

USE OF PERSONAL PROTECTIVE EQUIPMENT AMONG HEALTHCARE PERSONNEL DURING COVID-19 PANDEMIC

By

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Abstract

Introduction: COVID-19 is a real threat to Egypt which needs effective preparedness for crisis of infections that could happen. Use of personal protective equipment is pivotal to limit the transmission of COVID-19 in the healthcare settings. **Aim of Work:** To assess the feasibility of a training intervention program to HCWs (doctors, nurses, pharmacists, technicians and workers) which was used to evaluate their level of knowledge regarding COVID-19 pandemic, to promote their degree of confidence in using PPE, and to improve their knowledge during the current pandemic. **Materials and Methods:** A quasi-experimental study was carried out at Tanta Chest Hospital. Participants answered a self-administered validated questionnaire which included questions regarding socio-demographic, knowledge about COVID-19 and confidence of the usage of PPE as a protective measure. The questionnaire was used before and after intervention health education program and training sessions. **Results:** Means of knowledge scores of physicians and nurses after intervention (11.19 ± 2.18 and 10.06 ± 2.26 respectively) were statistically significantly higher than all other subgroups of HCWs. Only 13.9% of physicians, 6.0% of pharmacists, 10.7% of nurses, 2.4% of technicians and no workers had high confidence regarding PPE as a preventive tools, and a significant increase in confidence level after intervention to be (62.9%, 53.4%, 61.2%, 44.7% and 55.3%) respectively. A linear regression analysis revealed that there was a statistically significant relation between high confidence in PPE after intervention with increased years of experience and total knowledge score. **Conclusion:** Intervention training program significantly increased knowledge and confidence level of targeted participants in PPE. Hence,

ongoing training for HCWs is fundamental for health care personnel especially during pandemics.

Keywords: Personal protective equipment, knowledge, Health care workers, COVID-19 pandemic and Confidence.

Introduction

Coronavirus disease (COVID-19) emerged in Wuhan, China in December 2019, causing a pandemic all over the world. Egypt has reported the first case of confirmed COVID-19 was in 14 February 2020 in Aswan. Egypt as a developing country may pose severe burden if spread of infection continues (Verity et al, 2020 and MOHP, 2020).

Chest hospitals in Egypt are one of the main authorized places by Ministry of Health and Population to receive suspected or confirmed COVID-19 cases (MOHP, 2020). Thus, healthcare workers (HCWs) in chest hospitals are at increased risk of infection while offering care for COVID-19 patients. Infection of HCWs by COVID-19 will reduce quality of services offered in hospitals due to sickness absence and deaths among them especially, during outbreaks, epidemics and pandemics that result in physical, psychological and financial costs to health care systems (Williams and Carnahan, 2013, Ogbaini et al., 2018, WHO, 2020).

COVID-19 virus is transmitted through droplets and close contact with patients (WHO, 2020). Therefore, the ability to limit the transmission of COVID-19, the disease caused by the novel coronavirus, in the healthcare setting requires infection prevention and control measures, of which PPE is a fundamental element (PHE, 2020). WHO recommended use of personal protective equipment (PPE) for health care workers in health care settings, especially in chest hospitals. PPE includes: medical masks or respirators as (N95 or FFP2 equivalent), gloves, goggles, face shield, gowns and aprons (WHO, 2020). Adequate knowledge and compliance regarding different types of PPE and protection offered by each type (which vary according to type of activity performed), proper use of PPE, maintenance, and safe storage of the PPE is mandatory especially in Corona virus crisis(WHO,2020).

Confidence and compliance of HCWs towards protective effect of PPE was found to be related to HCWs' training regarding PPE and its proper use on how

to put on, remove, and dispose (Schwartz et al, 2014). Compliance with the use of PPE and recommended infection control precautions is critical pillar to prevent the transmission of COVID 19 virus (WHO,2020). When used PPE, such as gloves, aprons, eye protection, masks and gowns, in a correct way, they function as a physical barrier to the transmission of infectious particles present in bodily fluids, and they also protect patients from transmission via the contaminated hands or clothing of healthcare staff (Brown et al, 2019). It is a fundamental issue to mitigate the associated risk with incorrect use of PPE that highlights the importance of carrying out donning and doffing in the correct sequence (PHE,2020). Thus, it is critical to provide HCWs with training to ensure that staff members are well trained on correct donning and doffing of PPE, and health care personnel know which PPE they should wear in each setting and context (Brown et al, 2019).

