.

Engage appropriate stakeholders, draft policy changes, and seek appropriate committee approval for policy changes. Stakeholders were identified to review medications that were stored in the ED ADCs. Clinical pharmacy specialists in emergency medicine, medication safety and informatics personnel, operational managers, and pharmacy

Figure 1. Overview of the policy on autoverification of medication orders (MM049). DDI indicates drug-drug interaction; ED, emergency department; LIP, licensed independent practitioner.

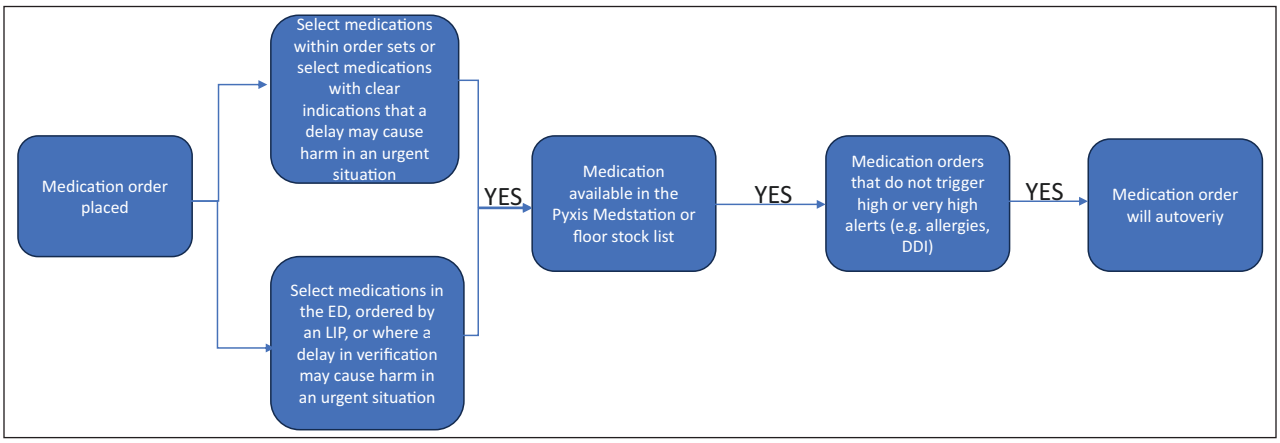
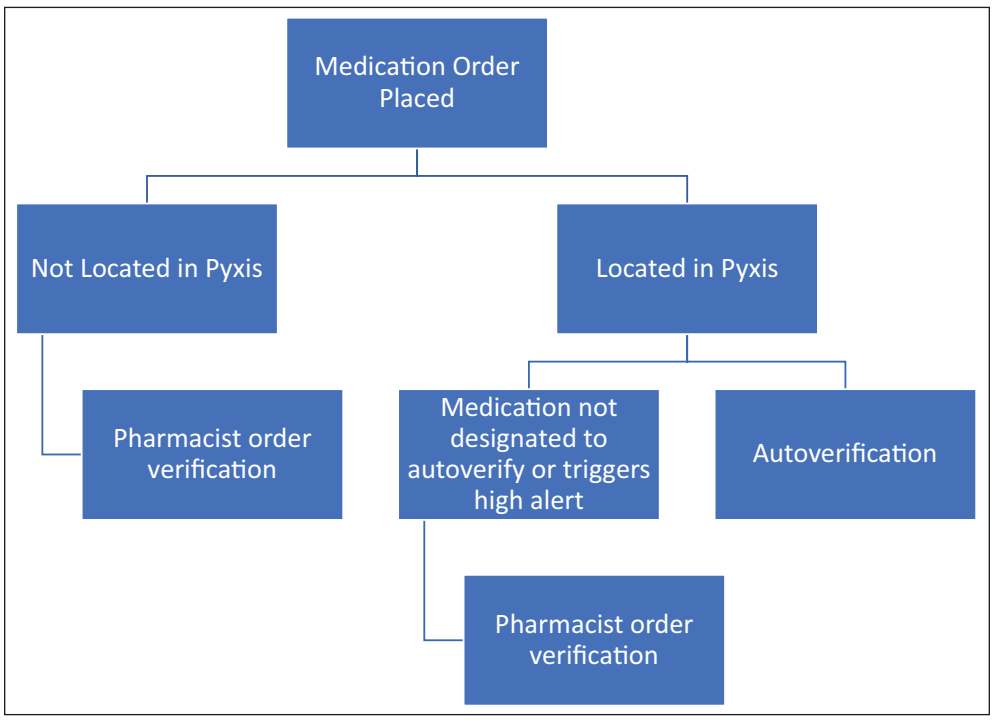


