Microbial Sampling and Analysis taken from Laboratory white Coats Staff Working at Al-Yarmouk Teaching Hospital

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Laboratory white coats, Bacteria, Fungi contamination, Hospital, Antimicrobial

ABSTRACT
Lab coats are protective elements to people working in health care and researches that separates them from pollutants. However, if not properly used, it can be a source of multiple microbiological contaminations. This study was done at AL-Yarmouk Teaching Hospital-Baghdad, during from 15th November 2023 to 15th March 2024. It was designed to find the most common bacteria, fungi and yeasts that might be present on staff lab coats. 53 samples (106 swabs) were cultured after collected from the sleeves and pockets of staff Lab coats and observed the antimicrobial susceptibility in lab swabs culture for 14 isolates out of 106 swabs belonged to Gram positive bacteria and sensitivity patterns against 16 antimicrobials. Gram positive bacteria found to be the most common organisms in lab coats represented by Microbiology unit with 71.4%, followed by Phlebotomy units 21.4% , which represented by Coagulase-negative Staphylococci(CoNS) Staphylococcus epidermidis (43.9%),Staphylococcus haemolyticus and Staphylococcus warneri (21.4% ,14.3%) respectively. , It turns out, higher bacteria growth in female Lab coats)85.7%(than in male)14.3% (and in sleeves)15.1%(than in pockets(11.3%) ,in addition , increased response to sensitivity test for antibiotics , especially Tigecycline antibiotic 100% ,Gentamycin, Levofloxacin, Moxifloxacin, Teicoplanin and Rifampicin (92.9%),as well others but in varying degrees , and not any type of fungi were isolated. In conclusion, Gram positive bacteria population was the most common organisms, higher prevalence of microbial infection in female than in men and increased of antibiotic sensitivity specially Tigecycline antibiotic, however, should proper maintenance and educational practices must be applied to minimize contamination.

1. Introduction

Hospital environment constitute as a strong contributor to the pervasive cases of hospital acquired infections (HAI) (Akanbi et al.,2017). A white coat or the laboratory coat is one of the personal protective equipment's (PPE) to protect workers in the laboratories and other health care workers from the microbial contamination of skin and clothing as a consequence of direct contact with different laboratory samples or direct contact with patients, which are un avoidable in hospital environment at all. (Burden et al., 2013; Naik et al., 2016). Should wear lab coat only in the workplace to avoid tracking contaminants home and prevent bodily harm and never disregard the potential for laboratory hazards, even that safe the workplace activities may seem. (Environmental Health and Safety,2022) The white coat used by physicians, pharmacists, nurses, physician assistants, dentists, in spite of that white coats are known to be potentially contaminated with pathogenic bacteria and there has been always a concern about the risk of transmitting pathogenic bacteria in hospital settings (Robati et al., 2013) and it may play a big role in transmitting infections within and outside hospital setting (Hamilton, 2017; Samsan et al., 2021). However, there are few reports of fungal contamination in lab coats, which does not mean that fungal contamination is uncommon or less harmful than the bacterial contamination in this type of PPE (Brandão et al., 2017). A previous study confirmed that laboratories white coats are more likely to be bacteriologically contaminated at points of frequent contact (lapels, pockets, and cuffs), when recorded that methicillin-sensitive and resistant *Staphylococcus aureus,* (MSSA);(MRSA) respectively, also, vancomycin-resistant enterococci (VRE) were isolated from white coats swabs ,when cultured on bacterial media(Cosgrove et al., 2003),In the same context, Qaday et al., from Tanzania and Monawer from Duhok /north of Iraq ,published that most of the Laboratory white coats examined, were contaminated by high percent of gram positive (*Staphylococci* species

) while less percentage by up Gram negative rods (Qaday et al., 2015 ; Monawer, 2018). Several studies have been conducted to estimate the prevalence of significant nosocomial pathogens, and the possible factors linked with infection (Mogan et al., 2012).Patients are likely exposed to many bacteria through direct contact with white coats, curtains, and ties or indirectly through the hands of clinicians, using computer keyboards and cell phones (Cataño et al., 2012),wherever, study in 2022 revealed, that 83% of the coats were contaminated with *Staphylococcus* spp., and antibiotic sensitivity testing showed bacterial isolates on the laboratory coats was 100% resistant to Cloxacillin, Erythromycin, Ceftriaxone, Cefuroxime, Ceftazidime, Augmentin and Oxacillin. (Jesumirhewe et al.,2022)

The Aims:

1-Determining microbial contaminants present in specific parts of Lab staff white coats working in AL-Yarmouk Teaching Hospital in Baghdad.

