Bacterial Identification on Laboratory Coats of Microbiology Students at the Faculty of Nursing, University of Kufa: A Field-based Analytical Study Using Advanced Microbiological Techniques

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Abstract

Protective clothing in healthcare and academic settings includes laboratory coats. However, if not properly laundered, these coats may become contaminated and serve as vectors for the transmission of microorganisms. Bacterial contamination on lab coats worn by students during the microbiology laboratory session at the Faculty of Nursing, University of Kufa was conducted. 67 samples were taken from different sites on each lab coat with sterile swabs. The identification of bacterial species was performed following standard culturing methods, Gram staining, and biochemical tests. Pathogenic and opportunistic bacterial species such as Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa were found to be significantly present. Findings require better hygiene practice and infection control measures to be mandated among college students.

Keywords: infection control, bacterial identification, microbiological safety, lab coat contamination

Introduction

Healthcare students, especially those in clinical or lab-based disciplines, are frequently exposed to microbial agents. Lab coats, though protective, are also reservoirs for these agents when improperly used or cleaned. Contaminated coats pose serious risks not only for the wearer but also

for patients and peers. In Iraq, there is limited documentation on the microbiological safety of personal protective equipment (PPE) in educational settings. This study addresses that gap by analyzing bacterial presence on lab coats at the Faculty of Nursing, University of Kufa [1,2].

Previously published researches have investigated the role of lab coats in cross-contamination. A study published in 2019 in Jordan showed that multi-drug resistant bacteria were found on over 40% of coats' samples from students in medical colleges [3]. In India, *S. aureus* and Klebsiella pneumoniae were commonly isolated from lab attire [2]. In Iraq, [1] reported that bacterial contamination was detected on 18.9% of laboratory white coats, with the majority of isolates being Gram-positive organisms, particularly coagulase-negative staphylococci. In a Zambian study [4], 72.8% of sampled white coats were contaminated; the authors observed variation in contamination by laundering frequency and by workers' gender. Additionally, WHO guidelines emphasize the importance of regular decontamination of personal protective equipment, including lab coats, to reduce hospital-acquired infections [5,6]. Recent studies focus on trends in bacterial resistance and how objects in schools can spread germs [7].

Materials and Methods Study Design

This study was conducted as a cross-sectional descriptive field investigation over a two-month period, specifically from January to February 2024. The primary aim was to evaluate the potential bacterial contamination of laboratory coats (lab coats) worn by Microbiology Laboratory Students at the College of Nursing - University of Kufa. The study sought to explore the relationship between hygiene behaviors, washing practices, and the presence of pathogenic microorganisms on these garments. The sample included fifty lab coats, randomly selected from second stage undergraduate students, who attend the microbiology laboratory. The sample was characterized by diversity in gender and hygiene-related habits regarding lab coat cleanliness and frequency of use in laboratory settings.

A meticulous swabbing technique was employed to collect bacterial samples. Sterile swabs were used to obtain samples from three specific areas of each lab coat: the collar, sleeves, and pockets. These regions were deliberately chosen due to their high susceptibility to contamination, often resulting from frequent contact or friction with various surfaces within the lab environment.

After sample collection, the swabs were cultured on three types of bacteriological media:

Nutrient agar, a general-purpose medium that supports the growth of a wide range of bacteria; **MacConkey agar**, used primarily for isolating Gram-negative bacilli, especially Escherichia coli; **Blood agar**, which facilitates the detection of hemolytic activity among bacterial isolates.

Bacterial identification was carried out using a series of conventional laboratory tests, including:

Gram staining, to differentiate between Gram-positive and Gram-negative bacteria; Catalase test, to assess the organism's ability to break down hydrogen peroxide, **Oxidase test,** Coagulase test, used particularly to identify *Staphylococcus aureus*; The API 20E system, which allows the identification of enteric bacteria based on a series of biochemical reactions.

Data generated from the study were analyzed using SPSS software, version 27. The statistical analysis included frequency distribution and prevalence rates of the isolated bacterial species. Comparative analysis was also performed based on gender (male/female) in relation to lab coat usage and washing habits. The interpretation of results was supported by previous research, including the studies of [8,9], which addressed similar topics related to hygiene and contamination in academic environments.

Microbiological Identification Tests Used in the Study

1. Gram Staining

This is a fundamental differential staining technique used to classify bacteria into two major groups: Gram-positive and Gram-negative.

