

Analysis of an anatomy laboratory for microbiological contamination

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ABSTRACT

Aim: In order to prevent any microbiological contamination in laboratories, it is vital to determine both routine microbiological screening and the appropriate protocol. This study was based on this hypothesis and discussed the microbiological contamination and prevention procedures in an anatomy laboratory.

Methods: The study was carried out on 34 different spots in an anatomy laboratory. Swab samples taken from these points were examined for contamination and contamination was detected. The samples were taken from various locations, including the head, upper and lower extremities of both male and female cadavers, the door handle, the floor in front of the door, the faucet, the head, body, and foot parts of the dissection table, the dissection tool, the trailer, the inner and outer coating of the cadaver pool, the sink, the floor in front of the window, the stool, the living room wall, the formaldehyde liquid in the cadaver pool, the window handle, the instrument table, the morgue unit, the exterior surfaces of three different organ storage boxes, the inner surface of an organ storage box, the medical waste container, the handle of the organ storage cabinet, a training model, the lower surface of the dissection table, the medical waste storage box for dissection, and the blackboard.

Results: *Bacillus subtilis* was found in 16 out of 34 different spots and mold fungus was found in 2 of them. No contamination was detected in the remaining 16 spots. 69% of the spots were directly related to the cadaver.

Conclusion: As a result of our study, the importance of scanning anatomy laboratories in terms of microbiological contamination was highlighted and an appropriate protocol was determined.

Keywords: contamination, anatomy laboratory, microbiological analysis

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INTRODUCTION

The areas where students are taught together are of great importance for the spread of infectious agents and maximum attention should be paid to the disinfection of these areas (1,2). Due to the easy spread of bacteria, bacterial contamination in research laboratories where students are taught is of critical importance (3-5).

Taking precautions against biological agents and substances that pose a threat to humans is called biosafety (6). Several biosafety measures should be taken to minimize the spread in research laboratories. These measures can be listed as eliminating routes of transmission, providing educational information, controlling the risk factors, reducing exposure, scanning both individuals and laboratories at regular intervals, drafting a biosafety manual, posting warnings for contamination, establishing a routine cleaning procedure, providing training for waste management, providing, and controlling protective materials (3,6,7). Basically, these measures can be examined in two categories. The first category is the safety of the laboratory and the individuals in the laboratory, while the second one is the safety of the external environment of the laboratory (8).

Biological threats in research laboratories have been classified into four different groups. The first group is biological threats that do not cause any diseases in humans, the second group is biological threats that cause diseases in humans but do not spread. The third group is biological threats with a risk of spread that cause serious human disease, but for which there is an effective treatment. The fourth group is biological threats that cause serious diseases in humans, with a risk of spread, but for which there is no effective treatment (8).

Research laboratories are classified into four different biosafety levels: basic laboratories with a biosafety level of 1 (BSL-1) and biosafety level of 2 (BSL-2), isolation laboratories with a biosafety level of 3 (BSL-3) and high containment laboratories with a biosafety level of 4 (BSL-4) (9). BSL-1 research laboratories are laboratories that can be run with substances or agents that have a minimal impact on the environment and

individuals. BSL-2 are laboratories that can be operated with substances or agents of moderate impact. BSL-3 are laboratories that can be operated with substances or agents that may have a high impact. BSL-4 are those that can be run with substances or agents that may have a high-level impact and for which the route of transmission has not been fully determined (8). Anatomy laboratories are in the BSL-1 category.

Cadavers are the main teaching material in the anatomy laboratory. Infectious agents that may be found in cadavers during the dissection of cadavers for educational purposes are a serious source of contamination, especially for anatomists, students, and doctors. Many clinical conditions such as meningitis, phlebitis, peritonitis, pleuritis, and death have occurred due to this contamination. Prevention of cadaveric contamination has been the subject of research for many years and various procedures have been developed. However, the results of these studies are still inconclusive. For example, Burton Tabaac's study on cadaver fixation reported that bacterial growth occurred after fixation (10-12).

The aim of the present study is to review the state of the Karabük University, Faculty of Medicine Anatomy Laboratory in terms of microbiological contamination and to provide guidance to other laboratories on the precautions that can be taken.

MATERIALS AND METHODS

The study was carried out in the practice laboratory of Karabük University Faculty of Medicine, Department of Anatomy. The study was carried out with the approval of the non-interventional local ethics committee of Karabük University, dated 20.01.2022 and number 2022/785.

Cotton swabs were used to collect samples from 34 different areas, starting from the area closest to the laboratory door and including the furthest point, to determine the microbiological contamination in the anatomy laboratory. The samples were taken from various locations, including the head, upper and lower extremities of both male and female cadavers, the door handle, the floor in front of the door, the faucet, the head, body, and foot parts of the dissection table,

the dissection tool, the trailer, the inner and outer coating of the cadaver pool, the sink, the floor in front of the window, the stool, the living room wall, the formaldehyde liquid in the cadaver pool, the window handle, the instrument table, the morgue unit, the exterior surfaces of three different organ storage boxes, the inner surface of an organ storage box, the medical waste container, the handle of the organ

storage cabinet, a training model, the lower surface of the dissection table, the medical waste storage box for dissection, and the blackboard (Figure 1).

