

Autopsy Simulation as a Model for Pathology Outreach Among Students

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Abstract

The global shortage of pathologists, driven by rising diagnostic demands and a declining workforce, threatens future healthcare systems. Limited exposure to pathology in medical school and low public awareness contribute to this issue. This study investigates the use of an autopsy simulation to promote early interest in pathology among high school students. Conducted with a rural STEM club, the activity guided students through a mock forensic case involving alcoholic liver cirrhosis. Participants engaged in gross organ examination, histology analysis, and toxicology review, diagnosing the cause of death through collaborative critical thinking. The simulation sparked interest in pathology careers and supported public health education by highlighting alcohol's effects on the body. Its low cost, interdisciplinary design, and scalability make it a promising model for outreach. By introducing students to pathology in an interactive way, such simulations may help address workforce shortages and inspire future careers in medicine and science.

INTRODUCTION

Despite the central role that pathologists play in the healthcare field, the average layperson most likely could not adequately detail the job of a pathologist. Because the role mainly involves reporting diagnoses to other physicians, most pathologists have limited interaction with patients, medical trainees, and even pre-medical students. Even among practitioners in the healthcare field, pathologists are often perceived as tucked away from the public eye. This portrayal of pathology may contribute to the lack of interest students typically have in pursuing this career. Traditional approaches to increasing the pathology workforce have included outreach through guest lectures or shadowing, yet these methods provide little opportunity for exciting hands-on learning that students so often crave. Perhaps a novel approach lies in the use of simulations. Autopsy simulation provides students with an opportunity to engage with pathologists and utilize investigative thought. This approach may give students a hands-on experience that mitigates the ethical barriers of real autopsy observation and the risks of compromising a forensic case. This method aims to spark interest in the field of pathology through accessible, experiential learning.

Pathologist Shortage Worldwide

The role of pathologists includes analyzing fluids, tissues, and cells to diagnose disease. With the recent shift towards preventative care in medicine, the modern landscape of pathology is rapidly changing to accommodate increased demand in both academic and private practices (Gross et al., 2018). Accompanying this flourishing job market are concerns regarding a pathology workforce shortage on a global scale (Walsh & Orsi, 2024). From 2017 to 2022, the number of pathologist job listings in the United States more than doubled, suggesting a widening range of duties and increased demand for screenings and complex diagnostic procedures worldwide (Zynger & Pernick 2023). In the UK, the Royal College of Pathologists reported that among all histopathology departments surveyed, only 3% indicated that there was adequate staffing to meet their workload (Walsh & Orsi, 2024). Other studies demonstrated significant disparities in pathologist-patient ratios, with Poland having the lowest ratio in Europe (one pathologist per every 63,028 citizens) and Niger having the lowest ratio in Africa (one per every 9,264,500 citizens) (Walsh & Orsi, 2024; Märkl et al., 2021). Even in countries with significantly higher pathologist-patient ratios such as the United States, the workforce may have shortages for a variety of reasons. Although ~600 pathology residency positions become available each year in the US, some will remain unfilled. Of those completing residency programs, many pathologists will forgo clinical practice, becoming physician scientists working in laboratories (McCloskey et al., 2020). In addition, 2022 Main Residency Match data revealed that 44% of PGY-1 pathology residency positions were filled by international medical graduates, some of whom would be expected to practice in other countries (McCloskey et

al., 2020). A significant portion of pathology PGY-1 positions being filled by international medical graduates indicates a growing reliance on a global workforce. Many IMGs face visa restrictions or many intend to return to their countries of origin, raising concerns about the long-term stability and self-sufficiency of the US pathology workforce. This trend also may reflect a relative lack of interest or awareness among US medical graduates about pathology as a viable specialty. As a result, surveys from the College of American Pathologists have shown that ~26% of open pathologist positions go unfilled each year (Gross et al., 2023). Some specialties such as forensic pathology face a larger recruitment crisis; there are currently ~700 board-certified forensic pathologists practicing in the U.S., yet more than 1,200 are needed to adequately serve the population (Tatsumi & Graham, 2022). The need for pathologists exists on a global scale, prompting a need for increased recruitment efforts toward medical students earlier.

