Brief Report

Improvement in Pharmacy Student Responses to Medication-Related Problems with and without Clinical Decision Support Alerts

Jeremy S. Stultz⁎, Chasity M. Shelton, Tyler M. Kiles, James S. Wheeler

⁎ Corresponding author.
E-mail address: jstultz2@uthsc.edu (J.S. Stultz).

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ABSTRACT

Objective: To assess pharmacy student responses to medication problems with and without clinical decision support (CDS) alerts during simulated order verification.

Methods: Three classes of students completed an order verification simulation. The simulation randomized students to a different series of 10 orders with varying CDS alert frequency. Two of the orders contained medication-related problems. The appropriateness of the students' interventions and responses to the CDS alerts were evaluated. In the following semester for 2 classes, 2 similar simulations were completed. All 3 simulations contained 1 problem with and 1 without an alert.

Results: During the first simulation, 384 students reviewed an order with a problem and an alert. Students exposed to prior inappropriate alerts within the simulation had less appropriate responses (66% vs 75%). Of 321 students who viewed a second order with a problem, those reviewing an order lacking an alert recommended an appropriate change less often (45% vs 87%). Among 351 students completing the second simulation, those who participated in the first simulation appropriately responded to the alert for a problem more often than those who only received a didactic debrief (95% vs 87%). Among those completing all 3 simulations, appropriate responses increased between simulations for problems with (n = 238, 72–95–93%) and without alerts (n = 49, 53–71–90%).

Conclusions: Some pharmacy students displayed baseline alert fatigue and overreliance on CDS alerts for medication problem detection during order verification simulations. Exposure to the simulations improved CDS alert response appropriateness and detection of problems.

1. Introduction

A drug utilization review (DUR) is a mandated process where pharmacists review and assess medication orders for problems (eg, drug allergies, drug dosage, and drug interactions).1 This is an essential process in medication order fulfillment, which is considered an entrustable professional activity (EPA) pharmacy students should be able to independently complete upon graduation.2 Competence in this EPA is related to numerous Center for the Advancement of Pharmacy Education outcomes, including medication use systems management, problem-solving, problem identification, and plan development.3

Clinical decision support (CDS) is a widespread component of pharmacy practice.4–6 A common form of CDS is the presentation of alerts to pharmacists during medication order verification. A CDS alert can be appropriate (identifying an actionable medication problem) or inappropriate (order is without a problem). Orders may appropriately lack an alert (order is without a problem) or inappropriately lack an alert (order contains a problem). Pharmacists can usually verify orders with (after overriding the alert) and without alerts, and this could be inappropriate if there is a medication problem with the order.

Implementation of CDS has reduced errors and adverse drug events, but 80–90% of CDS alerts should be overridden and health information technologies are only estimated to detect 50% of errors.8–14 Excessive inappropriate alerting could lead to “alert fatigue,” which we are defining as a situation where the pharmacist may override a CDS alert for an actionable problem without sufficiently analyzing the alert because they are frequently overriding inappropriate alerts that do not identify an actionable problem.15 Additionally, pharmacists may display “overreliance” on CDS. This we are defining as a situation where the pharmacist does not sufficiently analyze an order for a problem because
of the belief that a CDS system would alert them if there was a problem. Pharmacy students must be educated on possible limitations of CDS and should be trained and assessed on response appropriateness to CDS alerts for potential medication problems.10

We aimed to assess baseline pharmacy student responses to medication problems with and without CDS alerts during simulated order verification. Then, we aimed to determine if exposure to simulations incorporating CDS improved student response appropriateness to medication problems with and without CDS alerts.

2. Methods

This was an Institutional Review Board approved, multi-year, randomized, and repeated order verification simulation that took place between 2018 and 2020 at the University of Tennessee Health Science Center College of Pharmacy. The simulation series occurred in 2 required courses, 1 focused on medication safety and digital health and a second one that assesses competency in skills required for pharmaceutical care. The simulations were created using the Question Pro Survey Software (QuestionPro Inc., Seattle, WA). A brief didactic introduction to the concept of CDS, CDS capabilities for detection of problems, types of alerts and responses, and process for the simulated order verification was given by the same faculty member before the first and second simulations.

Fig. 1 and the following paragraphs summarize the simulations. In 2018, the first simulation occurred in the second professional year (P2) Fall semester, although it was moved to the first professional year Spring semester for 2019–2020 because of curricular changes. In 2019–2020, the first simulation was followed by 2 additional simulations in the P2 Fall semester with the third simulation being part of an objective structured clinical examination.