Figure 2. Preoptimization autoverification logic in the emergency department electronic health record.



leadership were identified to review medications eligible for autoverification. The process of selecting medications for which orders would autoverify included reviewing every individual medication located in the ADCs and determining whether it met TJC and/or CMS criteria for autoverification. Following optimization, the autoverification rules for the ED were proposed to relevant committees at our institution such as the ED comprehensive unit-based safety program and the ED medication safety committee. Interdisciplinary ED leadership was included in reviewing the final list of medications eligible for autoverification following optimization of the autoverification rules. The autoverification rules following optimization are illustrated in Figure 3.

Evaluate implementation approach (ie, pilot vs full-scale implementation). The list of medications eligible for autoverification after optimization was given to the pharmacy informatics team for incorporation into the EHR. The rules were tested in the background of production to estimate the number of medication orders that would be autoverified, the number of medication orders per day requiring pharmacist verification, and the percentage of medication orders autoverified after optimization of the autoverification rules. These postoptimization autoverification metrics are illustrated in Table 1 and Table 2 for the adult and pediatric EDs, respectively.

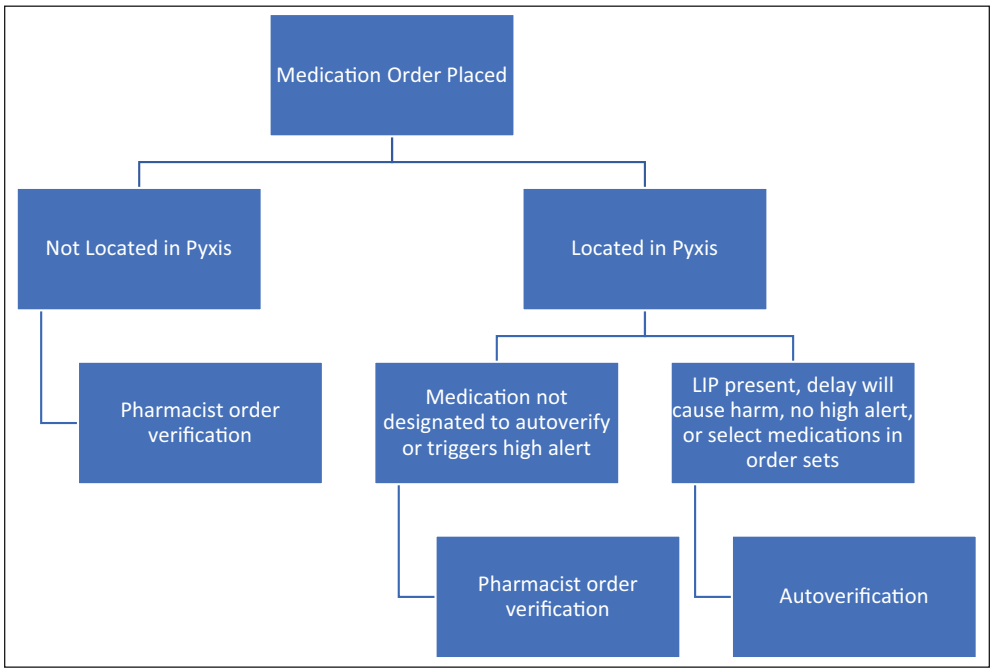
Develop a process for continued assessment and optimization/new requests for autoverification and develop an education plan for all appropriate stakeholders. Under the autoverification of medication orders policy (MM049), new requests for autoverification are handled as follows. Requests for modification of autoverification criteria are made electronically using the medication autoverification request form. Requests are initially reviewed by the pharmacy informatics design team and approved by the clinical practice counsel. Any approved changes to the autoverification criteria follow the standard EHR change request process for implementation.