2-Culturing and identifying any bacterial isolates and conduct an antibiotic sensitivity test to isolates.

3-Direct examination (wet test) of these swabs to confirm if fungi are there.

Materials and Methods

This study designed over a period of 4 months, from 15th November 2023 to 15th March 2024 to reflect the existence of the microbiological contamination in white coats of lab workers at AL-Yarmouk Teaching Hospital in Baghdad capital of Iraq

Samples collection:

Sterile swab stick moistened in sterile normal saline (Sodium Chloride,0.9%) was used to swab on the white coats of laboratories workers. The total study samples were 53(106 swabs each coat have two swabs one from pockets other from sleeves/cuffs), the collection of the sample was performed according to Pluta (Pluta et al ,2013).

Media preparation:

The culture media were prepared using the MediaClave and MediaJet (Integra-Biosciences KK-/Japan). This system can process up to 1100 INTEGRA Petri dishes in a single hour and provides truly fast and reliable walk-away operation media. It is Equipped with a UV lamp, and the filling chamber where Petri dishes are automatically filled with agar medium which is kept free from contamination. (h t t p s: / / w w w. I n t e g r a b i o s c i e n c e s .com/Japan/en /media-preparation/mediajet). The media used in this study include blood agar and MacConkey agars

Bacteriological analysis:

Inoculation of all the swabs on Blood agar and MacConkey agar, were incubated at 35-37°C aerobically for 24-48hours (Jawetz et al. ,2019). Plates were examined daily for bacterial growth, identifying these isolates by using colony morphology, Gram strain of bacteria drawn from bacterial colonies.

Species identification was then carried out using matrix-assisted laser desorption ionization time-of-flight mass spectrometry on a VITEK®2 Compact ID/AST cards device (Biomerieux /France) according to the manufacturer's instructions (Scheer et al., 2019). VITEK®2 Compact device could offer platform for phenotypic identification methods to /more than 300 species of organisms (Gram Positive, Gram Negative, *Neisseria* and *Haemophilus* bacteria). Moreover, this device provided an option of automatic pipetting and dilution for antimicrobial susceptibility testing and all the positive samples for bacterial growth in this study were subjected to 16 antimicrobial susceptibility tests, these results coupled with Biomerieux advanced expert system provide an optimal level of clinically relevant information.

Questionnaire design:

The questionnaire was used to determine their white coats maintenance and handling practices (see the design below)

Statistical analysis:

Analysis of data was carried out using the available statistical package of IBM SPSS-29 (IBM Statistical Packages for Social Sciences- version 29, Chicago, IL, USA). Data were presented in simple measures of frequency, percentage. Value of less than 0.05 was considered as significant value. (Daniel and Cross ,2019)

Sample number ( )

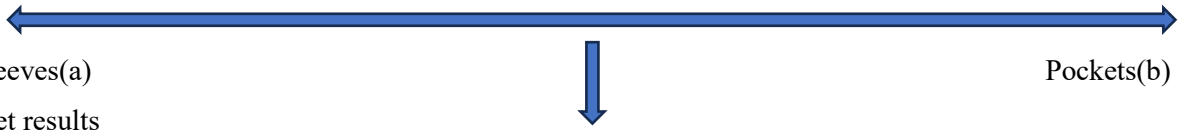
Gender(sex):

Work in Unit (in laboratory building): Work in Unit (out laboratory building):

When was cleaned laboratory coat? Day ( ) Week( ) Month( )

Type(name) of cleaner:

Swab Sample



Sleeves(a) Pockets(b)

Wet results

sensitivity sensitivity

Culture results

Results and Discussion

A total of 106 swabs were collected from the 53 white coats of Lab workers, working in different lab departments inside the hospital. The highest number of swabs were collected from Microbiology laboratory (26 swabs) followed by the Hematology and Burns unit's laboratories (12 swabs for each one) then Phlebotomy, Biochemistry, Medicine and Emergency unit's laboratories (10 swabs for each one), while the least number of swabs (8 swabs) were taken from Dialysis and Surgery unit's laboratories.

Results in (Table 1) showed that the highest rate of contamination of white coats was in the Microbiology unit with 71.4%, followed by Phlebotomy and Medicine unit's laboratory with (21.4% ,7.1%) respectively. On the other hand, Biochemistry, Hematology, Dialysis, Surgery, Burns and Emergency recorded no bacterial contamination in white coats swabs. As well, from total swabs (106), female was 66.1% percentage swabs which exceed that of male who revealed percentage 34%.

