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Impact of an Educational Program on Physicians' and Nurses' Knowledge and Performance in Management of Sepsis in the Intensive Care Unit

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ABSTRACT

Background: Sepsis is defined as a life threatening organ dysfunction caused by a dysregulated host response to infection, and it is one of the most deadly and costly conditions at hospitals. **Objective:** The aim of the current study was to decrease the incidence of sepsis and mortality related to it among ICU patients through applying educational programs and assessment of physicians' and nurses' knowledge and performance.

Patients and methods: A quasi-experimental study was carried out on physicians and nurses in Zagazig University Hospitals during the period between September 1, 2021 and February 28, 2022. The investigated units were the Emergency ICU (EICU) and the Surgical ICU (SICU) at Zagazig University Hospitals.

Results: There was significant difference in sepsis and infection control scores pre and post educational program among physicians and nurses, in relation to department where total sepsis and infection control score was statistically higher among Surgical ICU physicians and nurses than Emergency ICU physicians and nurses.

Conclusion: Implementation of an educational program has a positive effect on knowledge and performance of ICU physicians and nurses in management of sepsis. Therefore, this may help proper management of cases and reducing mortality rates. Education workshops should be based on the most recent guidelines.

Keywords: Educational Program, Knowledge, Performance, Management, Sepsis, Intensive Care Unit, Quasi-experimental Study, Zagazig University.

INTRODUCTION

Sepsis is defined as a life threatening organ dysfunction caused by a dysregulated host response to infection and it is one of the most deadly and costly conditions at hospitals [(1)].

Sepsis occurs in 1-2% of all hospitalizations and accounts for as much as 25% of ICU bed utilization. Due to it rarely being reported as a primary diagnosis (often being a complication of cancer or other illness), the incidence, morbidity and mortality rates of sepsis are likely underestimated [(2)].

National Institute for Health and Care Excellence (NICE) guidelines recommend ensuring that all healthcare staff involved in assessing people's clinical condition are given regular, appropriate training in identifying people who might have sepsis. This includes primary, community care and hospital staffs. All healthcare professionals involved in triage or early management should be given regular appropriate training in identifying, assessing and managing sepsis. This training should include risk stratification strategies, local protocols for early treatments, including antibiotics and intravenous fluids and criteria and pathways for escalation, in line with their health care setting [(3)].

A good knowledge of sepsis guidelines among physicians and nurses is essential to correct management of this condition and could be improved through educational training [(4)].

The aim of the current study was to decrease the incidence of sepsis and mortality related to it among ICU patients through applying educational programs and assessment of physicians' and nurses' knowledge and performance.

PATIENTS AND METHODS

A quasi-experimental study was carried out on physicians and nurses in Zagazig University Hospitals during the period between September 1, 2021 and February 28, 2022. The investigated units were the Emergency ICU (EICU) and the Surgical ICU (SICU) at Zagazig University Hospitals.

EICU had 22 beds including two isolated beds and SICU had 33 beds including 3 isolated beds at time of the study. Distance between beds was found to be 1.5 meter and there was physical separation in between. There were available sinks allocated for hand washing in addition to alcohol hand rub dispensers which were distributed between the beds.

The EICU admits all types of patients with critical illness from the emergency room, ward and the operating room. The SICU is more dedicated to patients in perioperative state who are arranged to be managed in ICU before and after elective operations.

There was one ICU resident and one ICU specialist continuously in each ICU. The nurse - patient ratio ranged mostly from 1:2 to 1:3 but only reached 1:4 in the EICU.

A quasi-experimental study that was divided into three phases: A pre-interventional phase, an interventional phase, and a post-interventional phase.

Study population: Physicians and nurses from the EICU and the SICU, Zagazig University Hospitals. They were arranged into two separated groups along the study, physicians group and nurses group.

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Inclusion criteria: All physicians and nurses in EICU and SICU were invited to be included in our study.
Exclusion criteria: All physicians and nurses in vacations and those who were in home isolation due to COVID-19 pandemic.

