Using Forensic Cases to Introduce First Year Pharmacy Students to Forensic Pharmacy and Strengthen Student Learning in Basic Sciences

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Abstract

Description of the problem: Forensic pharmacy is a scientific field in which trained forensic pharmacists apply their knowledge to assist law enforcement agencies in solving criminal cases. The role of forensic pharmacists is not emphasized in the pharmacy curriculum, and there is limited information about how faculty can introduce pharmacy students to this field.

The innovation: A unique curricular activity was created to introduce first-year pharmacy students to the craft of forensic pharmacy and promote student learning of basic sciences. Thirteen teams (68 students total) participated in this activity. Each team watched an episode of a TV show, *Forensic Files*; prepared a report; and presented data covering factors contributing to the incident, safety measures, the roles a forensic pharmacist plays in various criminal cases, mechanisms of action, major toxicities, and indications for the drug or compound that contributed to the harm.

Critical analysis: An anonymous survey tool was administered, with a 57% respondent rate, to assess the effectiveness of the activity. Approximately 70% of students agreed that the activity strengthened their knowledge in basic sciences, 75% agreed it promoted presentation and critical-thinking skills, and 80% agreed that the activity encouraged teamwork and self-directed learning. In addition, the activity promoted the six levels of Bloom's taxonomy to support student learning.

Next steps: Faculty can generate elective courses to introduce pharmacy students to forensic pharmacy and use real-life forensic cases to strengthen student learning.

Keywords: Forensic pharmacy, Student learning, Basic sciences

Description of the Problem

New and evolving educational methods, including elective courses, can promote student learning, expand students' professional interest, and cultivate pharmacists with more engaging roles to play in the pharmacy profession.[1,2] Additionally, authentic patient care cases can introduce and reinforce clinical sciences to produce positive impacts on student learning in pharmacy programs.[3] Integrating clinical relevance into basic sciences stresses the importance of learning basic sciences concepts and demonstrates future applications in patient care.[4] For instance, authentic medication errors have been used in a doctor of pharmacy (PharmD) program to support student learning in basic sciences.[5] It is, however, challenging to find authentic pharmacy related cases in basic sciences.

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Forensic pharmacy is one topic area that can help to reinforce basic science content. In a study that included bachelor of science (BS) students, it has been reported that using a progressive teaching and learning approach in forensic intelligence, built upon real-life situations, can promote critical thinking skills.[6]

Forensic pharmacy is a scientific field in which pharmacists apply the science of medications to legal issues during the regulatory process and the criminal justice system.[7,8] It has been reported that almost every pharmacy specialty has a forensic application, and there is a wide range of services that a forensic pharmacist can provide to the justice system that include issues surrounding abuse or misuse of medications in homicide, suicide, malpractice, child abuse, rape, and other injury cases.[7–9] Drug overdose and toxicity is a public health issue in the United States, because it is one of the leading causes of death from injury.[10] The Centers for Disease Control and Prevention estimated 107,543 deaths as a result of drug overdose in 2023.[11] When a crime that is related to a drug overdose or toxicity is committed, little is known about the source that caused an injury or death. Pharmacists can be trained to be part of the solution to legal issues by using their knowledge of basic sciences to map toxic mechanisms that are produced by drug overdose and other toxic compounds.[7,9]

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While it is suggested that most pharmacists do some type of forensic work at their practice site, there has been limited progress for pharmacists being trained and officially serving as forensic pharmacists.[7] In 2018, Bell and colleagues[12] mentioned that "the [forensic science] field is in dire need of deep and meaningful attention from the broader scientific community." It has been suggested that forensic science increases student engagement in chemistry classes and promotes critical-thinking skills among learners.[13,14] There are undergraduate programs that offer forensic science tracks within their BS degree in Chemistry. While PharmD programs deliver comprehensive basic sciences to pharmacy students, there is limited educational offering in the form of tracks to introduce or train students in forensic pharmacy. The Accreditation Council for Pharmacy Education Standards 2025 emphasizes the importance of offering students electives to explore and/or advanced study in areas of their professional interest.[15] PharmD programs can ignite students' interest in forensic science to expand the role of pharmacists in forensic pharmacy and use forensic cases to support student learning in basic sciences. This article describes an educational activity that introduced the role of a forensic pharmacist to pharmacy students and used authentic forensic cases to strengthen student self-directed learning in basic sciences. The objective of the subsequent study was to assess student perceptions of the activity and impact on educational objectives.