The simulations included case vignettes in which a medication profile and brief medical history were provided along with at least 1 new order (including drug name, dose, route, frequency, and duration). Each vignette contained a CDS alert section that either said “no alerts occurred” or gave a description of a CDS alert for a possible problem. The possible problems and alerts were related to drug interactions, dosing, duplicate therapies, and drug allergies. The problem without an alert in each simulation was a renal dosage adjustment.

After presentation of the vignette, students could select a response, including verifying the order or making a change. Free text boxes were used and students were required to provide rationales for overriding an alert and to describe the recommended changes. Students were unable to go back to prior orders once a response was submitted. The randomization described in Fig. 1 for the first simulation was done by the survey system. For simulation 1, the orders containing the 2 problems were the same for each student and occurred at the same order number. Partially completed simulations (eg, 7 of 10 orders) were only included for outcomes assessed by the completed orders. Students were able to use available electronic drug database references and could repeat the simulations if desired after the class session for educational purposes.

The didactic debrief sessions were provided by the same faculty member each year. Approximately 30% of each didactic debrief involved the faculty member describing the 2 medication problems in the simulation and aggregate class performance on the simulation. Additionally, approximately 70% of each didactic debrief was a traditional lecture summarizing available CDS functionalities, effectiveness and limitations of CDS systems, and the potential for alert fatigue and overreliance on CDS among health care practitioners.

2.1. Statistical Analysis

From the first simulation, the first student response was categorized based on the presence of inappropriate alerts before the first problem with a CDS alert and separately by the presence of an alert for the second problem. Because participation in the first simulation and attendance at the first didactic debrief (done at a separate time) varied, 3 prior student CDS exposure categories were created for the second simulation: students who participated in the first simulation and debrief, students who only attended the didactic debrief, and those who did not receive CDS related instruction in either format. Students who reviewed a problematic order with and without a CDS alert across all 3
simulations were also identified for paired comparisons.

The primary outcome was an appropriate response to the orders with a medication problem. An appropriate response was defined as recommending to change the order and providing an appropriate change (based on free text responses). This definition is from a framework by McCoy and colleagues for alert categorization and response appropriateness. For comparisons of appropriate responses between independent groups, the chi-squared test was used. The Cochran’s Q test followed by posthoc Dunn analysis assessed for differences between paired groups. Significance was set a priori at $p < .05$.

3. Results

Across 3 years, 384 students (69% of possible students) participated in the first activity and responded to the first problem with a CDS alert. Of those, 321 students had time to complete the entire simulation, including the second problem. Students who reviewed orders with alerts that were inappropriate (did not necessitate intervention) before the first order with a problem and an alert (that should prompt intervention) were less likely ($p = .049$) to appropriately respond to the alert for a problem. Students viewing a CDS alert for the second problem were more likely ($p < .001$) to make an appropriate recommendation for that problem compared to those not viewing a CDS alert for the same problem (Fig. 2).

Across 2 years, 376 students completed the second simulation (98% of possible students) of which 238 had completed the first simulation, 113 only attended the didactic debrief for the first simulation, and 25 did not participate in the first simulation or attend the debrief. Students who reviewed an order with a medication-related problem and CDS alert on simulation 1 ($n = 238$) had significantly higher appropriate responses to the CDS alert for an order with a medication-related problem on simulation 2 compared with those who did not (95% vs 86%, $p = .005$). The response appropriateness among those reviewing a problem with a CDS alert on simulation 1 ($n = 238$) remained significantly higher compared with students ($n = 113$) who only attended the didactic debrief for simulation 1 (95% vs 87%, $p = .012$). Students who were randomized to review an order with a problem lacking a CDS alert on simulation 1 ($n = 49$) did not significantly differ in response appropriateness for the problem lacking a CDS alert on simulation 2 compared with the 327 students who did not previously review an order with a problem lacking a CDS alert (71% vs 61%, respectively, $p = .18$).

Among students who viewed an appropriate alert for a problem in all 3 simulations, there was a significant increase in appropriate response between the first and second simulations (Fig. 3). Excluding students who did not view an inappropriate alert before viewing the appropriate alert in simulation 2, because of a survey rule logic issue, there remained an improvement in appropriate response from the first to second simulation (69% vs 92%, respectively, $p < .001$). Among students who reviewed problems lacking CDS alerts in all 3 simulations, there was a significant increase in appropriate responses across all simulations (Fig. 3). On the third simulation, 81% of students ($n = 384$) made appropriate recommendations for both problems, with 94% and 86% making appropriate recommendations for problems with and without a CDS alert, respectively.