Methods

During preparation, the following tools were developed to be used: A specifically designed questionnaire which included questions that cover all the essential aspects of sepsis and infection control to assess knowledge of the participants. It also included a part for the demographic data (age, sex, education level, years of experience, occupation and department). The informed consent also was included. An observational checklist which was designed to cover most of essential measures of infection control and specific care bundles to assess practical performance of the participants. A specific checklist was developed to assess physicians' compliance to the Antibiotics Stewardship Program (ASP); some explanatory tools like posters and scripts to make the important points simpler and easier to remember.

Development of the questionnaire: A 20 questions form was created using easy English language and was administered to each participant. All of the questions were multiple choice questions.

It was designed to assess level of participants' knowledge about sepsis regarding definitions, recognition of cases and points of management including elements of ASP and about infection control regarding general essential measures and specific care bundles that are mostly used inside the ICU according to the 2016 International sepsis guidelines and CDC infection control guidelines [(5)].

Process

The study went through three phases [(6)].

Phase one (The pre-interventional phase): This phase occupied the first month of the study. During this phase, the study was introduced to the health staff of the two investigated ICUs. Thereafter, the questionnaire (the pre-test) was applied to all the participants to assess their baseline level of knowledge concerning sepsis and infection control.

Phase two (The interventional phase): This phase occupied the next four months of the study. During this phase, all the participants were arranged into an educational course in the form of lectures and clinical rounds. The course was designed to cover all aspects of sepsis including definitions, early signs, recognition of cases and guidelines to properly diagnose and manage these cases as early as possible. The course also included all essential measures of infection control inside the ICU and how to apply them in a perfect manner.

Phase three (The post interventional phase): This phase occupied the last month of the study. During this phase we reassessed all the participants again to detect the effect of the educational course on the level of their knowledge and practical performance. The questionnaire (the post-test) was applied to all the participants and also, the observational checklist was applied, both in the same way as done before in phase one. Physicians and nurses were tested separately and each group from the both ICUs was tested at the same time. Then, the scores were calculated and registered.

Ethical Considerations:

The study gained the approval of the Institution Review Board (IRB) of Faculty of Medicine at Zagazig University [IRB; 6323-18-8-2020]. Attendance of the pre-intervention test was considered as consent and all participants were informed of that in the questionnaire paper. All participants were free to withdraw from the study at any time upon their request. The collected data was used only for scientific purposes. An informed written consent was taken from each participant in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical Analysis

The collected data were analyzed by computer using Statistical Package for Social Sciences (SPSS) version 24 for windows. Qualitative data were defined as numbers and percentages. Chi-Square test and Fisher's exact test were used for comparison between categorical variables as appropriate. Quantitative data were tested for normality by Kolmogorov-Smirnov test. Normal distribution of variables was described as mean and standard deviation (SD), while non-parametric data was described as median and range. Mann-Whitney U (MW test) was used for Comparing numerical variables between 2 groups, it is the non-parametric equivalent of t test, is used if the data cannot be assumed to have a normal distribution. Wilcoxon Signed Ranks Test was used for Comparing paired numerical variables, it is the non-parametric equivalent of paired t test, is used if the data cannot be assumed to have a normal distribution. P value ≤ 0.05 was considered to be statistically significant.

RESULTS

Table 1 is showing that physicians were statistically older than nurses as the mean age of the studied physician was 28.52 (SD 2.2) years old, with a range from 26 to 36 years old, and age of nurses was 25.9 (SD 1.86) years old, about 2\3 of physicians (61.9%) were male vs 42.9% of nurses, there was no statistically significant difference between both groups regarding sex distribution.

Table (1): Demographic data of the studied groups.

Demographic data	Physicians (N= 21)		Nurses (N= 21)		P-value
	No.	%	No.	%	
Age (years)					
Mean ± SD	28.52 ± 2.2		25.9 ± 1.86		0.000* (HS)
Median (Range)	28 (26-36)		25 (24-30)		
Sex					
Male	13	61.9	9	42.9	#0.354 (NS)
Female	8	38.1	12	57.1	

Mann Whitney U test. # Chi-square test. HS: highly significant, NS: Not significant.