The Innovation

The advancement in molecular biology techniques combined with their integration into forensic science has facilitated advances in criminal investigations to solve both current and decades-old cold cases.[16] In essence, thanks to forensic science, there has been a shift from "trust the examiner" to "trust the scientific method" to accurately use and apply the evidence-based forensic science to the legal system.[17] There is a growing body of evidence that supports positive learning outcomes gained from curricular activities that apply real-life scenarios and engage students to develop and advance their knowledge through self-directed learning, reflective observation, active participation, communication, and teamwork.[5,6,18] In the present curricular activity we used authentic crime incident forensic cases from a popular TV show, Forensic Files, to introduce first-year pharmacy students (P1) to the field of forensic pharmacy and strengthen student learning in basic sciences.[19] The goal of this innovative teaching and learning modality was to create a self-directed educational activity that directly connected students to real-life cases and would go beyond the traditional lecture-based pedagogy.

In order to prevent any potential anxiety or trauma to students who might have encountered similar situations that were presented in any given Forensic Files episode, students had the option to not participate in this curricular activity. The curricular activity was originally designed to be an on-campus learning experience; however, due to the COVID-19 pandemic, it was implemented remotely and online. Sixty-eight students (78% of the P1 cohort) opted to participate. A document listing a series of Forensic Files YouTube video links that exclusively focused on drugs and toxic compounds, along with a recorded introduction video, was posted on the school's learning management system Moodle (Moodle, Perth, Australia) by one of the authors (an assistant professor who was familiar with the field of forensic pharmacy). In addition, a list of select YouTube videos that related to professional presentation and DNA technology (Polymerase Chain Reaction [PCR], direct enzyme-linked immunosorbent assay [ELISA], and indirect ELISA) were shared with students via Moodle and email. Students were randomly divided into 13 teams, and each team had five to six students. Each team was randomly assigned a 30-minute Forensic Files episode to watch that was available to students for three weeks. By the time P1 students completed this curricular activity, 90% of the basic sciences curriculum had been delivered to students as part of the core curriculum. Following the review of the assigned video, each team was asked to write a report that was no longer than three pages, a format that was adapted from our previous work, to ensure all teams followed a consistent reporting structure.[5] Student teams were required to address a series of questions in their reports which included topics such as the effects of the incident on patients, contributing factors to the incident, safety measures that could help decrease the likelihood of this incident, the role of a forensic pharmacist in the episode, communication to a poison center, the mechanism of action (MOA), major toxicities, and how the chemical structure and/or pharmacokinetics/pharmacodynamics of the involved drug or compound contributed to the harm to the victim. Additionally, each team was asked to generate a PowerPoint presentation detailing key concepts from their report. Each team presented their slides via Zoom (Zoom Video Communications, San Jose, CA) for 15 minutes. A faculty member evaluated and graded both the report and presentation using a pre-designed rubric.

To assess the effectiveness of the curricular activity, an anonymous survey tool that included six questions based on

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past published survey questions was implemented.[5,18] Four questions assessed multiple areas with one question asking for a rating of the Forensic Files video and three questions assessing perceptions based on a five-point Likert scale of agreement from strongly disagree to strongly agree. Two questions were open-ended in nature. A total of 39 students completed the survey for a response rate of 57%. Additional information about the curricular activity's structure, its assessment, and presentation rubric are available from the authors upon request. An institutional review board granted this study exempt status.

Critical Analysis

The curricular activity was implemented remotely, during the P1 year, in the spring of 2021. The overall assessment results indicated a positive student perception of the curricular activity. When students were asked about how they would rate the forensic files videos that demonstrated how inappropriate use of medications had a harmful impact on patient populations, 35% and 33% rated them as excellent and very good, respectively. The remainder of students rated it as good (18%), fair (8%), and bad (6%). Table 1 indicates that approximately 70% of students believed that the activity strengthened their knowledge in a few basic sciences, including an increased interest in the MOA of drugs. A smaller number (54%) of students believed the forensic pharmacy activity strengthened their knowledge in medicinal chemistry.

Survey results indicated that approximately 80% of students agreed that the forensic pharmacy activity required their teams to effectively communicate to review and identify steps needed to generate an effective report and presentation. A similar number of students believed that the activity encouraged students to be a self-directed learner, and 75% of students believed the activity helped students gain skills in presentations and critical thinking. Since the curricular activity was designed to incorporate active learning of a few basic sciences in the P1 curriculum, we wanted to know more about students' perceptions of learning as it related to Bloom's taxonomy.[20,21] Table 2 demonstrates the extent that the curricular activity impacted all six educational objectives in Bloom's taxonomy. Roughly 70% of students agreed that the forensic pharmacy activity promoted the Evaluation learning objective, and 80-87% of students agreed that the activity promoted the other five learning objectives.