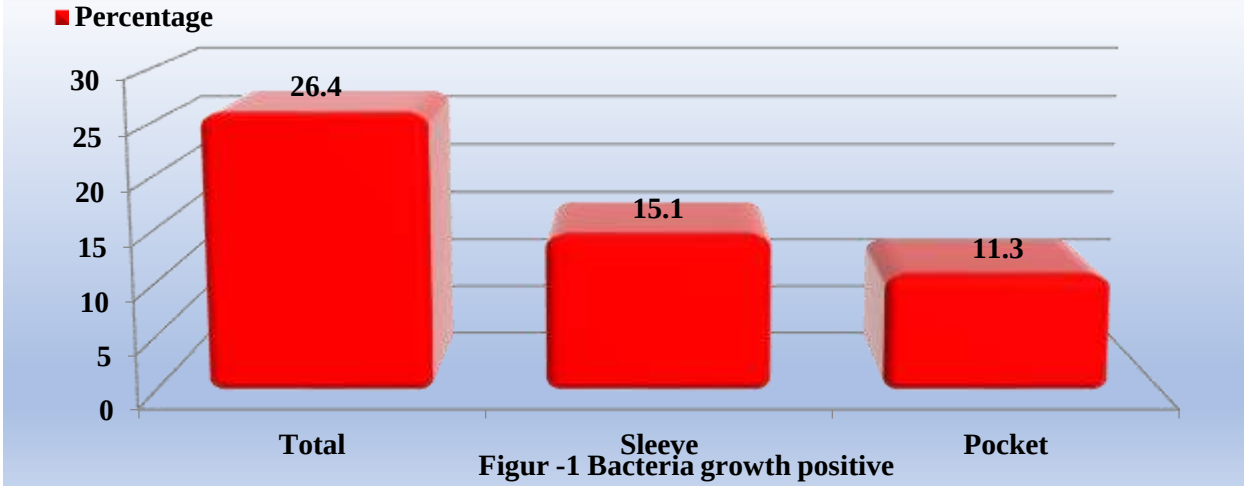
Table 1: Represent the total swabs collected from the two genders and its positive bacterial growth white coats of workers in different laboratories departments in the hospital

Laboratory units	**White coat**			**Swabs**			**Bacteria growth positive**		
	Female	Male	Total	Female	Male	Total	Sleeve	Pocket	Total
Phlebotomy	3	2	5	6	4	10	1	2	3
Microbiology	9	4	13	18	8	26	6	4	10
Biochemistry	3	2	5	6	4	10	-	-	-
Hematology	4	2	6	8	4	12	-	-	-
Dialysis	3	1	4	6	2	8	-	-	-
Surgery	3	1	4	6	2	8	-	-	-
Burns	4	2	6	8	4	12	-	-	-
Medicine	3	2	5	6	4	10	1	-	1
Emergency	3	2	5	6	4	10	-	-	-
Total	**35**	**18**	**53**	**70**	**36**	**106**	**8**	**6**	**14**

From the total percentage (26.4%) of bacterial growth positive in white coats, sleeves showed (15.1%) bacterial growth which was more than pockets (11.3%) but there were no significant differences between them P-value=0.826. (Table 2 and Figure 1).

Table 2. Total positive swabs for bacterial cultures taken from different parts of the Lab workers white coats in hospital departments during the studied period.

	Total (53)	**Female (n=35)**	**Male (n=18)**
Bacteria growth positive Total	14 (26.4%)	12	2
Sleeve	8 (15.1%)	7	1
Pocket	6 (11.3%)	5	1
P value		**0.826**	



Figur -1 Bacteria growth positive

In table-3, *Staphylococcus epidermidis* was the predominance (43.9%) among the Gram-positive bacteria isolated from different swabs, then coagulase-negative *Staphylococcus haemolyticus* and *Staphylococcus warneri* (21.4% ,14.3%) respectively. Whereas coagulase-positive *Staphylococcus aureus* then *Staphylococcus saprophyticus* and *Micrococcus luteus* were the least (7.1%). Female workers displayed high prevalence of positive bacterial cultures in different swabs whereas male workers showed that lowest percentage (85.7%, 14.3% respectively).

