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TEACHERS' TOPIC

Simulated Order Verification and Medication Reconciliation during an Introductory Pharmacy Practice Experience

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Objective. To create, implement, and assess a simulated medication reconciliation and an order verification activity using hospital training software.

Design. A simulated patient with medication orders and home medications was built into existing hospital training software. Students in an institutional introductory pharmacy practice experience (IPPE) reconciled the patient's medications and determined whether or not to verify the inpatient orders based on his medical history and laboratory data. After reconciliation, students identified medication discrepancies and documented their rationale for rejecting inpatient orders.

Assessment. For a 3-year period, the majority of students agreed the simulation enhanced their learning, taught valuable clinical decision-making skills, integrated material from previous courses, and stimulated their interest in institutional pharmacy. Overall feedback from student evaluations about the IPPE also was favorable.

Conclusion. Use of existing hospital training software can affordably simulate the pharmacist's role in order verification and medication reconciliation, as well as improve clinical decision-making.

Keywords: electronic health record, simulation, introductory pharmacy practice experience, medication reconciliation, order verification

INTRODUCTION

Use of electronic health records (EHR) in the hospital setting is expanding as it increases efficiency and improves patient safety. However, pharmacy students have limited exposure to EHR prior to experiential education and are more likely to be exposed to pharmacy software through internship or technician positions in the community. These systems are different, however, from hospital-based EHRs to which students have less exposure. Another challenge of hospital-based EHR is that most hospital software systems do not allow for a preceptor double check during order verification should a student initially complete the process. However, exposure to and successful use of an EHR is essential to caring for hospitalized patients. Thus, it is ideal for students to have exposure to the software prior to advance pharmacy practice experiences (APPE).

Institutional IPPEs are an opportunity to expose students to the EHR prior to APPE, but often students' functions are limited. Therefore, instruction on how to navigate the EHR may best be provided using computer-based simulation. Standard 12 of the Accreditation Council for Pharmacy Education (ACPE) 2016 Standards stipulates that simulations mimicking "actual or realistic pharmacist-delivered patient care situations" can account for 20% of the total IPPE hours.[1]

Several reports on the use of simulation have been published in the pharmacy literature,[2-9] and many colleges and schools of pharmacy use simulation to supplement IPPEs.[10-14] Vyas and colleagues reported 29.7% of responding schools used simulation during IPPEs.[12] Standardized patients and high-fidelity manikins are also used to supplement IPPE and demonstrate improving students' knowledge.[5,7] Reports are limited on using EHR simulation in health care education,[9,15-17] and no data on EHR order verification simulation exist in the pharmacy literature. Kirwin and colleagues and Frenzel described the use of EHR in pharmacy care laboratories where students gathered data to identify medication-related problems.[9,15] The former study included medication reconciliation, but neither study included simulated order verification.

Mountain and colleagues described an EHR in a simulation laboratory and assessed nursing students' documentation skills on clinical experiences before and after the simulation.[16] Milano and colleagues reported using the EHR training domain of EPIC during third-year family medicine clerkships to assess performance on

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common tasks, including medication reconciliation and adding omitted allergies.[17] Simulated EHR activities are used in health care education to improve students' exposure to and proficiency with EHR because students' access may be limited before and during experiential education.

The first exposure to the hospital EHR for many students at Mercer University College of Pharmacy is during institutional IPPEs, which are scheduled during the first 2 weeks (80 hours) of the spring semester of the third professional year. The average class size at Mercer is approximately 150 students, and IPPE students are divided among several local hospitals. College faculty members with hospital practice sites are significantly involved in the administration of institutional IPPEs. Emory Healthcare is the largest institutional IPPE training site for Mercer students and accommodates 25-36 students annually. Institutional IPPEs at Emory Healthcare include a variety of clinical and distributional activities designed to meet the instructional objectives defined by the college.

