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The Role of Educational Program in Eliminating Infection Potential Hazards inside Gynecology and Obstetrics Clinic in Alexandria

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ABSTRACT

Background: Over the past several decades, we have witnessed a significant shift in healthcare delivery from the acute, inpatient hospital setting to a variety of outpatient settings. Much of the inpatient care is now delivered in outpatient settings, using invasive procedures and advanced technologies, which increase the risk for HCAIs.

Objective: To evaluate the role of educational program in eliminating infection potential hazards inside gynecology and obstetrics clinic.

Material and Methods: Three phases interventional study included before education (phase I) for 3 months, after education (phase III) for 3 months, and interventional phase of 1-month (phase II) in which educational sessions about IC standard precautions, environmental cleaning and reprocessing medical devices done.

Result: Contamination level in phase I was 77.8% in bed, 83.3% in table, 63.9% in stethoscope, 80.6% in U/S abdominal probe, 50% in vaginal speculum after cleaning, and 16.7% in vaginal speculum after sterilization. This level decreased in phase III to 38.9% in bed, 38.9% in table, 30.6% in stethoscope, 27.8% in U/S abdominal probe, 13.9% in vaginal speculum after cleaning, and 0% in vaginal speculum after sterilization. The indicator organisms isolated were [MRSA, Pseudomonas spp., Acinetobacter spp. E. coli, and Klebsiella spp.]. (100%) S. aureus isolates (48/48) were MRSA, (100%) Acinetobacter spp. (15/15), E. coli (5/5), and Klebsiella spp. (3/3) were multidrug resistant (MDR), and 88.2% (15/17) of Pseudomonas spp. isolates were MDR.

Conclusion: The educational program in phase II succeeded in achieving a statistically significant reduction in contamination level ($p \leq 0.05$ at all sites), also achieved a decrease in number of indicator organisms found in all sample sites.

Keywords: Gynecology, Obstetric clinic, MDR Bacteria, Infection control, Educational program.

INTRODUCTION

Any care given in a place where a person does not remain overnight is referred to as ambulatory care (e.g., physician offices, urgent care centers, ambulatory surgical centers, public health clinics, hospital and non-hospital-based clinics, oncology clinics, physical therapy and rehabilitation centers). Over the past several decades, we have witnessed a significant shift in healthcare delivery from the acute, inpatient hospital setting to a variety of outpatient, ambulatory care settings, and community-based settings [(1, 2)].

The change resulted from rising healthcare expenses and a rise in healthcare consumers. Invasive treatments and cutting-edge technologies are employed often in ambulatory settings, while most healthcare was formerly offered as an inpatient service. Additionally, much of the same care is now provided in outpatient settings, which increase the risk for health care associated infection among patients at ambulatory care settings [(3)].

Ambulatory care settings provide many services including diagnostic testing, invasive procedures, and therapeutic care. As a result of this transition, there is an increased risk of contracting a healthcare-associated infection in outpatient settings, and these infections are not uncommon in outpatient clinics [(4)].

One of the ambulatory care settings is the gynecology and obstetrics clinic, which have high rate of patients visiting the clinic for different purposes and involving a wide range of invasive and non-invasive procedures using a lot of equipment, which is less likely to have standard cleaning protocols than the equipment used in the critical settings, so it is more likely to carry a risk for transmitting infection [(5)].

Hysteroscopy, vaginal specula, and vaginal ultrasonography probes are among the devices that must be well high level disinfected. Sterilization is required for all instruments, including biopsy tools, that come into touch with tissue through the vaginal or cervical wall. Additionally, it's important to clean and disinfect any surfaces in the environment that could be contaminated by vaginal or cervical secretions using an EPA-approved solution [(6)].

Associating with lack of infrastructure, resources, and strategies that are supporting infection prevention and surveillance activities in comparison with inpatient settings, all of these make outpatient settings generally and gynecology and obstetrics clinic specifically a potential hazard of transmitting infection [(7)].