The collected samples from the surfaces were also categorized into two groups: those directly associated with the cadaver and those that were not directly associated with the cadaver (Table 1).



Figure 1. Sample collection phase (a: Door handle, b: Faucet, c: Body of the dissection table, d: Outer coating of the cadaver table).

Table 1. Areas directly associated and not associated with the cadaver.

Areas directly associated with the cadaver	Areas not directly associated with the cadaver
Head, body and foot parts of the dissection table	Door handle
Dissection tool	The floor in front of the door
Trailer	Faucet
Inner and outer coating of the cadaver pool	Window handle
Formaldehyde liquid in the cadaver pool	Handle of the organ storage cabinet
Head, upper and lower extremities of a male cadaver	A training model
Head, upper and lower extremities of a female cadaver	Sink
Instrument table	The floor in front of the window
Morgue unit	Stool
Exterior surface of the three different organ storage boxes	Living room wall
Inner surface of an organ storage box	Blackboard
Medical waste container	
The floor of the dissection table	
Medical waste storage box for dissection	

The samples were transported to the microbiology laboratory at Karabük University Training and Research Hospital under cold chain conditions. Following the study protocol, the samples were incubated and bacterial identification was performed by a specialized microbiologist using BD Phoenix M50 (Canada).

A sterile standard transport medium was used to transport the collected samples to the laboratory. The samples were then inoculated onto blood agar, EMB, and chocolate agar. After inoculation, the samples were incubated for 24 hours at 35-37 °C in an incubator. The next day, bacteria grown on Petri plates were included in the identification process. Gram staining was performed by taking samples from bacterial colonies that fell into a single colony on the Petri dish. Bacterial identification was started according to the results. In our study, samples were taken from colonies with Gram-positive bacilli and added to Phoenix ID Broth. A range of 0.5-0.6 was accepted within McFarland. The bacteria were then introduced into the BD Phoenix M50 instrument and identified.

The BD Phoenix M50 device is a bacterial identification and susceptibility testing system with a detailed identification function. The device can identify bacteria

and yeasts at the genus and species level with the chromogenic and fluorogenic substrates it contains.

RESULTS

In the present study, *Bacillus subtilis* was found in 16 of the 34 spots sampled, while mold fungus was found in two and no contamination was found in the remaining 16 spots (Figure 2). *Bacillus subtilis* was found on the dissection tool, formaldehyde liquid in the cadaver pool, the head, upper and lower extremities of both male and female cadavers, the morgue unit, the exterior surfaces of two different organ storage boxes, a medical waste container, a training model, sink, floor in front of the window, stool, the medical waste storage box for dissection, and the blackboard. Mold fungus was found on the floor of the laboratory door and on the instrument table. In the study, only *Bacillus* subtyping was performed, no fungal subtyping was performed.

It was found that 11 of the detected *Bacillus subtilis* contaminations were in areas directly associated with the cadaver, while five were in areas not directly associated with the cadaver (Figure 3). The fact that the contaminated spots are directly associated

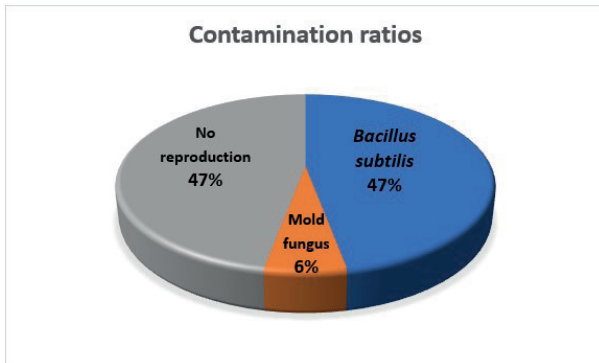


Figure 2. Contamination detected on the surfaces.

with the cadaver indicates that the contamination in the anatomy laboratory is related to the cadaver. Contamination was found in 69% of the 14 spots directly related to cadavers (the head, upper and lower extremities of cadavers, etc.). Further studies are planned to determine whether contamination in the anatomy laboratory is also observed among the personnel working in the laboratory.

Bacterial diseases have not been isolated in our laboratory so far. We attribute this to the strict precautionary procedures applied in the laboratory. Any disruption in these precautionary procedures may cause illness in laboratory staff and students.

DISCUSSION

Samples were collected from 34 different areas in the study. While *Bacillus subtilis* was isolated from 16 (47%) of these, mold fungus was isolated from 2 (6%). It was found that 69% of the samples with *Bacillus subtilis* were from areas directly associated with cadavers.