Incorporate autoverification as a consideration into existing processes for new formulary additions or new clinical services. In the preoptimization state, medication orders for any medication added to the ED ADCs were automatically autoverified and bypassed pharmacist review. In the postoptimization state, this rule is reversed such that medications must be designated to autoverify and thus orders do not automatically bypass pharmacist review when a medication is added to the ED ADCs.

Resolution

In the postoptimization state, autoverification in the adult and pediatric EDs was updated to better align with regulatory standards with the key principle of having medication orders autoverify if the medication was located within an ED Pyxis MedStation and (1) a delay would cause harm to a patient or (2) an LIP controlled the ordering, preparation, and administration of the medication. Medications for which a delay would cause harm include those used in ACLS, pediatric advanced life support, resuscitation, trauma, electrolyte management, sepsis, RSI, acute agitation, alcohol withdrawal, and other emergent needs as identified by stakeholders. Medications for which an independent practitioner controls the medication process include

Figure 3. Postoptimization autoverification logic in the emergency department electronic health record. LIP indicates licensed independent practitioner.



medications utilized in RSI and post-intubation sedation, ophthalmic agents, local and topical anesthetics, and procedural sedation as identified by stakeholders. Examples of medications that fall into these categories are depicted in Box 1.

After reviewing all medications located in the ADCs within the ED, certain high-risk medications were selected to never autoverify after implementation, including extended-release opioids, digoxin, and insulin, as determined by the stakeholder group. Following TJC and CMS guidance statements, maintenance medications were intended not to autoverify as these medications are not utilized in the ED in an emergent manner. Additionally, select medications reviewed by the stakeholder group were designated to autoverify only if the medication was ordered utilizing an order set or preference list (eg, aztreonam is autoverified if ordered through the sepsis order set vs à la carte). Example medications that were selected to be reviewed by a pharmacist are illustrated in Box 2.

After autoverification rule optimization in the adult ED, metrics were analyzed for a 30-day period before vs after optimization (July 2022 vs July 2023). The number of medication orders autoverified within a 30-day period decreased from 15,398 to 13,875. In the pre- vs postoptimization state of autoverification, the percentage of orders that autoverified decreased (75% vs 65%) and the number of medication orders requiring pharmacist verification increased from 5,216 to 7,526 (Table 1). After autoverification rule optimization in the pediatric ED, the number of medication orders autoverified within a 30-day period increased from 2,358 to 2,383. In the pre- vs postoptimization state of autoverification, the percentage of orders that autoverified decreased (49% vs 46%) and the number of medication orders requiring pharmacist verification increased from 2,499 to 2,773 (Table 2).

Box 1. Medications/Classes of Medications That Autoverify After Optimization of the Autoverification Rules in the Electronic Health Record

Delay will cause harm	LIP present
Intravenous antibiotics	Topical and local anesthetics
ACLS medications (eg, amiodarone, calcium)	Paralytics (eg, rocuronium, succinylcholine)
Vasopressors	Ophthalmic/otic agents
Analgesics	Post-intubation sedation agents
Intravenous steroids	Tenecteplase/alteplase
Inhalation agents	Antiplatelet loads
Psychiatric agents	Adenosine

Abbreviations: ACLS, advanced cardiac life support; LIP, licensed independent practitioner.

Box 2. Select Medications/Medication Classes That Do Not Autoverify After Optimization of the Autoverification Rules in the Electronic Health Record

Medication/class
Oral antibiotics
Oral blood pressure medications
Oral home maintenance medications
Insulin
Digoxin
Extended-release opioids
PED: certain high-risk medications (benzodiazepines, antibiotics, opioids, insulin, ketamine)

Abbreviation: PED, pediatric emergency department.

Discussion

This project utilized the guidance of ASHP's autoverification toolkit to refine our health system's approach to autoverification and contribute to the limited literature regarding appropriate use of autoverification technology in both the pediatric and adult ED. The process for updating autoverification rules in this study utilized TJC and CMS verbiage pertaining to autoverification of medication orders without room for interpretation and demonstrates a process that other EDs can follow to redesign their autoverification rules. This study was unique in developing and implementing autoverification rules utilizing the ASHP toolkit.