Many reported outbreaks have been linked to outpatient clinics and most of them are caused by non-adherence to recommended infection control measures and the main mode of transmission was health care personnel (HCP), contaminated environment, contaminated equipment, consequently ongoing education and training of HCP on infection control practices and hygiene and environmental cleaning are critical. These outbreaks reports have described

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transmission of gram-negative and gram-positive bacteria, mycobacteria, viruses, and parasites [8].

This study aimed to evaluate the role of educational program in eliminating infection potential hazards inside gynecology and obstetrics clinic.

MATERIALS AND METHODS

Study design

This study was an interventional study to assess the role of educational program on eliminating infection potential hazards inside gynecology and obstetrics clinic.

Study setting

This study was carried out in governmental obstetrics and gynecology clinic in Alexandria, Egypt. The clinic is part of a polyclinic center not attached to a general hospital this center found in a rural area.

Study tools

Swabs were collected by the researcher from 5 sites (medication table – procedure bed – stethoscope – U/S abdominal probe – vaginal speculum) after cleaning and disinfection except for vaginal speculum each time the swabs were collected before and after cleaning and then after sterilization. Swabs were taken 3 times per week distributed between beginning of the working day, between clients, and after the workday is over.

Wet sterile cotton swabs by a sterile saline solution were used to collect samples in measured area of 10 cm×10 cm for bed and table and measured area of 1 cm×1 cm for stethoscope, U/S probe, and vaginal speculum.

All swabs were cultured on Blood agar, MacConkey's agar and Sabouraud's dextrose agar plates. The plates were incubated aerobically for 24 hrs (blood & MacConkey's) to 72 hrs (Sabouraud's dextrose) at 37 ºC and evaluated for microbial growth. Colonies were counted and culture results were presented as Colony Forming Units (CFUs) /cm2. Level of contamination was determined by two ways; According to total plate count (>5 CFU/cm^2), and According to the presence of indicator organism (Staphylococcus aureus - gram negative bacteria) [9,10].

Bacterial colonies were stained by Gram stain and examined microscopically. Gram positive cocci were further tested using catalase test. Catalase positive G +ve cocci were isolated and inoculated on Mannitol salt agar and coagulase test was used to further distinguish Staphylococcus aureus (Mannitol fermenting grow as golden yellow colonies and positive coagulase test) and another Coagulase Negative Staphylococcus (CONS). Colonies grown on MacConkey's agar were identified as Gram-negative Bacilli by microscopic examination of Gram-stained films and were further identified by standard biochemical reaction (triple sugar iron agar (TSI) test, urease test, oxidase test, and IMVC)

Susceptibility test using disk diffusion method on Mueller-Hinton agar was conducted for Staphylococcus aureus colonies to determine their sensitivity to cefoxitin (30 mg) (R≤ 21mm – S ≥ 22 mm) for lab diagnosis of MRSA, and for all gram negative colonies to determine multidrug resistant organisms (MDR) by measuring inhibition zones [11].

Colonies grown on Sabouraud's Dextrose Agar (SDA) were identified as Fungi.

Intervention in the study

Educational sessions about infection control standard precautions in form of interviews, and lectures, were conducted by the researcher for one-month duration. These sessions were given to the personnel responsible for environmental cleaning and reprocessing of medical devices at the clinic.

Ethical considerations:

The study was conducted in accordance with the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on human subjects. The study as well took the approval of the Ethics Committee of the Medical Research Institute, Alexandria University (IORG#: IORG0008812).

Statistical analysis

Data were analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). Qualitative variables were described using number and percent. Chi square test was used for categorical variables, to compare between different groups and expressed by p value. Fisher's Exact or Monte Carlo correction was used for correction for chi-square when more than 20% of the cells have expected count less than 5. In all statistical tests, level of significance of 0.05 was used below, which the results are considered to be statistically significant.