4. Discussion

The findings of these educational simulations suggest that some student pharmacists have a baseline risk for alert fatigue and over-reliance on CDS to detect medication problems. Incorporating CDS, with a possible benefit to simulated CDS alert experiences, in pharmacy education is needed to prepare students for clinical practice.

Warholak and colleagues illustrated that pharmacy students are more adept at identifying medication-related problems than other professions. Previous work by Ives, Metzger, and Hincapie and colleagues regarding verification simulations have demonstrated positive student responses or increased confidence after learning activities that included order verification and CDS alerts. Minimal literature has analyzed student pharmacist responses to CDS alerts. Overriding an appropriate CDS alert increases the odds of adverse drug events 6-fold and could have legal implications if severe adverse events occur. Even in the small number of orders in these simulations, alert fatigue likely occurred in some students. These data highlight the need for pharmacy student education on how to assess and respond appropriately to CDS alerts despite system imperfections and thus be practice-ready before rotations and graduation.

Ensuring pharmacy students are prepared to detect problems without a CDS alert is an essential pharmacist skill. These data also suggest pharmacy students may rely on CDS systems to detect renal dosing medication problems lacking an alert. It is possible the students did not yet have the knowledge needed to identify the problem, but renal dosing concepts and the medications associated with the orders were covered in didactic lectures before the activities. Dosage

![Fig. 2. Student responses across 3 years to 2 orders with problems based on prior alert exposure and presence of a CDS alert. Groups compared via chi-squared test.](image-url)
adjustment based on renal function was a skill that Miranda and colleagues also focused on improving.\(^2\) The present analysis illustrated improved response appropriateness on the second simulation to an appropriate CDS alert among those participating in the first simulation vs those exposed to didactic materials alone. This validates the use of simulations for CDS educational activities, a teaching style also used by Kane-Gill and Vyas and colleagues in other skills-based educational activities.\(^23,24\) Interestingly, a significant difference was not detected for identification of a problem without an alert based on prior simulation participation. This finding could be because of a small sample size in this sub-analysis or the lack of therapeutic skill ascertainment or knowledge retention without a formal presentation as described by Gilligan and colleagues.\(^25\)

Repetitive learning using different but similar scenarios is another important educational strategy that has been used previously by Stultz and Ray and colleagues to foster the development of expert clinical reasoning vs memorization.\(^26–28\) The present analysis suggests repetitive exposures to order verification scenarios with and without CDS alerts improved detection of problems (Fig. 3). Although the last simulation was graded and potentially biased (because of more student attention to detail on a graded assignment vs an ungraded assignment), the improvements in appropriate responses were also observed between the ungraded simulations suggesting impact of the simulation itself. The orders with problems in each simulation were intentionally similar, albeit unique orders, to accurately assess a student’s ability to develop a skill vs memorizing 1 outcome.

The research presented here has some limitations. This was only performed at 1 institution and outcomes may differ at other institutions. One of the classes completed the simulations during virtual learning because of the COVID-19 pandemic, although this should not affect the findings, because the activity was completed electronically and references were allowed during all simulations. There is a possibility that difficulty in discerning order problems differed between simulations, but the use of similar types of problems minimized potential difficulty differences between simulations. Differences in difficulty would not affect findings in Fig. 2 or comparisons in simulation 2 based on participation in simulation 1. It is possible that student experiences outside of the classroom (eg, CDS and DUR exposure) differed between groups, although randomization of the groups by the system minimized the chances of this issue. The simulations occurred before advanced pharmacy practice experiences (in which DUR scenarios likely occur) and may not reflect skills of graduating students. The present simulations did not use an actual order verification system and thus do not exactly mimic scenarios in practice, but they contained the needed information to assess responses to CDS alerts.

5. Conclusion

Some pharmacy students may have alert fatigue or overreliance on CDS at baseline and thus CDS should be incorporated into pharmacy education. Simulated order verification may provide a greater impact compared with didactic instruction alone when educating students regarding CDS. Repeated exposure to order verification simulations may be needed to improve student abilities to appropriately identify medication problems with and without CDS alerts.

Declaration of Competing Interest

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References