At many of the institutional IPPE sites, students spend time shadowing inpatient pharmacists who are responsible for order entry and verification. Therefore, it is up to preceptors to explain their thought process for the evaluation and the verification of inpatient medication orders. One of the innovative activities conducted at Emory Healthcare is a computer-based simulation using the training domain of the hospital's EHR to orient students to medication reconciliation and order verification prior to their shadowing of inpatient pharmacists. This is unique because it is the same training software used by Emory Healthcare to train pharmacists, and it allows students to practice using the software without affecting patient care.

The training domain is fully operational and triggers the same clinical-decision support alerts that pharmacists receive when performing order verification. The use of an EHR simulation during institutional IPPEs is supported by Domains 2 and 3 in the updated CAPE Outcomes for 2013,[10] specifically "medication use-systems manager (Manager 2.2)" and "Problem solving (Problem solver 3.1)," and by Mercer's curricular goals for providing patient care by analyzing information and making decisions, evaluating prescription and medication orders, and demonstrating communication skills and use of informatics.

Furthermore, this short simulation exercise emphasizes Standards 1 (foundational knowledge), 2 (essentials for practice and care), and 3 (approach to practice and care) of 2016 ACPE Accreditation Standards by enhancing student opportunities to build on foundational knowledge (1.1), patient-centered care (2.1), medication-use management (2.2), and problem-solving (3.1), while meeting preAPPE curriculum requirements (Standard 12).[1]

DESIGN

Emory Healthcare uses an electronic order-processing system. Physicians enter orders using computerized physician order entry (CPOE), and the pharmacist verifies orders electronically. The orders are active for patient administration as soon as the pharmacist approves them. Students are only able to observe pharmacists verifying orders on actual patients and cannot use the software directly, as there is no mechanism for a preceptor double check of student-performed order verification. A computer-based simulation using the Cerner Millennium software (Cerner Corporation, North Kansas City, MO) training domain is used to orient students to the pharmacist's use of the EHR. The simulation exercise highlights the thought process and problem-solving that the inpatient pharmacist implements during CPOE verification and medication reconciliation. Students may observe pharmacists clicking to dismiss alerts and approving orders, but pharmacists might not verbalize their thought processes or give students a complete understanding of the alert.

This thought process is an important skill for students, and faculty members want to ensure students understand the need for a structured process when evaluating each aspect of the medication order and evaluating clinical decision support alerts. Also, depending on which pharmacist students are assigned to for their clinical experience during IPPEs, they may or may not have an opportunity to observe the pharmacist complete a medication history and perform medication reconciliation. While students receive ample training in conducting a medication history during the curriculum, few truly grasp the complexity of medication reconciliation in the inpatient setting and do not recognize common reasons why home medications may be held during admission (eg, for acute kidney injury). The primary goal of this simulation activity was hands-on exposure to the EHR and recognition of the complexity of order verification and medication reconciliation, so students would have a better understanding of the process when shadowing pharmacists in the inpatient pharmacy.

Two Mercer University College of Pharmacy faculty members who have active clinical practice sites at Emory Healthcare approached the pharmacy administration, including the information technology (IT) pharmacist, about acquiring access to the training domain to build a training patient for IPPE students to use. Faculty members had access to the training domain at no charge. The IT pharmacist provided the faculty members with dates the training domain is accessible for edits, as this only

happens during downtimes for system maintenance. Instructions on how and when to access the training domain editing software to create the training patient were provided. The data input only required a working knowledge of how to enter orders in the active patient care domain, as the process is the same in the training domain. The faculty members spent approximately 12 hours developing the patient case, and 6 hours contacting administrators and entering case information into the training domain.

The patient case included a history of present illness, past medical history, laboratory data, home medications (see Appendix 1), and disease states covered during previous pharmacotherapy modules (nervous system, cardiovascular, renal, musculoskeletal, gastrointestinal disorders, endocrine disorders, and pulmonary disorders) The case also included medications that had not yet been covered during class but are typically used in the inpatient setting (eg, vancomycin and meropenem). The patient case reinforced long-term retention from previous pharmacotherapy courses. The integration of unfamiliar drugs emphasized the use of real-time drug information resources. The patient's home medications and verified and unverified inpatient orders were included in the EHR simulation. A facilitator's guide provided instructions and an answer key for the simulation.