RESULTS

At the current study, out of the 36 samples taken from the different 5 sites there was a statistically significant increase in the percent of samples, which showed no growth between phase I and III [bed 22.2% versus 61.1% (P=0.002) – table 16.7% versus 61.1% (P=0.001) – stethoscope 36.1% versus 69.4%(P=0.008) – U/S probe (abdominal) 19.4% versus 72.2%(P<0.001) – vaginal speculum after cleaning 50.0% versus 86.1%(P=0.001) – vaginal speculum after sterilization 38.3% versus 100%(P=0.022)] **(Table 1).**

Table (1): Comparison between results of swab cultures after decontamination process in phase I and phase III according to site of samples

Site of samples	Phase I (n = 36)				Phase III (n = 36)				□□	p
	No growth		Growth		No growth		Growth			
	No.	%	No.	%	No.	%	No.	%		
Bed	8	22.2	28	77.8	22	61.1	14	38.9	12.724*	0.002*
Table	6	16.7	30	83.3	22	61.1	14	38.9	15.025*	0.001*
Stethoscope	13	36.1	23	63.9	25	69.4	11	30.6	10.179*	MCp=0.008*
U/S probe (abdominal)	7	19.4	29	80.6	26	72.2	10	27.8	25.415*	MCp <0.001*
Vaginal speculum before cleaning	0	0.0	36	100.0	0	0.0	36	100.0	-	-
Vaginal speculum after cleaning	18	50.0	18	50.0	31	86.1	5	13.9	10.797	0.001*
Vaginal speculum after sterilization	30	83.3	6	16.7	36	100.0	0	0.0	6.344*	MCp=0.022*

X^2: **Chi square test** MC: **Monte Carlo** p: p value for comparing between the studied groups
*: Statistically significant at $p \leq 0.05$

Regarding procedure bed according to current study, it was found that the baseline contamination rate in phase I was 77.8% (28/36), of them 44.4 % were polymicrobial, contaminated with more than one type of microorganisms (CONS, MRSA, Micrococci, Pseudomonas spp., Acinetobacter spp., Bacillus spp., and fungus), and 33.3% of them were contaminated with one type of the previous microorganisms. In phase III the contamination rate decreased to 38.9% (14/36), of them13.9% were polymicrobial (CONS, Micrococci bacillus spp., and fungus), and 25.0% of them were contaminated with one type of the previous microorganisms **(Table 2)**. When assessing procedure bed's contamination level as regards total plate count we found that 11.1% (4/36) of samples showed failed decontamination procedure (counted >5CFU/cm2) in phase I, which decreased to 2.8% (1/36) after education program and as regards to indicator organisms, we found that before intervention 13.9% of samples showed growth of MRSA, 11.1% showed growth of Pseudomonas spp., and 5.6% showed growth of Acinetobacter spp., while after intervention there was an absence for all potentially pathogenic indicator organisms (MRSA, Pseudomonas spp., and Acinetobacter spp.) within samples collected from procedure bed.

Table (2): Comparison between results of swab cultures taken from bed (mattress) in phase I and phase III according to growth status and total plate count.

Site of sample: - bed (mattress)	Phase I (n = 36)		Phase III n = 36)		□□	p
	No.	%	No.	%		
No growth	8	22.2	22	61.1	11.200*	0.001*
Growth	**28**	**77.8**	**14**	**38.9**		
Sig. growth	4	11.1	1	2.8	1.934	FEp=0.357
>5 CFU/cm^2						
<5 CFU/cm^2	24	66.7	13	36.1	6.727*	0.009*

X^2: **Chi square test** FE: **Fisher Exact** p: p value for comparing between the studied groups
*: Statistically significant at $p \leq 0.05$