Figure 1 shows that 67% of physicians had M.B.B.Ch, and 33% of them were completing their post graduate degree; 28% had master's degree and only 5% of them had MD degree.

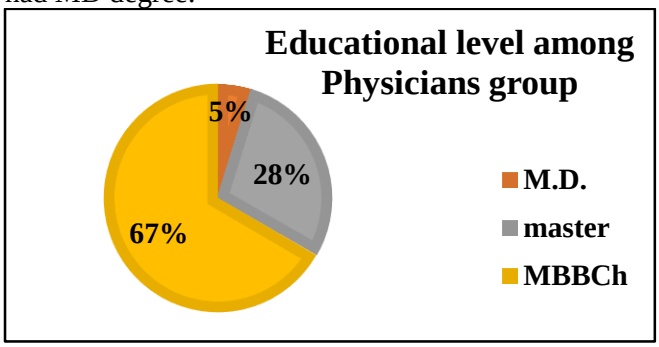

Figure (1): Pie chart representing level of education among physicians.

Figure 2 shows that 62% of nurses were graduated from nursing institute, only 5% of them completing their post graduate master degree.

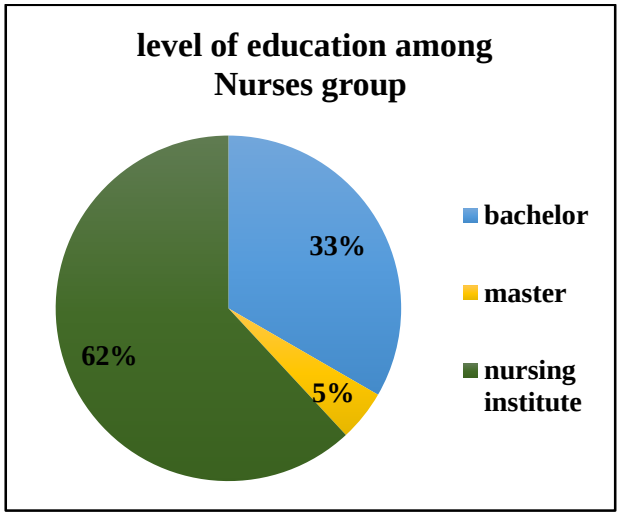

Figure (2): Pie chart representing level of education among nurses.

Table 2 showed that there was significant difference in scores pre and post educational program among physicians and nurses, total scores increased by 7.47% and 24.8% among physicians and nurses, respectively.

Table (2): Pre-test and post-test knowledge scores among the studied physicians and nurses groups.

Items	Physician		[a] P-value	Nurses		[b] P-value
	Pre intervention	Post intervention		Pre intervention	Post intervention	
Sepsis						
Definition						
Mean ± SD	1.9 ± 0.88	2.52 ± 0.51	0.010* (S)	1.62 ± 0.74	2.1 ± 0.53	0.002* (HS)
Median (Range)	2(0-3)	3(2-3)		1(1-3)	2(1-3)	
Recognition						
Mean ± SD	2.67 ± 0.57	3 ± 0.0	0.020* (S)	2.19 ± 0.6	2.38 ± 0.49	0.046* (S)
Median (Range)	3(1-3)	3(3-3)		2 (1-3)	2 (2-3)	
Management						
Mean ± SD	2.86 ± 0.72	3.1 ± 0.62	0.025* (S)	2.05 ± 0.8	2.76 ± 0.53	0.001* (HS)
Median (Range)	3(2-4)	3(2-4)		2(1-4)	3(2-4)	
Infection control						
General						
Mean ± SD	4.19 ± 0.68	4.57 ± 0.51	0.011* (S)	3.19± 0.75	4.1± 0.70	0.000* (HS)
Median (Range)	4(3-5)	5(4-5)		3 (2-5)	4 (3-5)	
ICU bundles						
Mean ± SD	3.62 ± 0.85	3.95 ± 0.66	0.008* (S)	2.38 ± 0.92	3 ± 0.89	0.000* (HS)
Median (Range)	4(2-5)	4(3-5)		2(1-4)	3(2-5)	
Total knowledge score						
Mean ± SD	15.19 ±2.35	17.1 ±1.6	0.000* (HS)	11.48 ± 2.4	14.33 ± 2.05	0.000* (HS)
Median (Range)	15(10-20)	17(15-20)		12(6-14)	14(11-18)	
Percentage of increase	**↑7.47%**		---	**↑↑24.8%**		---