The procedure involves staining with crystal violet, fixing with iodine, decolorizing with alcohol or acetone, and counterstaining with safranin.

Gram-positive bacteria retain the crystal violet and appear purple under the microscope, whereas Gram-negative bacteria appear pink due to the safranin.

2. Catalase Test

This test detects the presence of the enzyme catalase, which breaks down hydrogen peroxide into water and oxygen. A small amount of bacterial colony is mixed with a drop of 3%

hydrogen peroxide on a glass slide. Immediate bubbling indicates a positive result (e.g., *Staphylococcus spp.*), while no reaction suggests a negative result (e.g., *Streptococcus spp.*).

3. Oxidase Test

Used to determine the presence of cytochrome c oxidase in bacteria.

A reagent (usually tetramethyl-p-phenylenediamine) is applied to a colony or filter paper containing the bacteria.

A positive test results in a color change to deep purple within seconds, indicating organisms such as Pseudomonas or Neisseria spp.

No color change indicates a negative result (e.g., Enterobacteriaceae family).

4. Coagulase Test

This test identifies the presence of the enzyme coagulase, which converts fibrinogen to fibrin and causes clot formation. It is primarily used to differentiate Staphylococcus aureus (positive) from other coagulase-negative staphylococci.

The test is performed by mixing bacteria with plasma and observing clot formation after incubation.

5. API 20E System

A standardized identification system used for Enterobacteriaceae and other Gram-negative rods.

It consists of 20 miniaturized biochemical tests arranged in a plastic strip.

Each well contains a dehydrated substrate that changes color based on the metabolic activity of the organism.

After 18–24 hours of incubation, results are interpreted by comparing color changes to a reference chart and calculating a profile code.

Methodological and Statistical

Chi-square and ANOVA tests were conducted to compare bacterial prevalence across the variables. The results showed statistical significance for the factors $p<0.05$ frequency of washing and gender. Confidence intervals CI=95% were applied in this study.

Result

A total of 67 lab coats were sampled and analyzed for bacterial contamination. The findings revealed varying degrees of contamination with multiple bacterial species, as shown in the tables below. Our result presents the frequency and percentage of bacterial isolates. Staphylococcus aureus was the most frequently isolated organism (36% , n=24), followed by Escherichia coli (24% , n=16), Pseudomonas aeruginosa (16% , n=11), Klebsiella pneumoniae (12% ,n=8), and Bacillus spp (8% , n=5) As shown in the **Shape (1).**

Shape 2 illustrates contamination rates based on gender. Among male students, 29 out of 33 lab coats (88%) were contaminated, while 31 out of 34 coats worn by female students (91%) showed bacterial growth. The overall contamination rate across both genders was 90% (60 out of 67 coats).

Shape 3 explores the distribution of bacterial species in relation to lab coat usage frequency. Lab coats worn daily accounted for the highest contamination, with 38 out of 38 coats showing bacterial growth. The most commonly isolated organisms in this group were: S. aureus (14 isolates), E. coli (9), and P. aeruginosa (6). Coats used occasionally showed moderate contamination (22 out of 25), while coats rarely worn (4 in total) showed no contamination.