Regarding medication table according to current study, it was found that the baseline contamination rate in phase I was 83.3% (30/36), of them 33.3% were contaminated with more than one type of microorganisms (CONS, MRSA, Bacillus spp., and fungus), and 50.0% were contaminated with one type of the previous microorganisms. In phase III the contamination rate decreased to 38.9% (14/36), of them 13.9% were contaminated with more than one type of microorganisms (CONS, MRSA, and Bacillus spp.), and 25.0% of them were contaminated with one type of the previous microorganisms **(Table 3).**

Table (3): Comparison between results of swab cultures taken from table in phase I and phase III according to growth status and total plate count

Sample: - **Table**	**Phase I (n = 36)**		**Phase III n = 36)**		□□	**p**
	No.	**%**	**No.**	**%**		
No growth	6	16.7	22	61.1	14.961*	<0.001*
Growth	**30**	**83.3**	**14**	**38.9**		
Sig. growth >5 CFU/cm^2	2	5.6	1	2.8	0.348	FEp=1.000
<5 CFU/cm^2	28	77.8	13	36.1	12.746*	<0.001*

X^2: **Chi square test** FE: **Fisher Exact** p: p value for comparing between the studied groups
*: Statistically significant at $p \leq 0.05$

Regarding stethoscopes, according to the current study, it was found that the baseline contamination rate of stethoscopes in phase I before education sessions was 63.9% (23/36) of total number of stethoscopes examined, of them 22.2% were contaminated with more than one type of microorganisms (CONS, MRSA, Streptococci, Micrococci, Pseudomonas spp., Bacillus spp., and fungus), and 41.7% were contaminated with one type of the previous microorganisms. In phase III after educational sessions the contamination rate decreased to 30.6% (11/36), only 2.8% of them were contaminated with more than one type of microorganisms (CONS, MRSA, and Bacillus spp.), and 27.8% of them were contaminated with one type of the previous microorganisms **(Table 4).**
When assessing stethoscope's contamination level as regards total plate count, we found that 58.3% of samples showed failed decontamination procedure (counted >5CFU/cm2) in phase I, which decreased to 27.8% after intervention. As regards to indicator organisms, before intervention 8.3% of samples showed growth of MRSA and 2.8% of samples showed growth of Pseudomonas spp., while after education only 2.8% of samples showed growth of MRSA with absence of Pseudomonas spp. in this phase.

Table (4): Comparison between results of swab cultures taken from Stethoscope in phase I and phase III according to growth status and total plate count

Site of sample: - Stethoscope	**Phase I (n = 36)**		**Phase III n = 36)**		□□	**p**
	No.	**%**	**No.**	**%**		
No growth	13	36.1	25	69.4	8.025*	0.005*
Growth	**23**	**63.9**	**11**	**30.6**		
Sig. growth >5 CFU/cm^2	21	58.3	10	27.8	6.854*	0.009*
<5 CFU/cm^2	2	5.6	1	2.8	0.348	FEp=1.000

X^2: **Chi square test** FE: **Fisher Exact** p: p value for comparing between the studied groups
*: Statistically significant at $p \leq 0.05$

Regarding U/S probe, according to current study, it was found that the baseline contamination rate in phase I was 80.6% (29/36), of them 69.4% were contaminated with more than one microorganism (CONS, MRSA, Micrococci, Pseudomonas spp., Acinetobacter spp., Bacillus spp., and fungus), and 11.1% of them were contaminated with one type of the previous microorganisms. In phase III after educational sessions the contamination rate decreased to 27.8% (10/36), of them 13.9% were contaminated with more than one microorganism (CONS, MRSA, Pseudomonas spp., Bacillus spp., and fungus), and 13.9% of them were contaminated with one type of the previous microorganisms **(Table 5)**. When assessing U/S probe's contamination level, as regards to total plate count, we found that 77.8% (28/36) of samples showed failed decontamination procedure (counted>5CFU/cm2) in phase I, which decreased to 25.0% (9/36) after educational sessions. As regards to indicator organisms, we found that before intervention there was 30.6% of samples showed growth of MRSA, 22.2% of samples showed growth of Pseudomonas spp., and 25.0% showed growth of Acinetobacter spp., after intervention although the Acinetobacter spp. was not isolated, yet. Unfortunately, both MRSA and Pseudomonas spp. were still isolated (2.8% - 5.6% respectively).