COVID-19 represents a fast-moving threat that had aroused by surpassing actions in China. However, real possibility of infection have been faced by overworked and under-trained HCWs; also, depending on the incorrect information about a rapidly developing

epidemic may have a contributing role that HCWs may refuse or be unable to work which can lead to a critical HCW shortages(Schwartz et al,2020). So, health education sessions for HCWs in hospital setting, to raise their awareness regarding knowledge and PPE confidence, is beneficial and cost effective because protecting health professionals not only limits disease spread, but also ensures that there are adequate numbers of staff to cope with inevitable increasing demands for healthcare services in the coming weeks and months ahead.

Aim of Work

To assess the feasibility of a training intervention program to HCWs (doctors, nurses, pharmacists, technicians and workers) which was used to evaluate their level of knowledge regarding COVID-19 pandemic, to promote their degree of confidence in using PPE, and to improve their knowledge during the current pandemic.

Materials and Methods

Study design: It is a quasi-experimental study

Place and duration of the study: The study was conducted at Tanta Chest hospital, Egypt during the period from 1st of January to the end of February 2020.

Study sample:

This study targeted HCWs at Tanta Chest Hospital. Sampling frame was a list of active working health care personnel from Human Resources Department at the hospital. Inclusion criteria included: all health care workers who agreed to participate in the study, active working condition at the time of study, and their age is between 18 years and 60 years old.

Exclusion criteria included: HCWs who refused to participate in the study, who were in a vacation or were not actively working at time of study, and their age below 18 years or above 60 years old.

Sampling

A stratified random sampling technique was used. Each class was divided into four subgroups for practical training (20 subgroups). Two groups were chosen from each class randomly to be included in the study sample. Then, participants were chosen by random sampling of subgroups with optimum allocation until reaching the required calculated sample size.

Sample Size Estimation

In estimating the sample size for this study, previous data from the hospital

indicates that there were approximately 850 HCWs, and if 50% of those HCWs would be confident in PPE use, and tested at a conventional power of (1-beta) 0.80 and alpha of 0.05, a total number of 265 HCWs is needed. This number was doubled to compensate for dropouts. The sample included 151 physicians, 116 pharmacists, 121 nurses, 85 technicians and 65 workers; with a total sample equals 538 participants.

Study methods

❖ Part one: Collection of data using a questionnaire (before health education sessions)

A questionnaire was developed grounded on the associated literatures, the frequently asked questions posted on the World Health Organization (WHO) and the Egyptian Ministry of Health websites (WHO, 2020 and MOHP, 2020). The questionnaire consists of four sections as follows:

- **Section one** (seven items): it included participants' characteristics: age, gender, marital status, type of profession, department of work in chest hospital, attending previous infection control training and years of experience.

- **Section two** (fourteen items): This section aimed to evaluate the studied sample' general knowledge about coronavirus and the preventive measure tools. Dichotomized "Yes", "NO" and "I don't know" options were used for the purpose of evaluation. To make a clear demarcation of participants' knowledge level, the responses were scored. Every correct answer added one mark to the participants' total score, and zero was given for wrong or uncertain answers, with a maximum possible score of 14 and a minimum score of 0.

- **Section three:** assessed the self-perceived confidence of HCWs regarding PPE. It was developed grounded on the survey instrument developed in a study to assess the confidence regarding PPE during H₁N₁ pandemic (Schwartz et al, 2014). Confidence in PPE was assessed through the question, to what extent do you feel that PPE can protect you from infection by novel corona virus?

Answers were: NO, Low, Moderate or High.

- **Section four:** it assessed the subjective level of confidence in three domains: management of a contamination breach, practicing safe

clinical skills while wearing PPE, and donning and doffing PPE. These questions were answered using a 5-point Likert scale, with the anchors not at all confident and extremely confident. Replies were converted to their numerical value on the Likert scale from zero, not confident at all, to five points, extremely confident.