[a] P-value: for comparison between preintervention and post intervention among physicians. [b] P-value: for comparison between preintervention and post intervention among nurses. Wilcoxon Signed Ranks Test. P <0.05 is significant. HS: Highly Significant.

Table 3 showed that there was significant difference in Antibiotic Stewardship Program Assessment scores pre and post educational program among physicians, total score increased after educational program by 42.6%.

Table (3): Pre- and post-intervention Antibiotic Stewardship Program Assessment scores among the studied physicians.

Items	Physicians		[a] P-value
	Pre intervention	Post intervention	
Antibiotic Stewardship Program Assessment			
Diagnosis			
Mean ± SD	1.43 ± 0.81	2.62 ± 0.49	0.000*
Median (Range)	1(0-3)	3(2-3)	(HS)
Drug			
Mean ± SD	1.43 ± 0.59	1.81± 0.4	0.005*
Median (Range)	1(0-2)	2(1-2)	(HS)
Dose			
Mean ± SD	1.19 ± 0.60	1.95 ± 0.22	0.001*
Median (Range)	1(0-2)	2(1-2)	(HS)
De-escalation			
Mean ± SD	1.48 ± 0.51	1.62 ± 0.59	0.317
Median (Range)	1(1-2)	2(0-2)	(NS)
Duration			
Mean ± SD	0.71 ± 0.46	0.9 ± 0.30	0.046*
Median (Range)	1(0-1)	1(0-1)	(S)
Total score			
Mean ± SD	6.24 ±1.48	8.9 ±1.04	0.000*
Median (Range)	6(3-9)	10(7-10)	(HS)
Percentage of change	**42.6 % ↑**		

[a] P-value: for comparison between preintervention and post intervention among physicians. Wilcoxon Signed Ranks Test. P <0.05 is significant. HS: Highly Significant.

Table 4 shows that there was significant difference in sepsis and infection control scores pre and post educational program among physicians and nurses, in relation to department where total sepsis and infection control score was statistically higher among surgical ICU physicians and nurses than emergency ICU physicians and nurses.

Table (4): Comparison between the two studied ICUs, as regard Pre-test and post-test knowledge scores among physicians and nurses.

Items	Physician		[a] P-value	Nurses		[b] P-value
	Emergency ICU	Surgical ICU		Emergency ICU	Surgical ICU	
Pre-intervention						
Total sepsis and infection control score						
Mean ± SD	13.9 ± 1.51	16.6 ± 2.36	0.002*	10.55 ± 2.16	12.51 ± 2.5	0.037*
Median (Range)	14(10-15)	17(11-20)	(HS)	11(6-14)	14(7-14)	(S)
Post intervention						
Total sepsis and infection control score						
Mean ± SD	16.09 ± 0.94	18.2 ± 1.47	0.002*	13.64 ± 1.8	15.1 ± 2.13	0.093
Median (Range)	16(15-17)	18 (16-20)	(HS)	14(12-18)	16 (11-17)	(NS)
[C] P-value #	0.005* (HS)	0.016* (S)		0.003* (HS)	0.005* (HS)	

[a] P-value: for comparison between emergency ICU and surgical ICU among physicians. [b] P-value: for comparison between emergency ICU and surgical ICU among physicians. [c] P-value: for comparison between pre and post intervention within groups. # Wilcoxon Signed Ranks Test. Mann Whitney test. P <0.05 is significant. HS: Highly Significant., NS: non-significant.

Table 5 shows that there was significant difference in Infection Control Observational Check List pre and post educational program among physicians and nurses, Infection Control Observational Check List score was higher among emergency ICU than surgical ICU physicians and nurses with no statistically difference in relation to department.

