Pharmacometabolomics, Natural Language Processing and Data Visualization Potential Applications in Precision Pharmacy Education

VCU School of Pharmacy

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OBJECTIVES

- To describe the implementation of personalized medicine coursework at Virginia Commonwealth University (VCU) School of Pharmacy (SOP).[1]
- To discuss the use of pharmacometabolomics, natural language processing and data visualization in precision pharmacy education.

BACKGROUND

- The Accreditation Council for Pharmacy Education Standards 2016 include pharmacogenomics/genetics as a required element of the didactic Doctor of Pharmacy curriculum.[1]
- Rapid technological advances are fast enabling the personalization of medicine and the approach to pharmacy education must adapt to include these technologies.
- Current structure of personalized medicine coursework at VCU SOP.

2010: Required 1-credit introductory Personalized Medicine Course → 2015: Implemented active-learning laboratory session → 2017: Creation of 2-credit Advanced elective in Personalized Medicine

Intro Personalized Medicine Course

- A required 1-credit, introductory class in personalized medicine has been offered for the past eight years.
- Early efforts were focused on providing students with an understanding of pharmacogenetics and pharmacogenomics.
- In 2015, the course was expanded to include other topics related to personalized medicine including pharmacometabolomics and pharmacolipidomics
- The same year, an active-learning laboratory session was implemented to provide the students with a deeper understanding of the principles of pharmacogenetics.
- In 2017, an advanced elective was created where the students learned how to collect buccal cells and how to critically evaluate pharmacogenetics results. Additional topics were also covered.

Active-Learning Laboratory

A two hour active learning laboratory session to teach pharmacy students about clinical pharmacogenomics was implemented to run in sequence with their required Personalized Medicine lecture on Clinical Pharmacogenomics.

The laboratory exercise includes:

- Three team cases where students evaluate genetic profiles and make drug therapy recommendations to providers
- Counsel a patient on their genetic profile and corresponding drug therapy

Based on assessments, students knowledge and confidence increased after participating in the laboratory session.[2]

Elective Personalized Medicine Course

To better train pharmacy students who intend to pursue personalized medicine as a career, we created a 2-credit, advanced elective on personalized medicine in fall 2017.

The elective expanded on the course material covered in the 1 credit class. This course also emphasized the importance of understanding the effects of one or more pharmaceutical agents on the overall metabolism of the body at an individual level.

Understanding the relevance of multi-metabolite changes with respect to possible complications often requires an exhaustive literature search, a task that is becoming impossible due to the sheer volume of scientific literature. Thus, the topic of literature based discovery approaches via automated natural language processing was included in the elective.

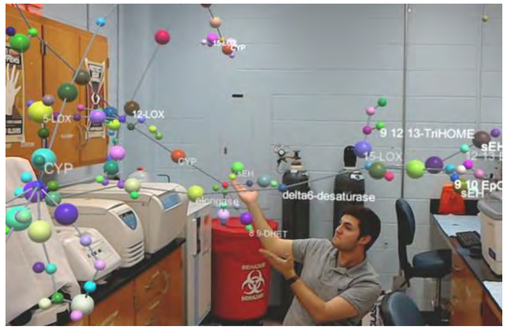

Fig 1: Understanding biochemical networks in its entirety. In personalized medicine, it is important to understand how individual variations can lead to overall changes in metabolism. This requires the ability to visualize large volumes of biochemical networks. In the advanced elective, we exposed the concept of using augmented reality to visualize such complex information. Depicted is the visualization of a part of the omega-3 and Omega-6 lipid metabolism network to enable the understanding of changes to metabolic flux upon treatment with NSAID's

Elective Personalized Medicine Course

New advances in natural language processing (NLP) has enabled intelligent machine driven information summarization to enable literature based discoveries (LBD). Output from LBD approaches are best visualized as networks, where the relationships among the identified information are easily comprehensible. As such, the students were also introduced to how AR/VR/MR can be used to visualize results from text mining as networks in an immersive, interactive and explorable environment.

Fig 2: An example of a student learning to use augmented reality to interact with virtual network environment. Due to the higher information density possible in 3D immersive environments, students were exposed to the concept of using augmented reality for investigating literature based discoveries. Depicted here is a pharmacy student interacting with an information network in augmented reality. The ability to physically interact and explore such information networks provides a better understanding of the concepts being learned and in return, longer retention of the knowledge gained.

In summary: The advanced personalized medicine elective combined pharmacometabolomics, natural language processing and ARVR/MR based data visualization to enable a comprehensive understanding of the metabolic perturbations resulting from an individual's response to a drug regimen.

FUTURE DIRECTIONS

Our ultimate goal is to create the next generation of pharmacists who are able to harness the advances from modern computing and integrate them to their practice. We are currently developing natural language processing algorithms that allow the merger of personalized medicine for polypharmacy patients. This knowledge will be included in our curriculum for the advanced elective this year.

REFERENCES

1. Accreditation Council for Pharmacy Education. Accreditation Standards and Guidelines for the Professional Program in Pharmacy Leading to the Doctor of Pharmacy Degree. Chicago, Ill: ACPE; 2015.
2. Powers KE, Buffington TM, Contaifer Jr D, Wijesinghe DS, Donohoe KL. Implementation of an active-learning laboratory on pharmacogenetics. Accepted at Am J Pharm Educ. Draft available online January 2018. https://doi.org/10.5688/ajpe6605

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