Table 3: Gram-positive *Staphylococcus* species and *Micrococcus* isolated from the different swabs

Bacterial isolates	**Sleeve (n=8)**			**Pocket (n=6)**			**Bacteria growth positive**		
	Female	Male	Total	Female	Male	Total	Female	Male	Total
Staphylococcus epidermidis	4	-	4	1	1	2	5	1	6
Staphylococcus saprophyticus	1	-	1	-	-	-	1	-	1
Staphylococcus aureus	-	-	-	1	-	1	1	-	1
Staphylococcus warneri	1	-	1	1	-	1	2	-	2
Staphylococcus haemolyticus	1	-	1	2	-	2	3	-	3
Micrococcus luteus	-	1	1	-	-	-	-	1	1
Total	**7**	**1**	**8**	**5**	**1**	**6**	**12**	**2**	**14**

Table 4: Antibiotics' sensitivity test of the isolates species *Staphylococcus* and *Micrococcus* bacteria

Antibiotics n=16	***Staph. epidermidis***	***Staph. saprophyticus***	***Staph. aureus***	***Staph. warneri***	***Staph. haemolyticus***	***Microco. luteus***	
	n=6	**n=1**	**n=1**	**n=2**	**n=3**	**n=1**	**Total=14**
Benzylpenicillin	-	1	-	-	-	-	1
Oxacillin	-	1	-	-	-	-	1
Gentamycin	6	1	1	2	2	1	13
Tobramycin	4	1	1	-	-	1	7
Levofloxacin	6	1	1	2	2	1	13
Moxifloxacin	6	1	1	2	2	1	13

Erythromycin	1	-	-	-	-	1	2
Clindamycin	1	1	-	2	3	-	7
Linezolid	5	1	-	2	3	1	12
Teicoplanin	5	1	-	2	4	1	13
Vancomycin	5	1	-	2	3	1	12
Tetracycline	5	1	-	2	1	1	10
Tigecycline	6	1	1	2	3	1	14
Fusidic acid	-	-	-	-	-	-	0
Rifampicin	6	1	-	2	3	1	13
Trimethoprim-Sulfamethoxazole	4	1	1	2	2	1	11

In general, Gram positive bacteria exhibited high frequency and susceptibility rates to Tigecycline (100%), Gentamycin, Levofloxacin, Moxifloxacin, Teicoplanin and Rifampicin (92.9%), followed by Linezolid and Vancomycin (85.7%), then Trimethoprim-Sulfamethoxazole, Tetracycline (78.6%, 71.4) respectively and Clindamycin, Tobramycin (50%), whereas, demonstrate less degree of sensitivity to Erythromycin (14.3%), Benzylpenicillin, Oxacillin (7.1%) and completely resistance to Fusidic acid. The bacteria that scored the highest rank of sensitivity were *Staph. epidermis*, *Staph. haemolyticus* and *Staph. Warneri*. (Table -4)

Table 5: Distributed Bacterial isolates in Laboratory white coats according to the different time detergents used.

Bacterial isolates		**Day (n=26)**	**Week (n=14)**	**Month (n=3)**
		+ve	**+ve**	**+ve**
Staphylococcus epidermidis	6	4	1	1
Staphylococcus saprophyticus	1	-	1	-
Staphylococcus aureus	1	-	1	-
Staphylococcus warneri	2	1	1	-
Staphylococcus haemolyticus	3	-	3	-
Micrococcus luteus	1	-	-	1
Total	**14**	**5**	**7**	**2**

Table 6: Total positive swabs in Laboratory white coats distributed according to the different time detergents used

Laboratory units		**Day (n=26)**		**Week (n=14)**		**Month (n=3)**	
		-ve	+ve	-ve	+ve	-ve	+ve
Phlebotomy	5	-	1	3	1	1	-
Microbiology	13	1	2	4	3	1	2
Biochemistry	5	4	-	1	-	-	-
Hematology	6	3	-	2	-	-	-
Dialysis	4	3	-	1	-	-	-
Surgery	4	1	-	2	-	-	-
Burns	6	5	-	1	-	1	-
Medicine	5	4	1	-	-	-	-
Emergency	5	5	-	-	-	-	-
Total	**53**	**26**	**4**	**14**	**4**	**3**	**2**

Regardless to the types of bacteria in (tables- 5-6), there is an overall increase in the number of isolates in duration to the disinfectant used a week followed by the day duration with (50%,19.2% respectively). However, the percentages of bacterial prevalence were (42.9%) of (*Staphylococcus haemolyticus*) and (*Staphylococcus epidermidis*) in duration of week and day respectively. Of the total 53 samples, (18.9%) revealed positive results for bacterial growth while (81.1%) showed negative results. Total percentage of negative results in duration to the disinfectant used of day was (49%), then the week and month durations (26.4%, 5.7% respectively), nevertheless, the same and the high percentage of bacterial growth in Microbiology unit was revealed in the three durations of the detergents used in this study.