Table (5): Comparison between the two studied ICUs as regard pre- and post-intervention Infection Control Observational Checklist scores among physicians and nurses.

Items	Physician		[a] P-value	Nurses		[b] P-value
	Emergency ICU	Surgical ICU		Emergency ICU	Surgical ICU	
Pre-intervention						
Infection Control Observational Check List						
Mean ± SD	16.09 ± 1.88	15.9 ± 2.5	0.317 (NS)	12.45 ± 3.38	11.2 ± 2.44	0.212 (NS)
Median (Range)	16(12-18)	15(14-21)		13(6-16)	11(8-16)	
Post intervention						
Infection Control Observational Check List						
Mean ± SD	22.27 ± 2.24	21.9 ± 2.13	0.591 (NS)	20.73 ± 2.86	19.7 ± 2.35	0.433 (NS)
Median (Range)	22(19-26)	21 (19-26)		21(16-24)	19 (17-25)	
[C] P-value #	0.003* (HS)	0.005* (HS)	---	0.003* (HS)	0.005* (HS)	---

[a] P-value: for comparison between emergency ICU and surgical ICU among physicians. [b] P-value: for comparison between emergency ICU and surgical ICU among nurses. [c] P-value: for comparison between pre and post intervention within groups. # Wilcoxon Signed Ranks Test. Mann Whitney test.
P <0.05 is significant. HS: Highly Significant, NS: non-significant.

There was significant difference in Antibiotic Stewardship Program Assessment pre and post educational program among physicians, Antibiotic Stewardship Program Assessment score was higher among emergency ICU than surgical ICU physicians with no statistically difference in relation to department.

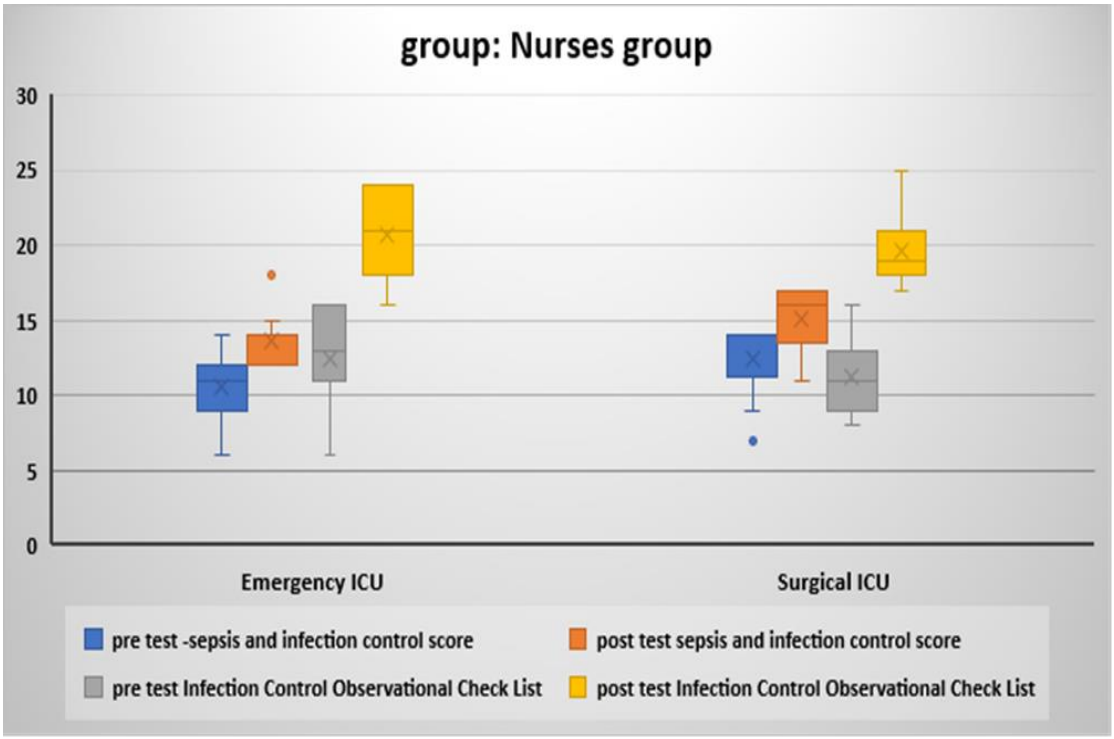

Figure (3): Comparison between the two studied ICUs as regard pre- and post- intervention scores among nurses.