Table (5): Comparison between results of swab cultures taken from U/S probe (abdominal) in phase I and phase III according to growth status and total plate count

Site of sample: U/S probe abdominal	Phase I (n = 36)		Phase III n = 36)		□□	p
	No.	%	No.	%		
No growth	7	19.4	26	72.2	20.196*	<0.001*
Growth	**29**	**80.6**	**10**	**27.8**		
Sig. growth >5 CFU/cm^2	28	77.8	9	25.0	20.071*	<0.001*
<5 CFU/cm^2	1	2.8	1	2.8	0.0	FEp=1.000

X^2: **Chi square test** FE: **Fisher Exact** p: p value for comparing between the studied groups
*: Statistically significant at p ≤ 0.05

Regarding vaginal speculum, in the present study regarding the sterilization of vaginal speculum, in phase I results revealed a 16.7% failure in sterilization compared to 0% in phase III, and this difference was statistically significant (FEp=0.025) **(Table 6)**.

Table (6): Comparison between results of swab cultures taken from vaginal speculum after sterilization (autoclave) in phase I and phase III according to growth status and total plate count

Sample:- Vaginal speculum after sterilization (autoclave)	Phase I (n = 36)		Phase III (n = 36)		□□	FEp
	No.	%	No.	%		
No growth	30	83.3	36	100.0	6.545*	0.025*
Growth	**6**	**16.7**	**0**	**0.0**		
Sig. growth >5 CFU/cm^2	5	13.9	–	–	–	–
<5 CFU/cm^2	1	2.8	–	–	–	–

□^{2}: **Chi square test**, FE: **Fisher Exact,** p: p value for comparing between the studied groups, *: Statistically significant at p ≤ 0.05

The cleaning process of vaginal speculum succeeded in the reduction of microbial load in phase III by (86.1%) compared to (50%) in phase I (**Table 7)**. In addition, it was able to mechanically wash all indicator organisms as (MRSA - Acinetobacter spp. - E. coli) and reduced the percentage of CONS from 75.0% to 13.9% in phase III while after sterilization it completely eliminated.

Table (7): Comparison between results of swab cultures taken from vaginal speculum after cleaning process in phase I and phase III according to growth status and total plate count

Site of Sample: Vaginal speculum after cleaning	phase I (n = 36)		phase III (n = 36)		□□	p
	No.	%	No.	%		
No growth	18	50.0	31	86.1	10.797	0.001*
Growth	18	50.0	5	13.9		
Sig. growth >5 CFU/cm2	5	13.8	1	2.8	0.123	FEp= 1.000
<5 CFU/cm^2	13	36.1	4	11.1		

□^{2}: **Chi square test** FE**: Fisher Exact** p: p value for comparing between the studied groups
*: Statistically significant at p ≤ 0.05

Regarding MDR organisms, a total of 88 organism isolated from all sample sites were tested. A 100.0% of Staph. aureus, Acinetobacter spp., E. coli, and Klebsiella spp. isolates were MDR (multidrug resistant), while 88.2% of Pseudomonas spp. isolates were MDR **(Table 8).**

Table (8): Number and percent of MDR organisms isolated from all sample sites

Microorganism	MDR		Not MDR	
	No.	%	No.	%
Staph. aureus (n=48)	48	100.0	0	0.0
Pseudomonas spp. (n=17)	15	88.2	2	11.8
Acinetobacter spp. (n=15)	15	100.0	0	0.0
E. coli (n=5)	5	100.0	0	0.0
Klebsiella spp. (n=3)	3	100.0	0	0.0

DISCUSSION

Adherence to infection prevention guidelines and procedures requires knowledge, which is crucial. **Hefzy *et al.*** [5] found that the major reason for non-adherence to infection control precautions in hospital outpatient clinics was lack of knowledge among health care workers.

