Using Clinical Trial Randomization to Ensure Uniform Medication Error Coverage in EHR Medication Verification Activities

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Abstract

OBJECTIVES
The objective of this project was to define a process to create and assign EHR patients that would (1) allow for the uniform coverage of 10 medication error types across three medication verification laboratories and (2) create a unique student-patient schedule that would limit the impact shared patient information outside of the laboratory.

METHOD
EHR usage for institutional medication verification laboratories simulated the creation of individual patient records to allow student access and processing of patient medication orders. Ensuring coverage of 10 medication error types required the creation of 4 medication error cohorts using random number generation. Four template patients were created for each medication cohort that contained 5 active medication orders. A modified Williams Design was used to assign student-patient schedules minimizing overlapping assignment of template patients.

RESULTS
152 unique patient assignment schedules were generated with 608 individual student-patient assignments. While each patient template was used for 30-40 students using this technique, the use of post-assignment naming limited identifiable patient duplication to <15 students. This ensured all students received exposure to all 10 medication error types. Student-Patient Assignments were distributed on barcoded activity rubrics used by facilitators to review student work during EHR laboratory sessions.

Course Background

MEDICATION VERIFICATION UNIT
The fall 2015 PHAR538 Abilities Lab 3 (ABL3) Medication Verification Unit followed the 2014 pilot implementation of the NeehrPerfect EHR to process inpatient medication orders electronically, providing students an opportunity to model independent practice in a simulated institutional pharmacy environment. To provide more coverage of medication errors and more opportunities to model independent practice, the unit was expanded from 2 to 3 medication verification laboratory sessions and the number of medication orders was increased from 3 to 5 per patient. Experiences from the pilot implementation raised questions about the implementation of laboratory activities with NeehrPerfect to achieve equitable coverage of medication errors while maintaining the integrity of independent laboratory activities.

Acitvity Design

DEFINING THE LABORATORY STRUCTURE
Preexisting student knowledge and facilitator to student-ratio together limits how many orders an average student can practically process and review within any given laboratory session. Combined with the introduction of new medications on the ABL3 "Drug List" and the insitutional medication use process, careful consideration was needed to determine how to structure patients, medication orders, and the introduction of errors. The numbers of orders and patients per laboratory session were increased based on average student performance in the fall 2014 course.

Unit Patient Assignment

	Laboratory 1 (L1)	Laboratory 2 (L2)	Laboratory 3 (L3)	Open Lab (OL)	Total Processed
Patients	2	2	2	2	8
Orders Processed	10	10	10	10	40

Laboratory Patient Assignment

50 minutes per laboratory | **2 patient charts** per student | **5 medications** per patient | **2-3 errors** per patient

DESIGNING PATIENT INTERACTIONS
The design of the NeehrPerfect VISTA inpatient pharmacy interface necessitated creation of approximately 300 patient charts per laboratory session to allow students the ability to physically verify or flag medication orders within the system within an open access environment. Coupled with the need to ensure equitable coverage of medication errors, this presented several challenges to build an implementation that met core objectives of the activity.

PROBLEM #1: Equitable Coverage of Medication Errors
Ensuring students have exposure to all medication error types in a guided laboratory environment reinforces learning and improves the potential long-term knowledge retention and ability to identify medication errors.

PROBLEM #2: Reducing Information Sharing
Enrollment and physical laboratory space requires a single laboratory rotation to be completed over an entire day. This creates potential opportunities for students to share patient information, limiting student engagement and learning in future laboratory sessions.

PROBLEM #3: Balancing Implementation Complexity
The impracticality of creating over 1200 unique patient charts for the fall 2015 semester required careful consideration on how to balance the need to reduce information sharing, ensure equitable coverage of medication errors, with a reasonable implementation approach.

1 Designing Medication Error Equity

CODING MEDICATION ERROR TYPES
To make assignment of errors to patient profiles easier, each medication error type included in the laboratory was coded with a two digit number to simplify referencing, assignment, and use across applications. Since students required access to 8 patients, medication errors were assigned in groups of 2-3 to ensure all ten errors were covered twice within the unit.

Medication Error Type Mapping

Error Code	Error Type
01	No Allergy Assessment
02	No Indication
03	Drug Allergy
04	Range Order - Dosage
05	Range Order - Interval
06	Route of Administration Error
07	Formulation Error
08	Dosage Error
09	Drug-Drug Interaction
10	Duplicate Therapy

Error Difficulty Indexing

Based on prior student observation in lab, we thought that errors 6-10 were more difficult for students to identify than errors 1-5 due to the knowledge needed to correctly determine the presence of an error.

For example, a missing indication (error 02) requires students to identify a missing element in a medication order without knowledge synthesis.

However, the assessment of duplicate therapy (error 10) requires a student to recognize that two antihypertensive medications from different classes is clinically appropriate, but you would not use two such medications from the same class. This requires accurate knowledge of medication classes.

PATIENT TEMPLATES
A template key was created to map medication error types to template patient cohorts. This limited the number of error combinations and answer keys needed by facilitators during laboratory sessions. Random number generation was used to assign errors to cohorts. Since only 4 patient cohorts were used, two cohorts in each patient set were assigned three errors.