The order verification and medication reconciliation simulation occurred during orientation on the first day of Emory's institutional IPPE, prior to students spending time in the inpatient pharmacy. Students were asked to bring a printed copy of the patient case along with the worksheet on the first day (Appendix 1). Paper cases are used because the training domain does not allow laboratory data and past medical history information to be entered for the simulated patient. The learning objectives for the simulation activity were to: (1) describe the processes of order verification and medication reconciliation using the Emory Healthcare EHR; (2) apply computer skills to navigate the EHR; (3) identify and resolve medication discrepancies after medication reconciliation of home medications with inpatient medications; (4) evaluate inpatient medication orders and determine if they should be verified for patient administration; and (5) defend the rationale for verifying or rejecting medication orders verbally and in writing.

For the order verification simulation, students were divided in half (groups of 12-16) to evaluate inpatient orders. Groups expanded in size as the number of students assigned to Emory Healthcare increased. Because there is only one simulation patient for IPPE use, the first group of students evaluated the first half of the patient's orders, and the second group evaluated the second half of the orders. The activity was split because the software only reset unverified orders at midnight each day, and the faculty members felt students should have this experience on the first day. Completing order verification for an entire patient individually was not feasible because there was only one patient, and only one person was able to view a training patient profile at any given time.

As a result, during the order verification exercise, students rotated serving as the "verifying pharmacist" at the front of a small classroom. The students projected work from a computer onto a screen for all students to view. Each student in the "verifying pharmacist" role read the order sentence and navigated the computer commands required to verify or reject orders. Clinical decision support alerts were triggered and appeared in real time on the projection screen. Student groups determined whether to verify or to reject inpatient orders based on the patient's laboratory data, other medications, and clinical conditions. Students were expected to use handheld drug information resources to look up medication doses and research medications unfamiliar to them. Students were tasked with persuading each other to support their position based on the evidence and with discussing how they should approach the provider to change the order.

Faculty members facilitated discussions among students during the activity and provided a pharmacist's perspective when students could not come to a consensus. After an order was verified or rejected, it was removed from the pending orders, as it would be in real life, and appeared in the patient's medication list as an active order or as an order requiring follow up. As students processed each order, they completed a worksheet justifying why they decided to verify an order or to reject it. A student from the first group and the second group paired up at the end of the simulation to review why orders were verified and rejected during each session. The worksheet was submitted at the end of the activity for faculty review.

The medication reconciliation simulation followed the order verification activity. Students divided themselves into groups of 2-3 and reviewed the patient case, home medications, and current inpatient medications. Students were instructed to compare the home medication list to the inpatient medication list and to identify issues that needed to be resolved, including missing information (dosage form, dose, route, and frequency) and therapeutic duplications. Students also were required to identify the indication for each medication based on the patient's past medical history and history of present illness and to assess if important medications were missing (eg, no rescue inhalers with a diagnosis of chronic obstructive pulmonary disease or no statin with a history of coronary artery disease).

Student groups shared issues they identified at the conclusion at the activity, and the faculty facilitator highlighted how and why these errors may have occurred and why it was important to resolve them. While students could not obtain direct feedback from patients or providers to clarify discrepancies found during simulated medication reconciliation, they were able to practice identifying problems and generating strategies to potentially resolve them.

A survey was used by the institutional IPPE faculty members to assess students' perceptions of the medication reconciliation and order verification simulation activity. Descriptive statistics were used to summarize survey results, and median scores for survey questions were calculated for Likert-scale data. A qualitative assessment of students' comments about what they liked most and least about the simulation was performed, and common themes were identified. The study was approved by the Mercer University Institutional Review Board, and a waiver of informed consent was granted.

EVALUATION AND ASSESSMENT

Each year a survey containing 10 Likert-scale questions (1=strongly disagree, 2=disagree, 3=neither agree or disagree, 4=agree, 5=strongly agree) and 2 open-ended questions assessing what students liked most and least was distributed to students to assess their perceptions of the activity. Eighty-three students (98%) completed the perceptions survey over a 3-year time frame. Table 1 illustrates the survey questions and results for the 3 years. Overall, 95% percent of students agreed (selected 4 or 5 on the Likert scale) that the simulation enhanced their learning, and 76% agreed the simulation stimulated their interest in institutional pharmacy. Ninety-eight percent of students agreed that the simulation was realistic and that it integrated information from other courses. The majority (96%) also agreed the simulation exercise taught valuable decision-making skills.