Dissection

White coats have been known as potential reservoirs for bacteria and other pathogens, while these garments are an essential part of the health care attire, their frequent use and exposure to various clinical settings can contribute to their role as carriers of potentially harmful microorganisms which are transferred either from one person to another, between pieces of equipment, or within the body and can play a large role in the transmission of nosocomial infection in health care settings. These infections can lead to a slew of problems (Lamphier,2023)**.** Out of the 53 staff white coats from different Al Yarmouk Hospital labs , who were participated in this study,18(33.9%) were males and 35 (66.03%) were females ,moreover, from 53 lab coats screened , we found only 10 (18.9%) to be contaminated , subsequently, female display high prevalence of positive bacterial cultures in different swabs whereas male showed that lowest percentage (85.7%, 14.3% respectively), which was lower than the result in Colombia study by (Catan`o et al. ,2012) when a total of 52 isolations were obtained, from those, 39 (75%) were considered potentially clinically relevant highlighting bacteria **,** simultaneously , (Naik et al. , 2016) , recorded out of the 96 who participated in the study,42(43.75%) were males and 54 (56.25%) were females ,while 61(63.54%) white coats found to be contamination . Other studies resulted, high rate of contamination in Laboratory coats, like Monawer conducted at 2018 in Duhok/ Iraq founded the prevalence of contaminated microorganisms was (100%) from 50 Laboratory white coats were examined, and in 2020 study of Kumar and et al recorded that, from 120 samples were collected, out of these 72(60%) were male and 48 (40%) were female, and 88 (73.3%) percentage of laboratory white coats were contaminated **(**Monawer,2018) (Kumar et al. ,2020). Microorganisms have been shown to attach and survive on fabrics which are used to make lab white coats, either cotton or polyester materials for about 1-12 weeks. This could be a reason for the bacterial contamination were observed, as well as, the possible route of transmission (jesumirhew et al. ,2022)

Our findings incompatible with others when we scored lower percentage of positive bacterial growth in lab white coats(26.4%) , also sleeves swabs showed bacterial growth percentage more than pockets (15.1% ,11.3%) respectively, and markedly in female more than in male, while (Akanbi et al. ,2017) affirmed, that no significant difference in white coats which possessed bacterial growth found on the sleeve and mouth of pocket (P>0.05), also (jesumirhew et al.,2022) study, who revealed that 83% percentage of the white coats were contaminated with bacteria and male coats more contamination than of female subjects ,on the other hand, the pockets swabs showed high growth of bacteria**.** Other previous studies clarified, why the inappropriate use of the lab coats by health professionals and related areas, is considered a serious public health problem, and therefore, a more efficient educational and surveillance action is necessary and clarify its effect to the community to be safe(Brandão et al. ,2017), in the same context, (Stock et al.,2021) , confirmed that a proper conservation and handling practices must be applied, to minimize the heavily contaminated which that scored in technician's coats.

In the present study various Gram - positive bacteria isolated from laboratory white coats. Maximum isolates were Coagulase negative *Staphylococci* (CoNS), followed by *Staphylococcus aureus* and *Micrococcus luteus* were the least percentage which illustrated in (Table- 3), this finding is supported by a similar study reported that most of the coats were contaminated by *Staphylococci* species (Qaday et al. ,2015), also, (Naik et al., 2016) scored maximum isolates were CoNS (52.45%), *Staph. aureus* (1.63%), in the same context, (Kumar et al. ,2020), reported that out of 64 Gram positive cocci, (75%) were CoNS. Study (Morgan et al. ,2013) illustrate, the differences in these results could be attributed to the environmental contamination which was the major determinant of transmission to healthcare workers and the compliance with direct contact precautions and more environmental cleaning may decrease trasmission.