Regarding procedure bed according to current study, it was found that the baseline contamination rate in phase I was 77.8% (28/36). In phase III the contamination rate decreased to 38.9% (14/36).

In **Santos *et al.*** [12] the percentage of approved samples (counted ≤ 2.5 CFU/cm2) from gynecology examination table (procedure bed) were 37.5% and this percent increased after educational intervention to 87.5%, which indicates improvement in cleaning and disinfection of the procedure bed after educational intervention, and this is consistent with our findings.

In 2018 a total of 34 swab samples were taken from bed surfaces from six wards in Mizan-Tepi University teaching hospital, southwest Ethiopia, 6 of them were from obstetrics and gynecology department. 33.3% (2/6) of them were contaminated with potentially pathogenic organisms namely, E.coli and Serratia spp. [13]. For medication table according to current study, it was found that the baseline contamination rate in phase I was 83.3% (30/36). In phase III the contamination rate decreased to 38.9% (14/36). In 2018, in Mizan-Tepi University teaching hospital, southwest Ethiopia, a total of 27 swab samples were taken from table top from six wards, 5/27 were from obstetrics and gynecology department. 60% (3/5) of them were contaminated with potentially pathogenic organisms namely, E.coli (2) and klebsiella spp. (1) [13]. In **Hefzy *et al.*** [5] they found that all medication tables showed decrease in the median of total plate count from (500.0 ACC to 100.0 ACC) after education. They also found a complete absence of gram-positive organisms in all medication tables after education sessions mainly S. aureus and Enterococci from 66.7% to 0.0% and from 66.7% to 0.0% respectively. As regards Gram negative bacteria, they reported a decrease in their percent from 100.0% to 66.7%.

According to the current study, it was found that the baseline contamination rate of stethoscopes in phase I before education sessions was 63.9% (23/36) of total number of stethoscopes examined. In phase III after educational sessions the contamination rate decreased to 30.6% (11/36). In 2018, in Mizan-Tepi University teaching hospital, southwest Ethiopia, a total of 20 swab samples were taken from stethoscopes from six wards, (3/20) were from obstetrics and gynecology department. 33.3% (1/3) were contaminated with potentially pathogenic organism (klebsiella spp.) [13]. While, in **Hefzy *et al.*** [5] the baseline contamination rate of stethoscopes was 100.0% with a median of aerobic colony count of 50.0 ACC which decreased to 2.00 ACC after educational sessions. Despite they didn't find any MRSA isolates on stethoscopes, they found other indicator organisms as Enterococci and Gram-negative bacteria, which decreased from 55.6% to 0.00%, and from 66.7% to 22.2% respectively after educational sessions.

In the present study, disinfection of stethoscopes was carried out using 70% alcohol. The same method used by **Hefzy *et al.*** [5] who found that the use of 70% isopropyl alcohol swab was effective regarding decontamination of stethoscopes. The study of **Álvarez *et al.*** [14] compared the effect of isopropyl alcohol, triclosan, and chlorhexidine for disinfection of stethoscopes, they found that chlorhexidine is more efficient than alcohol and triclosan as a disinfectant.

Regarding U/S probe, according to current study it was found that the baseline contamination rate in phase I was 80.6% (29/36). In phase III after educational sessions the contamination rate decreased to 27.8% (10/36). In consistent with these results the findings of **Hefzy *et al.*** [5] detected a baseline contamination rate of 100.0% in U/S probes, and high rates of indicator organisms (Enterococci and gram-negative bacteria), which decreased after education from 83.3% to 0.0, and from 33.3% to 0.0% respectively. No one can determine the best product to disinfect U/S probes, as the manufacturing recommendations for the type of agent that could be compatible with the machine are varying depending on the model of the U/S machine. The American Institute of Ultrasound in Medicine [15], stated some guidelines for cleaning noninvasive probes as removing residual gel using clean cloth, cleaning with soap and water or QUATs sprays or wipes, then rinsing and drying the probe. In the current study we used soap and water to clean the abdominal U/S probe.