A qualitative analysis of students' comments showed they liked that the simulation required application of previous course material, that it imitated real life, and that it included group work. Some students reported the instructions for medication reconciliation activity were unclear and that there was not enough time to complete the activity. The most common suggestion for improvement was the opportunity for future students to use their own computers and work on the patient individually before discussing answers as a group. The overall student evaluations for the institutional IPPE at Emory Healthcare were favorable, with a mean score of 4.75 out of 5 (1=strongly disagree, and 5=strongly agree).

The faculty members logged into the training domain prior to the IPPE to ensure the patient case had not been inactivated and that it still worked properly. On one occasion, the case was deleted and it needed to be re-entered. On another occasion, the patient name had changed, so the IT pharmacist was contacted to obtain the new training patient's name, and the faculty members updated the facilitator and student instructions for the activity.

DISCUSSION

This EHR simulation was unique for several reasons. The simulation used existing training software available through the hospital at no cost to the college and was

Table 1. Survey on Student Perceptions of Simulation Activity (n=83)

Question	1	2	3	4	5
The simulation stimulated my interest in institutional pharmacy practice	2 (2.4)	2 (2.4)	16 (19.3)	47 (56.6)	16 (19.3)
The simulation stimulated my interest in medication reconciliation.	2 (2.4)	5 (6)	23 (27.7)	39 (47)	14 (16.9)
The simulation allowed me to use the knowledge that I have learned in previous courses.	0 (0)	0 (0)	2 (2.4)	36 (43.4)	45 (54.2)
The simulation recreates real-life situations.	0 (0)	1 (1.2)	1 (1.2)	47 (56.6)	34 (41)
Clinical decision making skills taught with this simulation are valuable.	0 (0)	0 (0)	3 (3.6)	36 (43.4)	44 (53)
I enjoyed participating in this simulation.	0 (0)	2 (2.4)	15 (18.1)	32 (42.2)	31 (37.3)
The simulation should be further incorporated into the IPPE curriculum.	0 (0)	1 (1.2)	7 (8.4)	43 (51.8)	32 (38.6)
Overall, the simulation enhanced my learning.	0 (0)	0 (0)	4 (4.8)	51 (61.4)	28 (33.7)

Data are presented as n (%), Likert scale (1=strongly disagree, 2=disagree, 3=neither agree or disagree, 4=agree, and 5=strongly agree)

a replica of the software used for patient care. The simulation oriented students to the complexity of order verification and medication reconciliation prior to their dispensing and clinical experiences during the institutional IPPE.

The EHR simulation in this study had several strengths. The most important strength was the simulation highlighted the deceptively complicated processes of medication reconciliation and order verification. While students can recite the steps required for reconciling medications or verifying an order, they do not always appreciate the complexity of these processes. For example, when evaluating an inpatient order, the inpatient pharmacist not only evaluates the specifics of the medication order (dose, route, and frequency) and assesses for drug-drug interactions, but often is required to assess the patient's renal function, weight, and other laboratory data that affect the safety and efficacy of the medication. This may differ from a community setting, where the emphasis is on accurate prescription transcription and medication filling because a lack of clinical data is available. Moreover, students observing medication reconciliation or order verification might not see or understand all steps the pharmacist is completing prior to verifying an inpatient order. The hands-on EHR use allowed students to respond to clinical decision support alerts as they would in real life, reinforced pharmacotherapy knowledge covered in earlier didactic courses, and required synthesis of information in the context of multiple diseases states. The simulation also improved verbal communication skills and the use of real-time drug information, as the students had to look up information and discuss it with their group. The EHR simulation may also be an affordable option for schools of pharmacy without the resources to purchase teaching EHR software but that are affiliated with medical centers willing to share access to their training domain.