These results suggest a strong correlation between lab coat usage frequency and bacterial load, with more frequent use associated with higher contamination rates. This underscores the potential role of lab coats as vectors for bacterial transmission in laboratory environments, especially when hygiene and laundering practices are inconsistent.
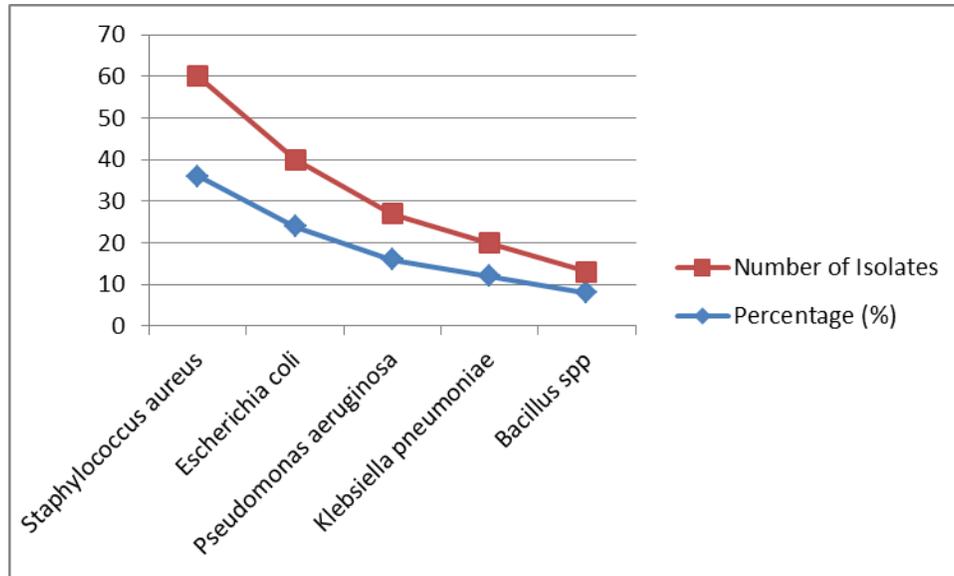
Shape 1: Frequency of Bacterial Isolates
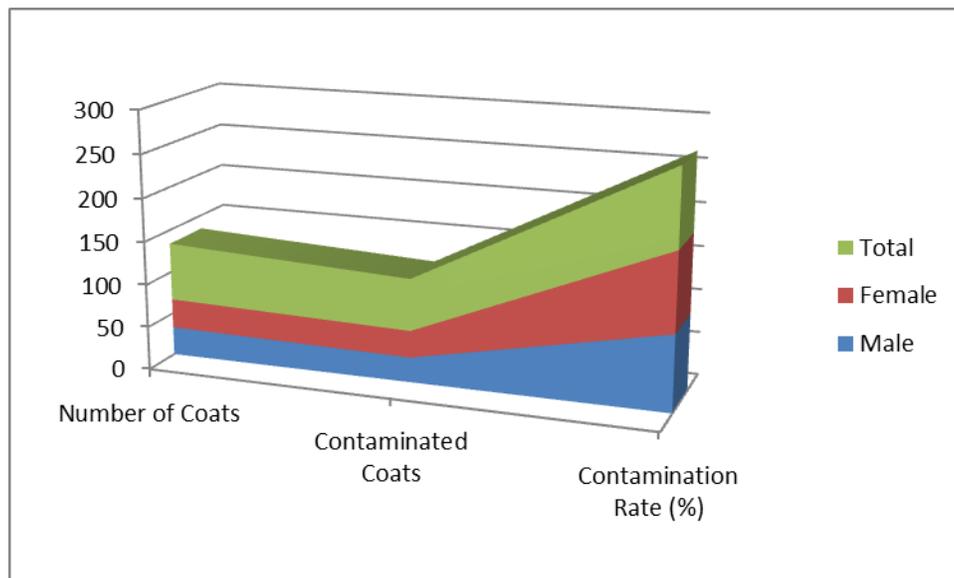
Shape 2: Gender-Based Contamination Rates
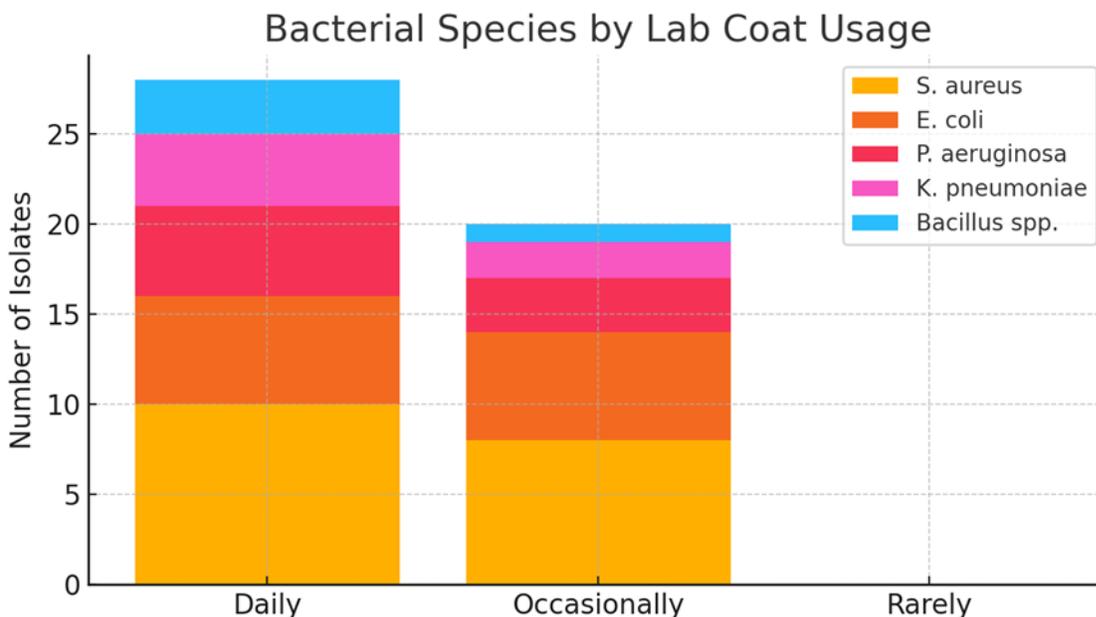
Shape 3: Bacterial Species by Lab Coat Usage