There was significant difference in sepsis and infection control scores in pre and post intervention among physicians and nurses (**Figure 4 and 5**).

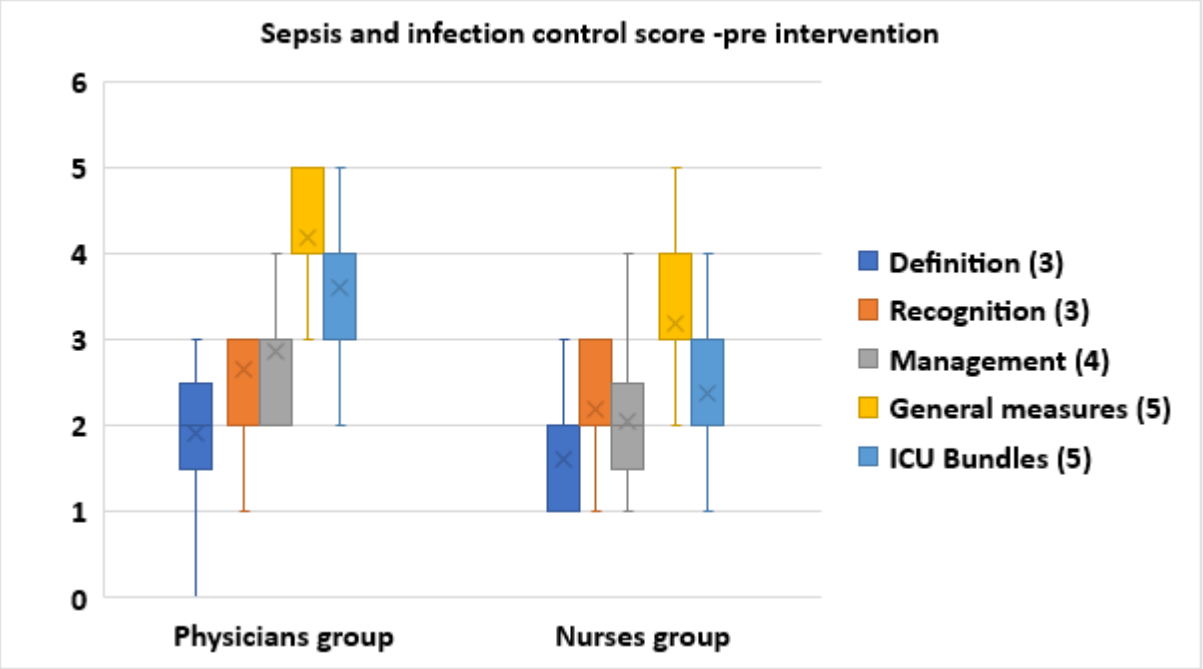

Figure (4): Box plot representing pre-test knowledge scores between physicians and nurses groups.