Exposure and Recruitment Challenges

Surveys among medical students have provided insight into possible barriers to increasing the number of students pursuing pathology. In these surveys, many students felt they had not been sufficiently exposed to pathology to consider it as a career choice (McCloskey et al., 2020). 30-40% of students found the roles of a pathologist to be unclear, which may further signify a lack of exposure both before and during medical school (Tatsumi & Graham, 2022). Another survey revealed that 55% of allopathic and 53% of osteopathic students decided on their specialty during the third year of medical school (McCloskey et al., 2020; George et al., 2022). Factors such as exposure to role models, clinical experiences, and earning potential have been found to significantly influence medical students' specialty choice (Yoon et al., 2018; Azok et al., 2024). Considering the fact that pathology is not often a required core rotation in medical students' third year during which the majority of these students determine their specialty, one solution to increasing pathology interest may lie in increasing the number of pathology-related experiences before the fourth year of medical school.

Surveys also found that 16% of allopathic students and 24% of osteopathic students determined their specialty before matriculation into medical school (George et al., 2022; Schukow et al., 2023). The Association of American Medical Colleges reports an even higher rate, with 26-28% of students remaining in their desired pre-matriculation career interest at graduation (Association of American Medical Colleges, 2022). These values can vary among specialties, with psychiatry holding a higher retention rate from matriculation to graduation (59%) than surgery (24%) (Westfall et al., 2025). Additionally, of the students applying for PGY-1 pathology positions, 25% reportedly had already chosen to pursue pathology before medical school (George et al., 2022; Schukow et al., 2023). Though these surveys also report that a majority of students match into a specialty different from their initial preference during pre-clinical years, the significant percentage of students

matching into their pre-matriculation specialty interest indicates a possible avenue for workforce outreach. The exposure of young adults to pathology even before matriculation – such as during the high school or undergraduate years – may be beneficial for the recruitment of future pathologists. Multiple high school and undergraduate early exposure programs have noted increased interest in health careers following program attendance (Affini et al., 2024; Gunaldo et al., 2018; Sugarman et al., 2024). However, most pathology subspecialties differ from typical healthcare fields in their relative lack of patient interaction, rendering pre-medical exposure programs less helpful in the recruitment of pathologists. There are few early exposure programs in the U.S. customized for increasing pathology interest in high school and undergraduate students. Due to the global concern for pathologist shortages, a demand exists for increased pathology education resources and exposure programs to both increase awareness of the career and foster interest in pathological specialties.

METHODS

To study the efficacy of autopsy stimulation we obtained ATSU-KCOM, IRB (SM-001). To evaluate the efficacy of autopsy simulation as a model for pathology outreach, a high school STEM club in a rural area was recruited to participate in an autopsy simulation. All aspects of the simulation were approved by high school STEM staff prior to the simulation to determine the most age-appropriate topics. Students were first given this prompt:

“You are a new pathologist working in Adair County. A case was brought in this morning when a 30-year-old male was found face down, deceased in the kitchen by his wife. According to his family, he was always in good spirits and “perfectly healthy” from what they could gather, but he often refused to go to the doctor. There is a history of colon cancer in his family (uncle), but otherwise everyone else is healthy. His family is requesting an autopsy, because he is young and no one knows why he died. You can ask the investigator any questions you want about the scene, as well as ask the wife questions you think are important (ex: what was his mood lately, what did he last eat, have you seen him get in a fight recently?) Once you have all the information you need from the family, it’s time to perform the autopsy. Rotate through each station and take note of things pertinent to the death investigation. Use the worksheet as a guide, but feel free to add whatever else you think might be important.”

Students were then given instructions to investigate the cause of death for a “patient” using clues from three stations, each representing the basic stages of an autopsy as detailed in “Principles of Forensic Pathology”: external exam, internal exam, and additional testing (Ely & Gill, 2023). The external exam station featured a live, human model. His skin was dressed in yellow makeup and bruising patterns along the arms and legs - a common presentation among

decedents with liver cirrhosis. Students documented the decedent's clothing, injuries, and stage of decomposition. Students were also instructed to collect fingerprints, height, and weight to aid in the confirmation of the patient's identity.

The internal exam station featured plastic organs and scales. Students documented gross pathologies such as tumors, ulcers, and other color changes. The liver was painted patchy-yellow mimicking a cirrhotic liver. Ulcers were found in the stomach lining, and large nodes made from clay were plastered onto the large intestine to represent the slightly higher incidence of colon cancer among patients with alcoholism. Students also weighed organs and were given "normal ranges" to determine if organs were normal or abnormal; weights can be useful for determining potential pathologies involving atrophy, hypertrophy, or edema. Though current studies show that liver cirrhosis is not associated with a significant change in weight, the liver in this activity was weighted to be below the normal range indicating atrophy, for simplicity's sake. The spleen and kidney were enlarged due to portal hypertension, and the heart was above normal weight due to cardiomegaly that may occur in patients with chronic liver dysfunction.