Numerous investigations have been carried out on the contamination of research laboratories, as well as on the staff and students trained in these facilities, revealing significant findings. In a study examining 96 gowns belonging to medical faculty personnel for contamination, Koç et al. (13) found bacterial contamination in 25% of the gowns. It was determined that 62.5% of the contamination was caused by coagulase-negative staphylococci. Özkeser et al. (14), in a study assessing contamination levels in 20 research and student practice laboratories, found fungal and

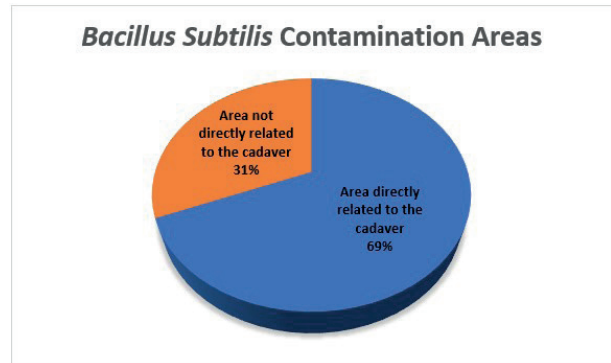


Figure 3. *Bacillus subtilis* contamination areas.

bacterial contamination in 30%. In a study investigating the contamination of mobile phones used by staff in intensive care units and operating rooms, Güldeş et al. (15) reported a contamination rate of 90.6%, with coagulase-negative staphylococci accounting for 57% of the contamination, and the presence of *Bacillus subtilis*. Alpay et al. (16) conducted a study examining the mobile phones of healthcare professionals and found contamination in 17.7% of 45 samples. In a study investigating the risk of microbial contamination in chemistry and microbiology laboratories, Farnsworth et al. (17) took 165 samples from laboratory surfaces and personnel and found contamination in 30% of them. In another study investigating viral contamination in a clinical microbiology laboratory, Wang et al. (18) found contamination in gloves, fume hoods, and clothing. Wurtz et al. (19) included 119 BSL-3 and BSL-4 laboratories in their contamination analysis study and found contamination in 23 of the laboratories. They found 15 different laboratory-acquired infectious agents in 4 of the 23 laboratories where contamination was detected. These studies show that there is always a risk of contamination in research laboratories. In our study, the anatomy laboratory in the BSL-1 category was used, and *Bacillus subtilis* was found in 16 of 34 spots and mold fungus in 2 of them. The fact that 11 of them are directly related to the cadaver in the areas where contamination is detected suggests that the cadaver is a major source of contamination. When we look at the literature, it is clear that laboratories and laboratory equipment used for different purposes in different categories are at risk of contamination. This can be true even for laboratories where some protective and sterilizing

substances are used. One of the best examples of this is the presence of contamination in cadaver pools and cadavers despite the use of formaldehyde.

Cadavers are the primary source of contamination in anatomical laboratories. Examination of historical accounts reveals instances in the literature where physicians, particularly anatomists who provide cadaver training, have succumbed to cadaver contamination. For instance, Anatomist Dr. Marie-Francois Xavier Bichat, renowned as the father of hematology, and the contamination-related deaths of students and anatomists in William Hewson's Department of Anatomy in Philadelphia serve as striking examples of this phenomenon. Many diseases such as Hepatitis B-C, HIV, prion diseases, Tuberculosis, and Creutzfeldt-Jakob disease have been reported in the literature due to cadaver contamination. The widespread use of cadaver embalming and fixation solutions and the more frequent application of appropriate procedures have reduced cadaveric contamination (11,20-22).

Biosafety procedures are indispensable factors in preventing this contamination. According to biosafety procedures, research laboratories should be cleaned at least once a day and appropriate disinfection or sterilization methods should be used in laboratories, the management scheme of research laboratories should be clear and management personnel should inspect both laboratories and personnel on a daily basis, warning signs should be displayed in areas or on substances susceptible to contamination and the personnel in research laboratories should be trained regularly. In addition to these, procedures should be established for the disposal or recycling of waste materials, ensuring a consistent supply of appropriate protective materials to meet the needs of research laboratories and implementing regular ventilation procedures for these laboratories. In addition, transmission routes in research laboratories should be determined and precautions should be taken, the physical infrastructure of research laboratories should be improved, and maximum safety conditions should be established (2,3,6-8,11,17).

The results of this study show the potential risk of contamination in anatomy laboratories and emphasize

the utmost importance of following biosafety protocols. The risk of contamination is evident even if these procedures are suspended for a short period of time. In summary, the recommended precautions include regular training, consistent sterilization practices, and periodic audits of precautionary procedures. We believe that this study will contribute to the literature by providing a reminder of contamination risks and precautions in the anatomy laboratory.

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Ethical approval

This study has been approved by the Ethics Committee of Karabük University (approval date 20.01.2022, number 2022/785). Written informed consent was obtained from the participants.

Author contribution

Concept: YS, ŞT, HS, EB; Design: YS, ŞT, HS, EB; Data Collection or Processing: YS, ŞT, HS, EB; Analysis or Interpretation: YS, ŞT, HS, EB; Literature Search: YS, ŞT, HS, EB; Writing: YS, ŞT, HS, EB. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

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