In a separate but similar study, the authors utilized a different approach in the implementation of autoverification rules within an ED.[4] The study evaluated a process for risk stratification that allowed medication orders to autoverify if they were considered to be for low-risk or high-volume medications. The study found that 41% of medications could be autoverified without compromising patient safety, which would theoretically increase the availability of EMPs for other needs in the ED.[4] In contrast, our study utilized the opposite approach of selecting medications to be autoverified, including only those for which a delay would potentially cause patient harm or an LIP was controlling the medication process—the 2 major guidelines set forth by TJC and CMS.[2,3] Almost by definition, the "low-risk" medications from the other study do not meet these guideline criteria.

Table 1. Adult Autoverification Metrics Before and After Optimization of Autoverification Rules in the Electronic Health Record

Metric	Before optimization (July 2022)	After optimization (July 2023)
Medication orders autoverified, No.	15,398	13,875
Medication orders requiring pharmacist verification, No.	5,216	7,526
Orders autoverified, %	75	65

Table 2. Pediatric Autoverification Metrics Before and After Optimization of Autoverification Rules in the Electronic Health Record

Metric	Before optimization (July 2022)	After optimization (July 2023)
Medications orders autoverified, No.	2,358	2,383
Medication orders requiring pharmacist verification, No.	2,499	2,773
Orders autoverified, %	49	46

Multidisciplinary collaboration was necessary to review orders for medications located in the ADCs. Clinical judgement and expert opinion were needed to determine which medications would align with the principles of a delay causing harm or an LIP being present for the entire medication process. Clinical pharmacist, physician, and nursing insight was taken into account to determine which medications should be selected for autoverification to align with these principles. In the preoptimization state, any medications added to the ADCs would automatically autoverify. However, after optimization, this rule was flipped such that medications added to the ADCs do not autoverify unless specified to do so. This model allows for easier incorporation of new medications in the ADCs that are commonly administered in the ED while maintaining patient safety. Additionally, optimization of autoverification rules allows more medication orders to be reviewed by a pharmacist, with fewer medication orders autoverified, which allows for more interventions to enhance patient safety. High-alert medications (eg, insulin, extended-release opioids, and digoxin) were taken off autoverification after implementation of the new rules, which could prevent medication errors from occurring. In contrast, in the pediatric ED, the percentage of medication orders that autoverified remained relatively unchanged from before to after optimization of the autoverification rules (49% vs 46%). This finding is consistent with the more stringent autoverification practices established in the pediatric ED before optimization. The adult and pediatric EDs have different pharmacist staffing coverage with different verification responsibilities. The pharmacists in the pediatric ED verifies all medication orders in the ED, whereas the primary responsibility of pharmacists in the adult ED is prospective patient chart review (ie, not verifying medication orders). The difference in pharmacist verification responsibilities meant that the pharmacist in the pediatric ED reviewed more medication orders before optimization; the more stringent autoverification rules are evident in the relatively unchanged autoverification metrics in the pediatric ED following optimization.

There were several limitations to this study. This study was performed in a single academic medical center, and the findings may therefore not be generalizable to community EDs. The inherently subjective nature of stakeholder review in selecting medications that should autoverify also represents a limitation to this study. Safety metrics were not analyzed after implementation of the optimized autoverification rules, warranting further research on the impact of autoverification on patient outcomes in future studies. Another limitation may be that the working hours of the EMP may not be generalizable to other EDs. These limitations may limit the external validity of the results.

Conclusion

This project utilized the guidance of ASHP's autoverification toolkit to refine our health system's approach to autoverification and add to the limited literature regarding appropriate use of autoverification technology in a pediatric and adult ED. Optimization of autoverification rules allows more orders for high-alert medications (eg, insulin, extended-release opioids, and digoxin) to be reviewed by a pharmacist, which may prevent medication errors from occurring. As autoverification technology continues to evolve, it is important to develop a formalized process for autoverification within a health system.

Data availability

The data underlying this article are available in the article.

Disclosures

The authors have declared no potential conflicts of interest.

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