This study had a few limitations, including the large size of each group. Smaller student groups or students working independently on reconciling and verifying orders and then discussing their rationale with other students would improve the activity. Smaller groups would increase individual involvement and hands-on experience with the EHR. Smaller groups also would enable faculty members to assess individual student performance. Large groups (12-16) were used because of the high number of IPPE students assigned to Emory Healthcare, the small number of faculty facilitators onsite, and the limited accessibility to the training domain. Another limitation was the use of a single training patient. The simulation could be improved by removing the paper case and uploading all of the data into the EHR training domain and by increasing the number of training patients, which would expand the number of disease states and medications students evaluated. It would also increase their familiarity with the EHR and would allow each student to spend more time in the role of a "verifying" pharmacist. A third limitation was that the study was unable to quantitatively assess the impact of the simulation activity on students' learning during IPPE and beyond, and primarily evaluated their perceptions of the activity. In the future, we hope to decrease the size of the groups, increase the number of training patients, and evaluate the impact of the activity on order verification and medication reconciliation performance.

The primary barriers with implementing the medication reconciliation and order verification simulation were related to technology and infrastructure. The use of the EHR training domain software was dictated by the relationship between the college and a health system and the ability to have both onsite and remote access. The training domain also may have limited the number of unique patients that can be created and the number of training domain log ins that can be supported by the system at any one time, which made it impossible for students to work independently on the assignment. Establishing faculty access to the training domain and instruction on how to build a patient was required prior to building the training patient, and opportunities to create new patients were limited because the training domain can only be updated during scheduled downtimes.

Overall, the simulation was positively received by students and was a unique opportunity to improve their understanding and use of technology in the hospital setting while reinforcing their clinical and drug information skills. Expansion of the activity is planned based on the feedback received over the past 3 years.

SUMMARY

Hospital EHR training software can be used to orient students to the institutional pharmacist's role, as well as reinforce material from previous courses and advance clinical decision making. Use of existing hospital training software can provide schools of pharmacy an affordable option for simulation.

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Appendix 1. Student Instructions for Medication Reconciliation and Order Verification Simulation

Medication Reconciliation

We will be reconciling home medications for a training patient and then verifying admission inpatient orders. You will be required to evaluate both the appropriateness and safety of each order. Please have drug information resources available to aid you in looking up medication information.

1. Step 1: Identify any issues that need to be resolved for medication reconciliation. Consider the following:
    a. Missing information
    b. Duplicate orders/therapeutic duplications

2. Step 2: Classify medications by disease state

Order Verification

1. Use the patient case on the next page to provide information not included in Med Manager or PowerChart.
2. Review the medications already verified prior to verifying a new order.
3. Assess each new order for accuracy, appropriateness, and safety.
4. Decide to **VERIFY** the order without changes or to **REJECT** the order and contact the prescriber.
5. Use drug information resources and discussion to determine the appropriate action.
6. Document your selection for each order on the provided worksheet and put this document into your portfolio.

Patient Case

CC: "I can't breathe"

HPI

Patient admitted through the ED for increasing SOB and DOE for the past 2 days. Patient is unable to climb his stairs, which he can do at baseline. He was recently admitted to an OSH for 5 days a month ago for heart failure exacerbation.

Past Medical History

1. HF
2. DM Type 2
3. CAD s/p NSTEMI with DES 6 months ago
4. Atrial fibrillation
5. Dyslipidemia
6. GERD
7. COPD

Allergies

Morphine (itching)

Home Medications per Physician Medication History (some information may be missing)