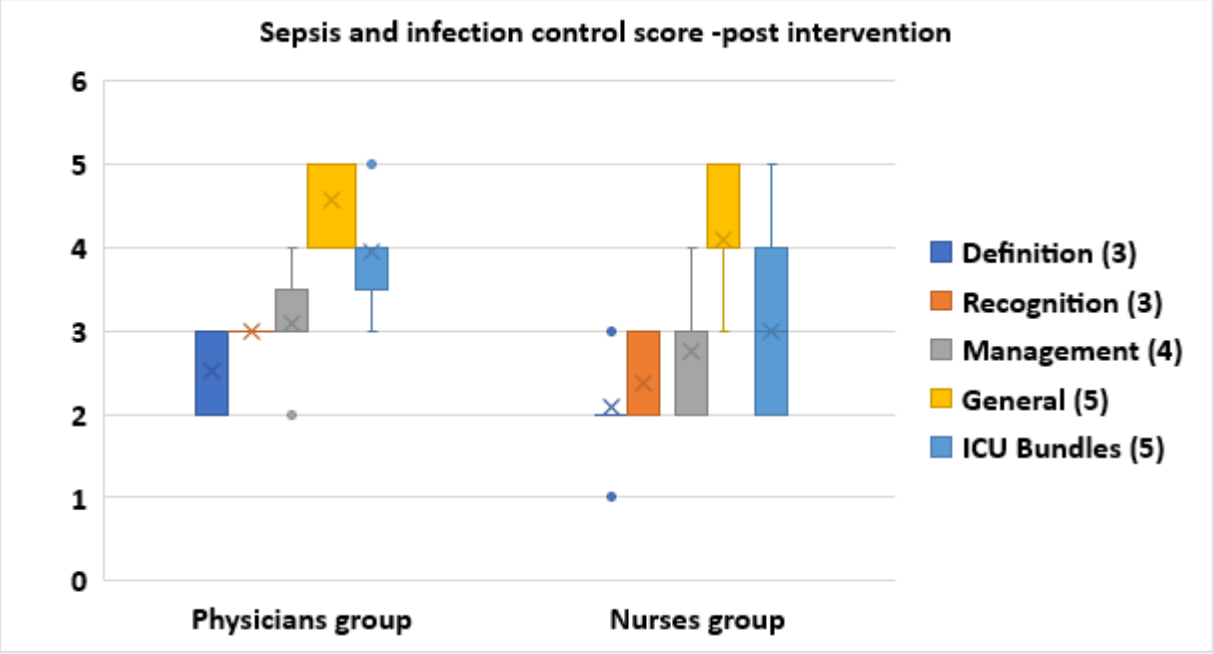

Figure (5): Box plot representing post-test knowledge scores between physicians and nurses' groups.

Table 6 shows that educational level, Years of experience, age were significant predictors for the total variation of the post intervention infection control score where their variations could explain 48% of change in post intervention infection control score, with a 1% increase in age, post intervention infection control score will increase by 0.82%, and with a 1% increase in educational level, post intervention infection control score will increase by 3.6%. Therefore, the analysis suggests that the age and educational level has a significant positive relationship with post intervention infection control score.

Table (6): Best fitted model for predictors of post intervention score among the studied sample.

Model	R^2	Unstandardized Coefficients		Standardized Coefficients	P-value	95% CI for B	
		B	Std. Error	Beta		Lower Bound	Upper Bound
(Constant)	0.48	14.54	6.645	---	0.035*	1.095	27.99
Age		0.820	0.298	0.509	0.009*	0.217	1.424
Years of experience		-1.416	0.313	-0.664	0.000*	-2.049	-0.783
Educational level		3.690	1.579	0.375	0.025*	0.493	6.887

ANOVA P-value =0.000*. Dependent Variable: Post intervention score. Predictors: (Constant), Educational level, Years of experience, age.

DISCUSSION

Survivors of sepsis are known to face long-term sequelae including cognitive impairment and functional disability, and also exhibit a high mortality rate post-hospital discharge compared with patients with other disease [(7)].

The current study was a part of studies series on continuous learning of health-care workers for improving level of knowledge and performance in intensive care units of Zagazig University Hospitals.

A previous study conducted in Zagazig University Hospitals, emergency ICU by **Negm *et al.*** [(8)] to assess the compliance with the device care bundles and the impact of their implementation on the incidence rate of associated infections and the mortality related to it highlighted the importance of continuous training the ICU staff members. Moreover, the study recommended expanding efforts to enroll more units.

Negm *et al.* [(8)] found that there was a significant improvement in health care workers' knowledge after the educational program intervention especially in hand hygiene, catheter-associated urinary tract infection (CAUTI) bundle, and total knowledge.

This quasi-experimental study was conducted in the EICU and the SICU, Zagazig University Hospitals on physicians and nurses.

The age of physicians was significantly older than nurses, due to the longer educational duration among physicians.