Validity of the tool

Validity of questionnaire was set up by a group of experts included two consultants of infectious disease and three Egyptian professors in epidemiology department to assess the items of the questionnaire were relevant and precisely measure knowledge and confidence of PPE among HCWs. The questionnaire was tested by a pilot study to assess its reliability. Fifty two HCWs, who were excluded from the current study, participated by refilling the questionnaire after fourteen days. Data were used to assess internal consistency reliability using alpha Cronbach and test-retest reliability by using the intra-class correlation coefficient, (with Cronbach's alpha = 0.82 for knowledge questions and 0.80 for PPE confidence questions included in sections three and four), which represented adequate internal consistency reliability.

❖ Part two: Intervention settings

Health education program and training sessions on emergency preparedness and precautions that should be implemented by health care personnel caring for COVID-19 patients.

It included PPE training, staff meetings about infection control, face-to-face education sessions for HCWs, and tighter hand-hygiene compliance oversight.

A- Health education session included the following general instruction:

- Mode of transmission of COVID-19 virus.
- How to protect yourself, patients, families, neighbors and community from COVID-19 infection.
- Maintaining distance at least 1 meter from any person.
- Frequent hand washing with soap and water.
- Hand rub with alcohol 70%.
- Avoid touching eyes, mouth and nose.
- Coughing and sneezing into tissue and dispose it immediately or in bent elbow.

B-Health education on how to choose appropriate PPE according to type of activity and personnel offering care to COVID-19 patients: e.g.

- Health care personnel in the direct contact with patients should use the following PPE: medical mask, eye protection, gloves and gowns.
- Specific procedures as: (tracheostomy, tracheal intubation, manual ventilation, cardiopulmonary resuscitation, bronchoscopy) health care personnel should use: respirators (N95 or FFP2 equivalent), eye protection or face shield, gloves and aprons.
- Cleaners of rooms of COVID patients should wear: heavy duty gloves, boots, medical mask, eye protection and gown.
- Lab technician: eye protection, gown, gloves and medical mask.
- Visitors: should wear medical mask, gloves and gowns.

C- Clinical Demo Training for staff on:

- Selection of proper PPE according to type of activity involved.
- Training on how to wear, remove,

and safely dispose of PPE.

❖ **Part Three : Collection of data using the same self -structured questionnaire after health education sessions**

On the end of last session, a post-test was conducted using the same tool to assess any gain in knowledge and confidence among the participants.

Consent

An informed consent was obtained from Tanta Chest Hospital staff members through Human Resource Department to take their agreement for participation with a brief explanation on the objectives of the study.

Ethical Approval

Ethical approval was obtained from the Ethical Research Committee at Faculty of Medicine Tanta University .

Data Management

Data were analyzed using software Statistical Package for Social Sciences (SPSS) version 20. Descriptive statistical methods were used to calculate numbers and percentages for each variable. Chi square test was used to assess PPE confidence among HCWs, and ANOVA analysis was used to compare knowledge scores among HCWs. Regression analysis was done to find predictors of confidence level of HCWs. p-value < 0.05 was considered statistically significant.

Results

Table (1): Demographic characteristics of the studied sample.

Variables	No.	%
Age (Mean± SD)	36.329±10.25 Range (21-60)=39 Median=34.50	
Sex	Male	187
	Female	351
Marital status	Single	75
	Married	455
	Divorced	2
	Widow	6
Type of Profession	Physicians	151
	Pharmacists	116
	Nurses	121
	Workers	65
	Technicians	85
Place of work in Chest Hospital	Emergency room	100
	Intensive care	47
	Inpatient clinics	156
	Outpatient clinics	42
	Hospital management	89
	Pharmacy	56
	Laboratory	48
Attend infection control training	No	65
	Once only	189
	Several times	284
Years of professional experience	Less than 10 y	334
	More than 10 y	204
	Mean ±SD	11.517±9.39

The mean age of the studied subjects was (36.329±10.25) years. About two thirds of the studied sample were females (65.2%) and 84.6% were married. About 28% were physicians and 29.0% are working in inpatient clinics. About half of them (52.8%) attended infection control training. More than half had been working for less than ten years (Table 1).

Table (2): Knowledge questions regarding COVID-19 among HCWs before and after health education intervention.