The final station detailing additional studies featured three histological images of organs belonging to the "patient" alongside photos of healthy organs. Students were asked to compare the patient's histology slide with the control slide and determine whether the patients were abnormal. A bone slide depicted osteoporosis, of which alcohol consumption is a risk factor. A liver slide depicted heavy fibrosis characteristic of liver cirrhosis, and a brain slide was provided depicting the loss of cytoplasm surrounding nuclei, indicative of neuronal damage. Although microscopic bone and brain specimens are not often analyzed in the forensic setting when investigating alcohol-induced liver disease, these additional photos were provided to increase student exposure to histology and pathology. This station also featured five drug testing strips, each showing negatives for morphine, cocaine, marijuana, ketamine, and methamphetamine. After students completed the worksheet and rotated through stations, they gathered for a discussion and debrief of their findings. Qualitative feedback was welcomed and recorded during this time.

RESULTS

After investigating the clues provided, students shared their findings in a group and discussed possible causes of death. Several students successfully deduced the cause of death as "complications arising from alcoholic liver cirrhosis." Students cited jaundice, abnormal gross/microscopic appearance of the liver, and negative toxicology findings as evidence of the diagnosis, though further discussion was warranted to demystify other gross abnormalities found at each station. Students were educated on the significance of the evidence presented as well as the physiologic processes beyond them, such as increased bruising found on the patient due to impaired liver function decreasing the production of clotting factors. These explanations led to broader discussions

regarding the effects of alcohol on the body – detailing how chronic, excessive use of alcohol exacerbates damage to the heart, liver, bones, and various other organs.

Beyond learning the content, the students had strong engagement with the material simulated in the activity. Facilitators observed that students questioned all the evidence, discussed differential diagnoses, and collaborated to connect the medical narrative, mimicking the investigative career of pathology. The simulation setting encouraged peer-to-peer learning, as students had to explain their reasoning and challenge one another's interpretations. The interactive format of the simulation also appears to support diverse learning styles. Visual learners benefited from examining gross pathology specimens and histologic slides, while tactile learners were engaged by touching different evidence stations and assembling the case collaboratively. Seeing the students being able to contribute to the discussion with minimal medical education suggests the simulation was appropriately taught to support students of various levels of background knowledge. The simulation also fostered an early professional identity by allowing students to mimic the role of a pathologist. They were encouraged to approach the case as a pathologist, drawing connections between findings, and considering the systematic impact of disease.

Many students had a new appreciation for the work of pathologists, which challenged the common perception that pathology is a field disconnected from patient care. Informal feedback from both students and teachers was positive with many students stating that the hands-on nature of the simulation deepened their understanding of the medical consequences of chronic alcohol misuse. Some students also asked about future opportunities to explore pathology or participate in similar simulations at the school. This simulation experience was a success for high school students, as it fostered critical thinking and collaboration. In addition, this event brought exposure to the field of pathology and the crucial, exciting work done by pathologists. This early exposure hopefully will encourage these high school students to explore the career of pathology and aid in reducing the pathologist workforce shortage in the future generation.

DISCUSSION

The autopsy provides an exciting, thought-provoking introduction to the work of pathologists. To solve this case, students had to consider diseases typically confirmed by pathologists working in various subspecialties, such as neurology, oncology, or infectious disease. This also provided an engaging setting for students to apply basic cytology principles to real-world problems. Feedback from this event was overwhelmingly positive; Students actively engaged in both the simulation and the following discussion, indicating that hands-on activities can significantly increase student interest in pathology and awareness of alternative career paths in medicine.

An unforeseen, added benefit of this event included the opportunity to discuss with high schoolers the risks associated with substance addiction. In a

2023 report by the Centers of Disease Control and Prevention (CDC), 22.7% of high school students reported alcohol use, making alcohol the most commonly used drug among teens (Hoots, 2023). The CDC also reported that 4,000 individuals under 21 years of age die from excessive alcohol use annually (Centers for Disease Control and Prevention [CDC], 2025). By participating in this activity, students saw first-hand the physical effects of alcohol abuse that might be seen in a real-life autopsy. Thus, students were able to logically and objectively assess the threat of substance abuse and make informed choices beginning at an early age. This crossover reinforces the value of interdisciplinary simulation-based learning as a tool for fostering career exploration and health education.