Current study results not coincide with other studies when (Akanbi et al. ,2017) revealed the predominant bacterial growth was 77.7% percentage represented by *Staph. aureus* (45.1%), *Klebsiella pneumoniae* (22.6%), *Pseudomonas aeruginosa* (3.7%) and *Enterococcus faecalis* (2.4%). Furthermore, (Monawer,2018) study show significantly difference of bacterial contamination in female coats, and reported that *Staph. aureus* (40%), *Bacillus* spp. and *Escherichia coli* (30 %,10 %) respectively. Subsequently, study (Kumar et al. ,2020) in Kolhapur/ India they indicated, out of 64 Gram positive, 16(25%) were *Staph. aureus*, while 24 Gram negative bacilli distributed to, *Escherichia coli* 12(50%) followed by *Klebsiella* spp 8(33.3%) then *Pseudomonas* spp. 4(16.7%), simultaneous, in (Samsan et al. ,2021) scored, from a total of 100 white coats studied, 58% were Gram positive cocci and 42% were Gram negative bacilli which includes, *Proteus* species, *Klebsiella* species, and *Escherichia coli*.

Furthermore in this study ,we demonstrates increasing in the number of bacterial isolates according to the duration of the detergents and disinfectant usage, as well as, frequency of washing either in week or day , however, the high percentage of bacterial growth in all these durations was recorded in lab coats swabs of ,

Microbiology then Phlebotomy units, which was congruent with study published in 2017 by (Akanbi et al. , 2017), who founded a significant difference between the age of white coats, usage, frequency of washing and number of white coats ($P < 0.05$) , while incompatible with our finding, when they showed that Surgery department had the highest degree of contamination than the other departments **.** Thus, (Brandão et al. ,2017) advised to wash the coat after each working day, separated from the other clothes and by using water with soap to remove the dirt, then immerse it in dilution solution of bleach for 5 minutes.

The susceptibility patterns were varied from one bacterial isolate to the other depending on the drug. The susceptibility test against bacterial isolates was 16 commercially used antibiotics was used, that ranged from highly sensitive (most antibiotics), to moderate sensitive, and completely resistance to one antibiotic. It is interesting to find that the results of this study ware close to the results of other study reported by (Robati et al. ,2013), despite our findings was not corroborative by two researchers reported that most isolates were moderate to complete resistance to the most antibiotics (Naik et al. ,2016), (Jesumirhewe et al. ,2022).

There are significant opportunities to reduce patients' exposure to frequently pathogenic bacteria in the hospital setting; by applying proper maintenance and handling practices with white coats are precautions should be taken, to minimize the degree of bacterial contamination, especially the patients are likely exposed to many bacteria through direct contact with white coats, thus should prevent cross contamination of healthcare associated infection pathogens in hospital setting. (Catan`o et al. ,2012) (Akanbi et al. ,2017), other suggestion published by (Samsan et al. ,2021) and (Lamphier,2023) who found a large proportion of white coats may be contaminated with microorganisms, including Gram negative pathogenic organisms, furthermore, white coats may be the major vector of transmitting infections from laboratory workers-patients -and vice versa, in tertiary hospitals. So, efforts should be made to discourage the usage of white coats outside the clinical areas. A study by (Brandão et al. ,2017) emphasized that, the role of fungi as contaminants in lab coats, and, as an effective means of transmission of pathogens in the community, when they observed fungal growth in all samples of the lab coats, and 19 isolates were counted, so fortunately our study didn't register any swab of lab coat had fungal growth.

Conclusion

Current study indicated that, lower bacteria population in general, which was represented by the Gram positive only as the most common organisms in Microbiology lab coat swabs followed by Phlebotomy units , which represented by Coagulase-negative *Staphylococci*(CoNS), It turns out, that lab coat swabs in female more contamination than in male and in sleeves than in pockets ,in addition , increased response in sensitivity test for antibiotics , represented by Tigecycline antibiotic and others but in varying degrees ,which is a good concern , also no any type of fungal isolated. Accordingly, we conclude that disinfection and sterilization materials, whether used in the departments of Yarmouk Hospital or in cleaning laboratory gowns, are clearly effective, in addition to the standard of personal hygiene for workers in our Arab Islamic society that differs from others.

Recommendations

As a result of the pathogenic potential of isolates recovered from laboratory white coats of workers in the hospital our recommended:

-Practical Training and learning on the correct use of the personal protective equipment PPE for all workers in health care.

-Further studying investigations are required in other Baghdad hospitals to evaluate the possible roles of these coats in the transmission of bacteria

-Efforts should be made to limit the use of laboratory coats outside the labs like in canteen/cafeteria and library, or outside the hospital as in markets and so on.

-Proper separate laundry of laboratory coats should be frequently carried out at least once weekly by using a disinfectant and strong detergent.

-Health workers having more than one lab coat, making another precaution that can be taken to reduce the degree of contamination in the environment.

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Conflicts of interest

All authors report no conflicts of interest relevant to this article.

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