Variables	Pre-intervention No. (%)	Post-intervention No. (%)	Test of significance
1- COVID-19 is originally from bats	333(61.9%)	406(75.5%)	$X^2=23.02$ $p=0.00^*$
2- It is a disease that does not affect China only	422(78.4%)	473(87.9%)	$X^2=17.27$ $p=0.00^*$
3- It can be transmitted by droplet and direct contact.	385(71.6%)	418(77.7%)	$X^2=5.34$ $p=0.021^*$
4- The causative organism of Corona>s disease is virus	477(88.7%)	511(95.0%)	$X^2=14.3$ 0.00^*
5- Corona disease is an infectious one.	444(82.5%)	475(88.3%)	$X^2=7.16$ $p=0.007^*$
6- Symptoms include fever, cough and dyspnea	416(77.3%)	456(84.8%)	$X^2=9.67$ $p=0.002^*$
7- You can diagnose the person with the disease.	264(49.1%)	378(70.3%)	$X^2=50.18$ $p=0.00^*$
8- The incubation period of COVID-19 (2-14 days).	71(13.2%)	314(58.4%)	$X^2=238.8$ $p=0.00^*$
9- COVID-19 leads to pneumonia, respiratory failure, and death.	430(79.9%)	440(81.8%)	$X^2=0.6$ $p=0.438$
10- No available treatment or vaccine until now.	416(77.3%)	450(83.6%)	$X^2=6.84$ 0.009^*
11- Elderly, pregnant, chronic- diseased patients and children are high risk groups.	454(84.4%)	492(91.4%)	$X^2=12.63$ $p=0.00^*$
12- Maintaining distance at least one meter from any person can prevent infection.	323(60.0%)	383(71.2%)	$X^2=14.8$ $p=0.00^*$
13- Visitors of patients should be wearing medical mask	218(40.5%)	447(83.1%)	$X^2=206.5$ $p=0.00^*$
14- Use of gloves does not replace need of appropriate continuous hand washing.	270(50.2%)	407(75.7%)	$X^2=74.76$ $p=0.00^*$

*: Statistically significant

Table 2 showed that there was a statically significant difference as regards all questions before and after intervention except for a question regarding COVID 19 leads to pneumonia , respiratory failure and death.

Table (3): Knowledge scores and PPE confidence among different categories of HCWs before and after health education intervention.

Knowledge Scores		Physicians	Pharmacists	Nurses	Workers	Technicians	Test of significance	
Pre-intervention	(Mean±SD)	8.78±2.3	8.36±2.79	8.71±2.26	7.15±3.27	8.18±2.97	F=4.8	p=0.001*
	Post-Hoc test	Physicians vs Workers(0.00*) Pharmacists vs Workers(0.004*) Nurses vs Workers(0.00*) Technicians vs Workers(0.01*)						
Post intervention	(Mean ± SD)	11.19±2.18	8.76±2.9	10.06±2.26	7.81±2.03	8.24±2.8	F=31.8	p=0.00*
	Post-Hoc test	Physicians Vs Nurses (0.00*) Pharmacists(0.00*) Nurses(0.00*) Workers(0.01*)		Pharmacists Vs Physicians(0.00*) Technicians (0.00*) Workers (0.00*)				
		Nurses Vs Physicians(0.00*) Pharmacists(0.00*) Workers(0.00*) Technicians(0.00*)		Workers Vs Physicians(0.00*) Pharmacists(0.018*) Nurses(0.00*)				
		Technicians Vs Physicians(0.00*) Nurses(0.00*)						
PPE Confidence								
Pre intervention	No	94 (62.3%)	94 (81.0%)	93(76.9%)	60(92.3%)	75(88.2%)	X ² =40.2 p=0.00*	
	Low	12(7.9%)	5(4.3%)	5(4.1%)	3(4.6%)	5(5.9%)		
	Moderate	24(15.9%)	10(8.6%)	10(8.3%)	2(3.1%)	3(3.5%)		
	High	21(13.9%)	7(6.1%)	13(10.7%)	0(0.0%)	2(2.4%)		
Post intervention	No	0(0.0%)	0(0.0%)	0(0.0%)	11(16.9%)	6(7.1%)	X ² =61.2 p=0.002*	
	Low	11(7.3%)	9(7.8%)	9(7.4%)	6(9.2%)	7(8.2%)		
	Moderate	45(29.8%)	45(38.8%)	38(31.4%)	19(29.3%)	25(29.4%)		
	High	95(62.9%)	62(53.4%)	74(61.2%)	29(44.6%)	47(55.3%)		