One open-ended question asked about the role of a forensic pharmacist in the investigation of the criminal case, and the second question asked about suggestions to improve the activity. A review of the provided student comments indicated a perception that pharmacists' knowledge in pharmacokinetics, pharmacodynamics, toxicology, and interpretation of lab values would have given more insight into the investigation. Students shared feedback that the activity: 1) provided information for a possible pharmacy career path; 2) was a very interesting way to learn about the field as well as apply knowledge acquired through didactic learning; 3) needed more videos to watch when completing the activity; 4) was presented during a stressful time; and 5) allowed them to learn more about what a forensic pharmacist does.

There are two limitations with our study. First, the response rate (57%) for the anonymous survey was lower than what we expected. This could be explained by the remote nature of the activity during a stressful COVID-19 pandemic. Second, there were 13 different episodes that 13 student teams watched and reviewed. It is possible that some of the episodes were more pharmaceutically relevant than others, which may have had an impact on the survey results.

Next Steps

Student perception, based on the survey results, indicated that the curricular activity created a self-directed learning environment that introduced students to the field of forensic pharmacy and strengthened students' knowledge in a few basic sciences. The pharmacy profession is evolving rapidly, and the pharmacist's role to engage in direct and specialized patient care, public and global health, and research and drug development are expanding. The forensic cases can provide learning applications to basic sciences and demonstrate how well a trained forensic pharmacist can be part of a larger solution to support the justice system. The Forensic Science Education Programs Accreditation Commission emphasizes the importance of forensic DNA biology courses.[22] The curriculum of a forensic pharmacy training should include well-established methods in molecular biology (particularly DNA biology), analytical chemistry (particularly chromatography), biochemistry (particularly the role of enzymes and acid/base properties), and pharmacokinetics (particularly toxicokinetics and toxicodynamics).[16,23] Pharmacists are well-equipped to apply their knowledge and training combined with their detail-oriented mindset and expertise in the handling of lab and data analysis to assist the criminal justice system in solving criminal cases.[8] Forensic pharmacy is a broad field, and PharmD programs can apply

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forensic science to generate specialized training courses to expand and/or tailor the role of pharmacists in forensic pharmacy.[8]

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Table 1. Student perceptions of how the forensic pharmacy activity assisted students in promoting their knowledge and skills in a P1 curriculum (n=39)

Assessment Question **The forensic pharmacy activity:**	**% Strongly agree + agree**
increased your interest in the mechanism of action of drug(s) discussed in the forensic files video.	74.4
required my team to effectively communicate to review and identify steps needed to generate an effective report and presentation.	83.8
strengthened my knowledge of pharmaceutical sciences.	75.7
strengthened my knowledge of pharmacology.	70.3
strengthened my knowledge of medicinal chemistry.	54.0
strengthened my knowledge of pharmacokinetics.	70.3
helped me gain skills in how to present data.	75.7
helped me gain critical thinking skills.	75.7
encouraged me to be a self-directed learner.	83.8

Table 2. Student perception on the impact of forensic pharmacy activity on Bloom's taxonomy educational objectives (n=39)[20,21]

Assessment Question **The forensic pharmacy activity promoted:**	**% Strongly agree + agree**
evaluation: In other words, the activity created an environment where you gave defensible opinions and, based on given criteria you have judged the project for accuracy, consistency, logic of information or argumentation.	69.5
analysis: In other words, the activity created an environment where you broke the activity into its constituent parts. You organized, clarified, concluded, or made inferences. This process of analysis helped you understand the relationship among the constituent parts to grasp the big picture you were learning. This helped you to be energized and engaged in the project.	80.6
synthesis: In other words, the activity created an environment where you integrated and combined different elements and parts to create a plan or structure that was not seen by you before.	80.6
application: In other words, the activity created an environment where you used and applied previously learned knowledge from the P1 curriculum in new and concrete situations with a minimum direction.	83.8
comprehension: In other words, the activity created an environment where you comprehended information based on prior learning from the P1 curriculum and translated knowledge into your own words.	86.5
knowledge: In other words, the activity created an environment where you remembered or recognized previously learned material from the P1 curriculum.	83.8

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