Our study was in line with **Negm *et al.*** [(8)] who revealed that the mean physician age was 28.5 (SD 3.1) years; most of them had less than 12 months of experience in the ICU. The mean age of the nurses was 29 (SD 4.2); most of them had less than 5 years of experience in the ICU.

Nucera *et al.* [(4)] revealed that most physicians (n= 30, 61%) were male and '41-50' age group was the most represented for physicians (n= 19, 38.8%). Most nurses (n= 82, 62%) were female and '31-40' age group was the most represented for nurses (n= 43, 32.6%).

Our study showed that there was significant difference in sepsis and infection control knowledge scores before and after the educational program among physicians and nurses, total scores increased after educational program by 7.47% and 24.8% among physicians and nurses, respectively.

Also, **Nucera *et al.*** [(4)] reported that educational training was effective in improving the levels of knowledge of sepsis among physicians and nurses.

As well, **Tromp *et al.*** [(9)] showed a significant improvement of knowledge on assessment of symptoms of sepsis among physicians after an educational intervention, emphasizing the active role of continuing educational activities during the training of residents.

Also, **Machado *et al.*** [(10)] who revealed that throughout the intervention, there was an overall reduction in the risk of death, in the proportion of septic shock, and the time to sepsis diagnosis, as well as an improvement in compliance with the 6-hour bundle.

The current study showed that that there was significant difference in Antibiotic Stewardship Program Assessment scores before and after the educational program among physicians, total scores increased after educational program by 42.6%.

Our results were supported by **Calò *et al.*** [(11)] who aimed to evaluate the effect that an education-based Antimicrobial Stewardship Program (ASP) implemented on the quality and appropriateness of antibiotic prescription, the findings of this study reinforce the importance of adopting an educational ASP in order to improve the quality of antimicrobial prescription in clinical practice and possibly to contribute to a reduction in the global phenomenon of antibiotic resistance.

The current study showed that there was a significant difference in sepsis and infection control scores pre and post educational program among physicians and nurses, in relation to department where total knowledge scores were statistically higher among SICU physicians and nurses than EICU physicians and nurses.

Also, this study indicated that there was a non-significant difference in Infection

We also found that regarding the Antibiotic Stewardship Program Assessment pre and post educational program among physicians, scores were higher among the EICU than the SICU physicians.

To the best of our knowledge this is the first study to assess the relation between ICU department and the improvement in practice among healthcare workers subjected to educational program.

Nucera *et al.* [(4)] revealed that there was a significant higher physicians' knowledge about risk factors and development of sepsis than nurses, but there was no significant difference in level of knowledge about early identification and management of sepsis between physicians and nurses.

In order to understand the relationship between the demographic data of participants and their scores, we analyzed data in our study and found that mostly, every increase in age, educational level and years of experience of physicians and nurses was accompanied by increase in their scores. Therefore, the analysis suggests that the age, educational level and years of experience have a significant positive relationship with post intervention scores.

Also, our intervention resulted in significant improvement in Antibiotic Stewardship Program Assessment score, which was agreed with previous study [(11)] which indicated that educational programs resulted in significant improvement in Antibiotic Stewardship Program Assessment score among healthcare workers in ICU.

All of the above helps understand the importance of regular and continuous evaluation and education of the medical stuff and how it can improve physicians' and nurses' knowledge and performance in order to achieve better results in management of sepsis.

CONCLUSION

Implementation of an educational program has a positive effect on knowledge and performance of ICU physicians and nurses in management of sepsis. Therefore, this may help proper management of cases and reducing mortality rates. Education workshops should be based on the most recent guidelines. Age, education level, experience and working environment have a significant effect on the compliance with the education and hence can affect the whole work, so, these factors should be considered well. Continuity is also important to achieve the goal of education as continuous learning helps keeping health workers up to date with the most recent clinical information and management measures.

DECLARATIONS

- **Consent for publication:** I attest that all authors have agreed to submit the work.
- **Availability of data and material:** Available
- **Competing interests:** None
- **Funding:** No fund
- **Conflicts of interest:** no conflicts of interest.

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