SD: Standard Deviation

*: Statistically significant (p <0.05)

Table 3 compares means of knowledge scores among HCWs subgroups. Before intervention, the means of knowledge scores of workers (7.15±3.27) were significantly lower than all other groups of HCWs (p<0.05). While means of knowledge scores of physicians, nurses, pharmacists and technicians were not significant with each other. After intervention, means of knowledge scores of physicians and nurses (11.19±2.18, 10.06±2.26) were significantly higher than all other subgroups (p=0.00*).

As regard confidence in PPE as a preventive tool against infection, only 13.9% of physicians, 6.0% of pharmacists, 10.7% of nurses, 2.4% of technicians and no workers had high confidence. A significant increase in PPE confidence is detected after the intervention.

Table (4): Assessment of PPE confidence among HCWs before and after intervention.

	Pre-intervention	Post-intervention	Paired t –test	p
Contamination breach	1.67±0.7	3.55±0.9	-4.46	0.002*
Clinical skills in PPE	1.56±0.52	3.66±1.2	-4.99	0.001*
Donning and doffing	1.44±0.52	3.42±1.1	-6.01	0.000*

*: Statistically significant (p <0.05)

Table 4 compares HCWs' confidence scores between pre and post training program, by using paired t test, in three key domains. It is evident that management of a contamination breach (1.67±0.7 vs 3.55±0.9), performing clinical skills while wearing PPE (1.56±0.52 vs 3.66±1.2), and donning and doffing PPE (1.44±0.52 vs 3.42±1.1) were higher in post training program with a statistically significant difference.

Table (5): Multiple linear regression analysis of some factors affecting confidence in PPE after health education intervention.

Model Summary

R	R square	Adjusted R Square	Std. Error of the Estimate
0.389	0.151	0.143	0.6943
ANOVA			
Df	Mean Square	F	Sig.
5	9.141	18.961	0.000*

R: Correlation coefficient

Df: Degree of freedom

F: F statistics

Coefficients

Variables	Beta	SE	Significance	95% confidence interval	
				Lower	Upper
Age	0.055	0.005	0.426	-0.006	0.014
Gender	0.016	0.067	0.707	-0.106	0.156
Previous infection control training	0.039	0.005	0.559	-0.007	0.014
Years of professional experience	0.228	0.007	0.000*	0.023	0.049
Total knowledge score	0.246	0.009	0.00*	0.038	0.075

Beta = Beta coefficient

SE =Standard Error

*: Statistically significant (p <0.05)

Table 5 showed the relationship between high confidence in PPE after intervention and some variables as (age, gender, previous infection control training, years of professional experience and total knowledge score); by using linear regression analysis. There was a statistical significant difference with increased years of experience and total knowledge score.

Discussion

Tanta Chest Hospital is one of hospitals that are responsible for treating COVID-19 patients. This intervention training program was a well-received method to all HCWs on how to deal safely with their patients during COVID-19 outbreak.

The majority of participants knew that causative organism of Corona's disease is a virus, it is an infectious one especially to high risk groups which include elderly, pregnant, chronic-diseased patients and children (88.7%,

82.5% and 84.4% before intervention) respectively; and after intervention, they became(95.0%, 88.3% & 91.4%) (Table 2). These results go hands in hands with that recoded by Huynh et al. (2020), who conducted a cross sectional study among 327 healthcare workers at District 2 Hospitals in Ho Chi Minh City (HCMC), and they found that the majority of HCWs were aware that patients with chronic diseases are more susceptible to get infected with higher risk of death (79.2%), and it is a viral infection (99.0%). The source of information of WCWs was either WHO

or means of social media transmit nearby the same information.