Documented medications=medications listed by patient, family, or provider
Prescribed medications=medication prescriptions written in the health system
Aspirin 81 mg: 2 tablets PO qDay, #60 tablets, no refills (Prescribed)
Clopidogrel: 1 tablet PO qDay, #30 tablets, no refills (Documented)
Clopidogrel 75mg: 1 tablet PO qDay, #30 tablets, no refills (Prescribed)
Digoxin 125 mcg: 1 tablet PO qDay, #30 tablets, no refills (Prescribed)
Digoxin (Documented)
Ezetimibe 10 mg: 1 tablet PO qDay, #30 tablets, no refills (Prescribed)
Fenofibrate 145 mg: 1 tablet PO qDay, #30 tablets, no refills (Prescribed)
Fluticasone/Salmeterol 250 mg/ 50 mcg: 1 puff inhaled BID (Documented)
Hydralazine/ Isosorbide Dinitrate: 1 tablet PO TID (Documented)
Insulin aspart 15 units subcutaneously (Documented)
Insulin glargine subcutaneously qHS (Documented)
Insulin isophane/ Insulin regular 70/30 subcutaneously BID (Documented)
Lisinopril 1 tablet PO qDay (Documented)
Metformin 1 tablet PO BID (Documented)
Metoprolol 50 mg PO qDay (Documented)
Pregabalin 100mg: 1 capsule PO BID, #30 capsules, no refills (Prescribed)
Ranitidine see instructions (Documented)
Spironolactone 25mg: 1 tablet PO qDay, #30 tablets, no refills (Prescribed)
Warfarin 5mg po qDay (Documented)

Inpatient Medications Orders

Medication Orders Pending Verification for Patient Administration

Albuterol-ipratropium 2 puffs aerosol inhaled q4h PRN shortness of breath
Atorvastatin 40 mg: 1 tablet PO qHS
Clopidogrel 75 mg: 1 tablet PO qDay
Enoxaparin 40 mg: Inject 0.4 mL injection subcutaneously qDay
Hydralazine-isosorbide dinitrate 37.5 mg/20 mg: 1 tablet PO BID
Ibuprofen 800 mg: 1 tablet PO q8h PRN pain
Insulin regular/NPH 70/30: 20 units subcutaneously AC breakfast and dinner
Lisinopril 20 mg: 1 tablet PO qDay
Meropenem in NS 500 mg/100 mL IVPB q6h
Metformin 500 mg: 1 tablet PO AC breakfast/dinner
Metoprolol XL 50mg: 1 tablet PO qDay
Oxycodone/APAP 5 mg /325 mg: 2 tablets PO q4h PRN pain
Salmeterol/fluticasone 230 mcg/21 mcg: 1 puff aerosol inhale BID
Spironolactone 25 mg: 1 tablet PO qday
Vancomycin 1 g/150 mL NS injection IVPB q48h

Medications Orders Verified for Patient Administration

Albuterol-ipratropium 3 mL solution inhale q6h PRN shortness of breath
Aspirin EC 81 mg: 2 tablets PO with breakfast
Digoxin 0.25 mg: 1 tablet PO qDay
Ezetimibe 10 mg: 1 tablet PO qDay
Famotidine 20 mg/2 mL injection IV qDay
Fenofibrate 145 mg: 1 tablet PO qDay
Insulin aspart 5 units injection subcutaneously with meals
Insulin glargine 20 units injection subcutaneously qHS
Pregabalin 100 mg: 1 capsule PO BID

Demographics

Age: 52 years
Height: 67 in
Weight: 60 kg

Vital Signs

Blood Pressure=110/66mg/Hg, Pulse=95bpm, Respiratory Rate=26bpm, Temperature=39.5C, oxygen saturation on room air=87%

Laboratory Values

Sodium	132
Potassium	5.5
Chloride	117
Bicarbonate	25
BUN	20
Serum Creatinine	3.0 (baseline is 1.5 from 1 month ago)
Glucose	215
WBC	15
HgB	13
Plts	250,000
BNP	2500
Digoxin level	0.6
INR	2.3

Medication Reconciliation and Order Verification*

1. Albuterol/ipratropium
2. Atorvastatin
3. Clopidogrel
4. Enoxaparin
5. Hydralazine/Isosorbide Dinitrate
6. Ibuprofen
7. Insulin NPH/Regular 70/30
8. Lisinopril
9. Meropenem
10. Metformin
11. Metoprolol succinate
12. Oxycodone/Acetaminophen
13. Salmeterol/fluticasone
14. Spironolactone
15. Vancomycin

*For each order, students chose either “a) Order verified as entered;” or “b) Order rejected and provider contacted. Explain:”