Given the low cost and design of this simulation, it can be adapted for other high schools or undergraduate institutions for pathology and STEM outreach. The curriculum can be modified to use various pathologies producing gross abnormalities in the human body, such as myocardial infarction with coronary vessel modeling or pulmonary embolism with lung dissection models. Use of the autopsy simulation in undergraduate pre-medical organizations may be effective in recruiting future pathologists directly.

SIGNIFICANCE

The success of the activity demonstrates the potential for pathology-focused simulations to be integrated into high school anatomy classes and undergraduate pre-medical programs. Other high school and undergraduate pre-medical programs have recently reported increased interest in healthcare fields in students with early exposure to medicine (Affini et al., 2024; Gunaldo et al., 2018; Sugarman et al., 2024). High school students' engagement and voiced interest in this simulation demonstrate its promise as an outreach tool. Participating students will not only be exposed to pathology careers, but also begin to develop clinical reasoning skills at an early age. While challenges may present themselves, particularly in introducing histological concepts to students with limited backgrounds, the model offers a scalable, low-cost approach for early pathology outreach in high school and undergraduate settings.

LIMITATIONS

One limitation of this activity was the low exposure to histology in high schoolers, as well as their limited knowledge of diseases. Future simulations could include an introductory lesson on histology and use of virtual microscopy tools to better prepare students for the simulation. While this activity was successful in giving students an introduction to histology and gaining interest in pathology, the approach may be more suited for individuals studying microbiology, infectious disease, or cancer biology at an undergraduate level. Additionally, this study could only provide qualitative data regarding students' interest in pathology careers after participating in the simulation. The study was not intended to measure students' continued interest in pathology through high

school, college, and medical school.

CONCLUSION

The dwindling pathology workforce is a cause of concern, with rising caseloads and unfilled pathology positions having the potential to increase rates of physician burnout and early retirement (Gross et al., 2023). Additionally, the global shortage of pathologists is a threat to timely and accurate diagnostic services (Zynger & Pernick, 2023). Despite the increased demand for diagnostic services, pathology remains underrepresented in medical education and career exploration prior to medical school, which contributes to the decreasing workforce (Walsh & Orsi, 2024). Surveys among medical students have demonstrated a need for career outreach during the pre-clinical years of medical school or even earlier (McCloskey et al., 2020). This study implemented an autopsy simulation in a rural high school STEM club to assess whether hands-on, case-based simulation could serve as an effective outreach model. The simulation successfully engaged students in active problem-solving and diagnostic reasoning while introducing principles in gross pathology and histology. Participants demonstrated strong critical thinking skills and collaborated to identify the cause of death, using evidence from multiple stations. In addition to meeting our educational objectives, the simulation created opportunities for public health conversations around the effects of chronic alcohol abuse on organ systems (MacKillop et al., 2022). Feedback from students was overwhelmingly positive, with many expressing interest in pathology as well as a greater appreciation for the specialty's role within the healthcare team. As the demand for pathologists continues to grow, novel interventions such as this simulation may empower future professionals to reduce critical gaps in diagnostic medicine

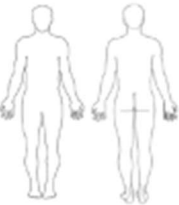
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APPENDIX A

Figure 1. Autopsy Report Form Given to Students

Investigator Name _____ Case # _____								
Autopsy Report								
Who is the Decedent?								
Name _____								
Age _____								
Sex _____								
Clothing _____								
Tattoos _____								
Other Marks _____								
Age	Race	Sex	Length	Weight	Teeth	Hair	Scars	
Blood Type		Toxicology Results		Signs/Marks		Liver/Marks		
Marks and Remarks				Injuries - Trauma				
								
Probable Cause of Death _____								
Date of Autopsy _____				Signature _____				

Pathologist Name _____ Case # _____		
Autopsy Report		
Organ	Weight	Remarks
Heart		
L Lung		
R Lung		
Spleen + pancreas		
Liver		
R Kidney		
Exam		
Insert Section 42		
Width	Length	Remarks
Stomach contents / appearance		
Intestinal appearance		
Toxicology		Final/Negative Result
Cocaine		
Barbiturates		
Morphine (heroin)		
Insulin/phenytoin		
Cocaine		
Investigator notes		
Brain/Abscesses		
Brain/Abscesses		
Liver/Abscesses		
Manner of Death: Accident, Natural, Homicide, Suicide, or Undetermined?		
Cause of death		Signature