Regarding knowledge of some preventive measures, about half of participants knew that maintaining distance at least one meter from any person, visitors of patients should be wearing medical mask and use of gloves does not replace need of appropriate continuous hand washing (60.0%, 40.5%, 50.2% before intervention); vs (71.2%, 83.1%, 75.7% after intervention) respectively (Table 2). Nearby results were recorded by Bhagavathula et al.(2020), who did a survey on HCWs regarding knowledge and perceptions of COVID19 during the first week of March 2020, and they detected that 85.6% of them illustrated that continuous hand hygiene, covering nose and mouth while coughing, and avoiding sick patients can help to prevent COVID-19 transmission. However, HCWs should always update their COVID-19 related knowledge and should use scientific sources of information .

After intervention, means of knowledge scores of physicians and nurses were significantly higher than all other subgroups (Table 3). This is in accordance with Zhou et al. (2020),

who carried out a cross sectional study which involved 1357 HCWs across 10 hospitals in Henan in China, revealed that doctors and nurses had higher knowledge scores regarding COVID-19 than other paramedics. These two previous results indicate that physicians and nurses, front line HCWs, more knowledgeable about disease which is an important pillar in their war against Corona disease.

The current study showed that after intervention, PPE confidence significantly increased and reached 62.9% among physicians, 53.4% among pharmacists, 61.2 % among nurses, 44,6% among workers and 55.3% among technicians (Table3). These were in line with a study done by Ann et al (2016) who conducted a training program to health care workers expected to care for patients with emerging Ebola viral disease in Ashanti Region of Ghana. Their study subjects reported that they were not confident at all in performance of clinical skills in PPE (67%), donning and doffing (66%) and in management of contamination breach (61%) before joining the program. After finishing the training course, participants' confidence

significantly increased to reach 96%, 97%, and 98% respectively. This similarity in both studies reveals having similar circumstance of severely aggressive emerging viruses as Ebola and COVID-19 pandemic. Also, both studies were done to prepare and train front line HCW to safely manage patients with COVID-19 and Ebola viral disease.

Higher level confidences in PPE was reported by Schwartz et al. (2014), who performed a cross sectional study included 617 HCWs (nurses and physicians) in 21 hospitals and 40 primary care clinics in Israel at the peak of H₁N₁ pandemic. The percentage of participants who had high or very high confidence in PPE was 58% and confidence was higher among nurses compared to physicians. This discrepancy might be due to continuous training of HCW and availability of PPEs in these hospitals that enable respondents to comply and confident with their use.

In the present study, the level of confidence of HCW in three key domains: management of a contamination breach, performing clinical skills while wearing PPE, and donning and doffing PPE showed significant difference between pre and post train-

ing program (Table 4). This is similar to the results of Annan et al. (2016), who reported that their intervention course significantly increased the confidence of participants for the three key domains. The similarity between results emphasizes the value of intervention courses in improving confidence of PPE among health care personnel. The current study also coincides with Poller et al (2018), they proposed novel simulation-based exercise to investigate the safety of the selected PPE by a panel of UK experts. This was done to improve preparedness for Ebola and other infections. PPE training ensured standardized safe practice in donning and doffing. Post intervention feedback of staff on PPE was positive and, no evidence of post- doffing contamination happened. Most of staff had high confidence level that when using PPE; they are more protected.

Ratnayake et al.(2016), observed differences between pre-test and posttest regarding the doffing procedure. Average pretest score by Abu alenain and Al-Alawi (2018) was 67% and post test score significantly increased to 85%. The studies coincided in re-

sponse to the rising global anxiety from COVID-19 pandemic and Ebola epidemic, to master skills that is needed to manage all infectious cases.

In a regression model, PPE confidence was significant associated with total knowledge score (Table 5). This finding was consistent with that of a study done in Israel during H₁N₁ pandemic(2014), illustrated that a high level of knowledge, both tested and self-perceived, regarding PPE use for H₁N₁ was associated with increased confidence in PPE among HCWs.

Conclusion

Intervention program significantly increased knowledge about COVID-19 and confidence level toward PPE. This intervention training program is one of the strategies that Center of Occupation Health and Safety in Gharbia Governorate implemented to ensure chest hospital preparedness for a wide range of infections during COVID-19 pandemic.

Recommendations

Ongoing training of HCW in donning and doffing of PPE and management of a contamination breach according to recent guidelines in all hospitals at regular intervals

is fundamental to improve their knowledge and confidence of PPE.

Conflicts of Interest

The authors declared that they have no competing interests.

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