Medication Error Patient Template Key

	Difficulty	Patient Cohort 1	Patient Cohort 2	Patient Cohort 3	Patient Cohort 4
Patient Set 1	Basic	01	02	03,04	05
	Advanced	10	07,09	06	08
Patient Set 2	Basic	01,02	05	04	03
	Advanced	08	09	07	06,10

2 Leveraging Clinical Random Assignment

POPULATING PATIENT COHORTS
Limiting the sharing of patient information necessitated the use of more than 8 total patients in the fall semester. For each patient set cohort key, 4 patients were created using a variety of medications and disease states. This created a total of 32 patients for assignment to students.

Patient Set 1, Cohort 1

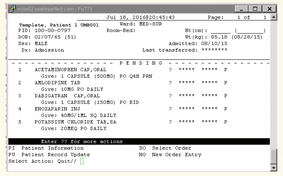
Cohort #1 (1,10)	Cohort #1 (1,10)	Cohort #1 (1,10)	Cohort #1 (1,10)
Template,Patient 1 UMB001	Template,Patient 2 UMB001	Template,Patient 3 UMB001	Template,Patient 4 UMB001
Male, 2/7/1965	Male, 6/2/1955	Male, 2/25/1970	Male, 1/13/1962
Allergy field blank	Allergy field blank	Allergy field blank	Allergy field blank
Acetaminophen 500 mg PO QHH prn pain	*Nadolol 20 mg PO daily for portal HTN (duplicate therapy)	*Carvedilol 12.5 mg PO BID for CHF (duplicate therapy)	*Amlodipine 10 mg daily for HTN (duplicate)
*Enoxaparin 40 mg SC daily for DVT prophylaxis (duplicate therapy)	Rifaximin 550 mg PO BID for hepatic encephalopathy	Digoxin .25 mg PO daily for CHF	Enoxaparin 40 mg SC daily for DVT prophylaxis
Amlodipine 10 mg PO daily for HTN	Lactulose 10 gm PO TID for hepatic encephalopathy	Lisinopril 10 mg PO daily for CHF	Hydrochlorothiazide 200 mg PO daily for SLE
*Dabigatran 150 mg PO BID for AFib (duplicate therapy)	*Inderolol 10 mg PO daily for HTN (duplicate therapy)	*Metoprolol tartrate 50 mg PO BID for HTN (duplicate therapy)	Prednisone 5 mg PO daily for SLE
KCL 20 mEq PO daily for potassium replacement	Furosemide 40 mg IV daily for edema	Spironolactone 25 mg PO daily for CHF	*Diltiazem 240 mg PO daily for HTN (duplicate)

CLINICAL TRAIL RANDOM ASSIGNMENT
Ensuring uniform randomization required the consideration of new techniques for random assignment. By modifying the Williams Design clinical random assignment technique[1] to consider each patient within a cohort as a possible treatment and each cohort as a treatment period, template patients could be assigned to students to ensure a uniform random assignment of patients within a given patient set. This technique was repeated twice for the patient sets in the unit.

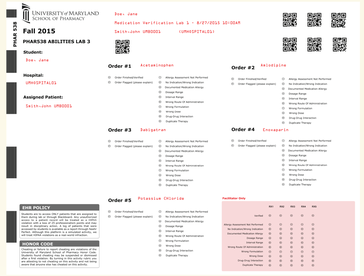
3 Implementation and Logistics

PATIENT CONSTRUCTION
Patients were created within the NeehrPerfect EHR by copying template patients into files with assigned names. Each template patient was utilize 12-16 times within the student population. To create the appearance of a more diverse population of patients, when copied each patient was assigned one of 2-3 names. Each patient was assigned 2-4 groups of unique names to introduce further variablity of patients within the system, using approximately 80-100 unique names. Since this version of NeehrPerfect provided no assignment mechanism, patient assignments were distributed through the use of a Scantron rubric.

Neehr Perfect Template Patient



Scantron Patient Chart



Future Implications

EHR CHANGES
The recent release of NeehrPerfect Go! fundamentally changes the EHR user interaction. The VISTA inpatient pharmacy interface has been replaced with a web-based interface that encapsulates concepts of the pharmacy order verification process used in ABL3. In fall 2017, the Medication Verification Unit and all EHR activities within ABL3 will require redesign. Since individual student-patient assignments are not necessary,. some consideration will be needed to determine how assignments will be made to balance equity issues in medication error assignment and medication use with randomized assignment. It may be possible to use the modified Williams Design routine to assign blocks of students to treatment/patient and period/cohort combination using pre-existing laboratory rotation schedules

OTHER CONSIDERATIONS
During the fall 2015 semester, medications were randomly assigned to patient cohorts. Due to repetition of some medications within other courses, there was a perception that some medications and patients within a cohort were "harder" than others because of drug selection. Changes were made within ABL3 to reinforce drug knowledge. This may negate the need to change drug assignment techniques, but more analysis is needed.

References: [1]Deng, C., & Graz, J. (2002). Generating randomization schedules using SAS programming. In *Proceedings of the 27th Annual SAS Users Group International Conference* (pp. 267-27). Cary, NC: SAS Institute.