Regarding vaginal speculum, in the present study regarding phase I results revealed a 16.7% failure in sterilization compared to 0% in phase III, the cleaning process of vaginal speculum succeeded in the reduction of microbial load in phase III by 86.1%) compared to 50% in phase I. These results was supported by others. **Widmer and Frei** [16] revealed that presence of residual proteins and/or salts on the instruments due to improper cleaning process was responsible for a 1% to 40% failure of sterilization cycles in all sterilization techniques other than steaming. Also, in WHO recommendation to use steam sterilization at 134°C for 18min to inactivate prions.

As a part of the current study, we performed an antibiotic susceptibility test for all S. aureus and gram-negative bacteria isolated during phase I and III. We tested a number of 88 organisms isolated from different sites for antibiotics susceptibility, (48 of them were S. aureus, 17 were Pseudomonas spp., 15 were Acinetobacter spp., 5 were E. coli, and 3 were klebsiella spp.) 97.7% of them were multidrug-resistant (MDR) while only 2.3% of them were not multidrug resistant. Interestingly, all S. aureus isolates in this study (48/48) were MRSA, 88.2% (15/17) of Pseudomonas spp. isolates were MDR, all of Acinetobacter spp. (15/15),

E. coli (5/5), and klebsiella spp. (3/3) isolates were also MDR (100%) as they showed resistance to three or more classes of antibiotics.

In 2016, **Hefzy *et al.*** [5] found that 38.9% (14/36) of S. aureus isolates from tables, stethoscopes, and U/S probe at outpatients clinics were MRSA and after intervention a significant reduction (p=0.000) occurred. On the other hand, **Worku *et al.*** [13] found that 79% (15/19) of S. aureus isolates from stethoscopes, thermometers, and inanimate surfaces of 5 wards (outpatient- gynecology and obstetrics- emergency services- pediatrics – medical and surgical wards) were MDR, 73.7% (14/19) of them were MRSA, which is less than our results as in the current study a 100% of S. aureus isolates were MRSA. At the same study there was 28.6% (4/14), 53.8% (7/13), and 30% (3/10) of E. coli, Klebsiella spp. and P. aeruginosa isolates respectively were MDR, and these rates are less than our MDR rates [13].

In 2019, **Bassyouni *et al.*** [8] reported that 54.3% (19/35) of all S. aureus isolates from operating room and surgical wards (urology- orthopedic – general surgery – gynecology) surfaces showed resistance to methicillin, 38.7% (12/31) of E.coli isolates were MDR, 20% of both P. aeruginosa (2/10) and Acinetobacter baumannii (1/5) isolates were MDR.

From all previous results we found that the education program in phase II succeeded partially in achieving a statistically significant reduction ($p \leq 0.05$ at all sites) in contamination level for all samples' sites. This was in agreement with **Bassyouni *et al.*** [8], who also found a statistically significant reduction of contamination level after education at all departments included in their study. Also, **Hefzy *et al.*** [8] found a significant improvement after educational intervention on contamination level in outpatient clinics. This also is consistent with **Santos *et al.*** [12], who found a positive impact for educational intervention on surfaces cleaning and disinfection.

CONCLUSION

Based on this study, we concluded that educational program in phase II succeeded in achieving a statistically significant reduction ($p \leq 0.05$ at all sites) in contamination level for all samples' sites, also achieved a decrease in number and sometimes complete elimination of indicator organisms found in all sample sites. Survival of some indicator organisms even after education and decontamination process, which indicates the need for more training and close supervision and may be anew disinfectant products.

DECLARATIONS

- **Publication Consent:** I confirm that the authors accepted to submit the manuscript availability of material and data.
- **Competing interests:** None identified
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- **Conflict of interests:** No conflict of interest.

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