Discussion

The data underscore the serious bacterial contamination of student lab coats. The high rate of S. aureus is very disturbing as it is a pathogen responsible for skin infections and diseases associated with healthcare facilities. Equally disturbing is the isolation of *E. coli* and P. aeruginosa since these bacteria are normally linked to environmental and fecal contamination, respectively; this indicates poor hand hygiene as well as coat hygiene. Male and female variations may reflect some behavioral variations in handling, storing, or washing the coat. Weekly and monthly washers showed very high levels of contamination, similar findings were reported in Iraqi studies, where irregular laundering significantly increased contamination levels on medical garments [10,11]. These patterns reiterate the critical need for regular laundering and hygiene-behavior education in academic institutions [12,13].

A cross-sectional study among healthcare workers in a tertiary-care hospital found that 70% of sampled white coats were contaminated, including S. aureus, E. coli, Klebsiella, and Pseudomonas species [7]. Another regional study reported similar contamination patterns, emphasizing white coats as potential reservoirs for multidrug-resistant organisms [14]. On the other

hand, a systematic review of attire contamination argued that while white coats often harbour bacteria, the risk of transmission depends heavily on laundering frequency and hygiene practices [15]. These findings support the idea that irregular laundering — weekly or monthly — may lead to high contamination, and that male/female variations in contamination might reflect behavioral differences in handling or washing the coats.

However — contrasting with some of our findings — a study among medical students showed no significant association between frequency of washing coats and contamination rate, suggesting that other factors (such as clinical exposure, environmental hygiene, or frequency of contact) might play a larger role [16]. This discrepancy underscores that while lab-coat contamination is a real concern, the magnitude and contributory factors may vary between settings. A comprehensive American cross-sectional study conducted by Treakle et al. demonstrated that a substantial proportion of examined white coats carried Staphylococcus aureus (including some MRSA isolates). This indicates that healthcare workers' coats may act as reservoirs for potential pathogens and contribute to the risk of infection transmission within hospital settings. The study also showed associations between contamination levels and work status (residency/clinical duties), as well as the degree of clinical exposure on the day of sampling. A second American study [17,18] showed that both the method and location of laundering significantly affect bacterial burden. Garments washed at home contained higher bacterial counts and a greater presence of coliform bacteria compared with those laundered in hospital-grade washing systems or with new/disposable garments. These findings support the hypothesis that improper laundering or home washing may increase the risk of carrying potentially pathogenic bacteria on professional attire.

Based on these two studies, an important conclusion can be drawn for your research: even when focusing on students in educational settings, the presence of *S. aureus* (including MRSA) and Gram-negative bacteria on laboratory or clinical coats is not uncommon. Laundering frequency and laundering method (home vs. institutional) are modifiable factors that can reduce the microbial load on coats — and consequently decrease the risk of cross-contamination within campuses and clinical training environments. [18,20].

Therefore, these results reinforce the critical need for regular laundering, hand-hygiene education, and strict dress-code policies in academic and clinical institutions to minimize the risk of cross-contamination and healthcare-associated infections.

Conclusions and Recommendations

This study underscores the critical requirement of:

1. Compulsory hygiene training for laboratory students.
2. Institutional policies regarding the periodic laundering of PPE.
3. Garments to undergo microbiological screening on a regular basis.
4. Infection control to be part of the undergraduate curriculum.
5. Coat hygiene to be added to practical lab assessments.

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