Construction of a common data model for artificial intelligence to interpret ICU medication outcomes

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Background

- Artificial Intelligence (AI) has the potential to enhance patient outcomes by providing real-time medication regimen feedback to pharmacists [1]
- Currently there is no common data model (CDM) for frequently used medications in the intensive care unit (ICU) that accounts for medication regimen complexity [2]

Purpose: To develop a CDM that can successfully standardize medication features, providing a basis for complex predictions and validated machine learning models in the ICU setting

Methods

A nine-member panel of critical care pharmacists utilized a 5-round Delphi method to generate components of CDM

Primary Outcome: To develop features for inclusion in the CDM after five rounds of the modified Delphi method

Secondary Outcome: To input data into each column of the CDM using various drug information resources

- Round 1: Panelists generated a list of potential features for drugs
- Round 2: Panelists generated additional elements and evaluated the significance of each
- Round 3: Panelists found themes from initial rounds and prioritized topic areas for inclusion into the first CDM
- Round 4: Panelists reviewed a medication regimen and updated a list of medication features
- Round 5: The feature list was sent for review with the goal of achieving consensus in April 2022

The medication list was identified from the electronic health record of 1,000 adult patients in the University of North Carolina Health System ICU from October 2015 to October 2020 using medications that are included in the medication regimen-complexity intensive care unit (MRC-ICU) scoring tool

Results

Figure 1. Flow Diagram of Feature and Medication Inclusion

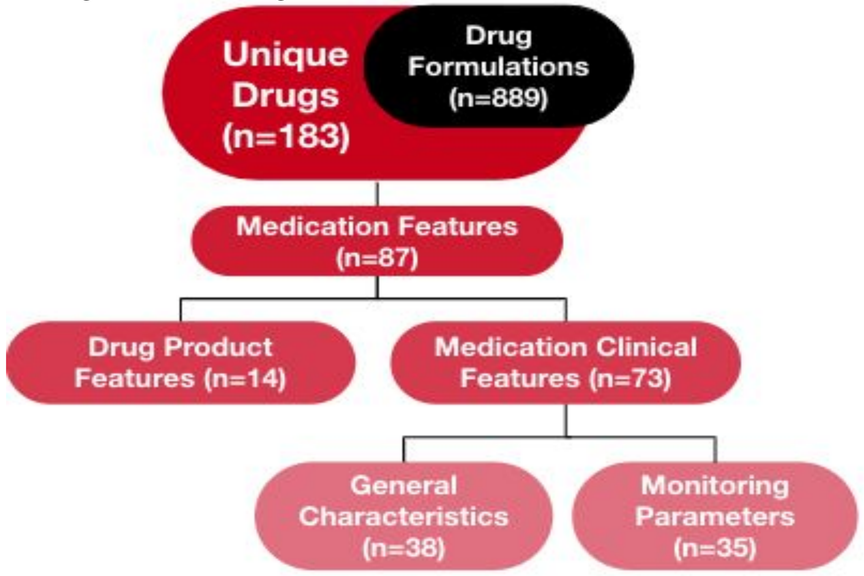

Table 1. Example Features

Drug Product Features	Medication Clinical Features
• Drug name • Pharmaceutical class • Therapeutic category • Drug strength • Drug strength units • Concentration • Concentration units • Route • Fixed route • Multiple routes	• MRC-ICU weight • Renal dose adjustment • Hepatic dose adjustment • Beer's Criteria recommendation • Role in prophylaxis • Route escalation • Weight-based dosing • Therapeutic drug monitoring • Adverse events • Maximum daily dose value

Figure 2. Excel Excerpt from Common Data Model

Drug-Strength-Formulation Drug-Strength-Formulation	Drug Name Drug	Pharmaceutical Class Descriptors PHARM_CLASS_NAME	 PHARM_SUBCLASS_NAME
AMPICILLIN/SULBACTAM 3 G POWDER FOR INJECTION	Ampicillin/Sulbactam	Antibiotic	Aminopenicillin
APIXABAN 2.5 MG TABLET	Apixaban	Anticoagulant	Direct Factor Xa Inhibitors

Discussion

This project yields the first CDM focused on medications in the ICU developed via an expert panel and a modified Delphi process with a foundation from patient case scenarios. The importance of this CDM includes its ability to predict ICU outcomes and provide a clinical decision support system (CDSS) in order to improve patient outcomes in the ICU with the CDM.

Limitations:

- Incomplete medication feature profile for each drug (e.g., non-CYP enzyme-associated drug-drug interactions)
- Non-comprehensive set of medications
- CDM profile was based on the opinion of experts, which may differ from that of uninvolved ICU clinicians

Study Impact: Through continuous refinement of this common data model, the standardization of drug features can improve how machine learning models operate in the future. The evolving tool can improve health outcomes for critically ill patients with the current technology, but also in the future with changing information. This current CDM tool is a mold for the future of CDM tools in the ICU, because future nuances and features may be added.

References

1. Amarasingham R. et al. *Arch Intern Med*. 2009. Jan 26;169(2):108-14. doi: 10.1001/archinternmed.2008.520
2. Yoon JH. et al. *Critical Care*. 2022. March 22;26(75). URL: https://ccforum.biomedcentral.com/articles/10.1186/s13054-022-03915-3