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Research Article

Effectiveness of Inspectors' Team in Increasing Compliance with Personal Protective Equipment Use and Reducing COVID19 Infection Spread Among Healthcare Workers; A Prospective Study

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Abstract

Introduction: There are several methods described in the literature to increase compliance with personal protective equipment (PPE) use and reduce health care workers (HCW) related infections. One of those methods is the institution of PPE inspectors' team. The purpose of this study to evaluate whether the implementation of such a team will ensure proper adherence to PPE protocols and reduce COVID-19 infection among HCWs.

Methods: A team of PPE inspectors was introduced in a tertiary care university hospital, where they randomly evaluated and reinforced PPE use in accordance with the guidelines set by the local health authority. The study period was from the 10th of May 2020 until the 31st of August 2020. The evaluations were divided into three categories; appropriate, missing, or unnecessary use of PPE and were compared to trends in healthcare workers' COVID-19 infection rates.

Results: A total of 720 HCWs were evaluated from the 10th of May 2020 until the 31st of August 2020. The appropriate use of PPE increased from 56% to 89% during the study period. Meanwhile, the incidence of positive COVID-19 among HCWs, which has peaked to 31 cases per day on the 18th of May 2020, has been declining to below 5 cases per day towards the end of the study period.

Conclusion: PPE inspectors' team served a positive role in increasing compliance with PPE use and was associated with reduction in the spread of COVID-19 infection among HCWs.

Keywords: COVID-19; HCW; Hospital; PPE; SARCOVQA: Quality Assurance

Introduction

In late 2019, a cluster of unexplained pneumonia emerged in Wuhan, China. The viral culprit was later discovered and named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) with the disease it causes labelled as 'COVID-19' [1]. The route of transmission is primarily via droplet mechanism. Interestingly

enough, aerosol transmission is also considered plausible [2]. The spectrum of symptoms ranged from asymptomatic/mild to life threatening outcomes [3]. This placed healthcare workers (HCWs) at the highest risk of infection compared to the general population. High mortality rate amongst HCWs has been reported in the literature, which drew attention to the importance of the availability and adherence to protective gear that serves as means of contact precaution [4]. It has been established that Personal Protective Equipment (PPE) consists of gloves, face masks, air-purifying respirators, goggles, face shields, and gowns [5,6]. The aforementioned will incorporate facial, respiratory, visual, and bodily protection. It is vital to understand that success in PPE will be incomplete if other protocols were not adhered to such as proper doffing and donning as well as physical distancing with patients and other fellow HCWs [7]. There are several approaches to increase compliance with PPE use and decrease rate of infection among HCWs, one of which includes the institution of PPE inspectors inside hospitals that will observe the magnitude of compliance of HCWs to PPE use and enforce policies set up in safety of HCWs. For that purpose, we studied the effects that PPE inspectors had in a tertiary care university hospital during the COVID-19 pandemic.

Materials and Methods

A team of healthcare workers under the name of PPE inspectors or 'PPE police" was introduced in a tertiary care university hospital. The implementation of PPE inspectors aimed to reduce the incidence of COVID-19 infection among HCWs by assessing and reinforcing compliance to PPE use and adherence to infection control methods based on the 'rational use of PPE' criteria compiled by the local health authority (see supplementary material- Figure S1). The criteria was circulated and sent to all HCWs in April 2020.

Ethical approval was obtained by the local ethical committee. This prospective study is not considered to be a clinical trial as per the International Committee of the Medical Journal Editors (ICMJE) recommendations.

For the purpose of subdividing health care workers in our analysis (see figure 1), the term HCWs incorporated physicians and other allied health workers (such as nurses, pharmacists, therapists, social workers, etc.) who provide direct care to patients. Those who provide indirect care were classified according to their job title in our analysis (cleaners, porters and administration employees). Healthcare workers, administrative staff, porters, and cleaning staff were evaluated via random selection in various departments and areas in the hospital, such as ER rooms, inpatient wards, laboratories, procedure rooms, pharmacies, corridors and inside patient rooms.

Health care workers were observed and evaluated randomly on a daily basis from the 10th of May 2020 to the 31st of August 2020 by the PPE inspectors' team. Random encounters were made daily by three different team members. The incidence of COVID-19 infection among HCWs was recorded from 25th of April 2020 until August 31st, 2020. Compliance to PPE was updated weekly and compared to the trends in HCWs' infections. The results were divided into three categories; appropriate, missing, or unnecessary use of PPE based on the criteria mentioned above (see supplementary material – Figure S1). These results were updated weekly during that period and were announced in a hospital COVID-19 crisis virtual meeting at the end of each week to provide continuous feedback.

Appropriate PPE use category was defined as those who wore minimal satisfactory PPEs without missing out on any equipment. Whereas missing PPE category included those who wore inadequate PPE with one or more of the necessary equipment missing. Finally, unnecessary PPE category involved those who wore extra equipment that were unnecessary (e.g. wearing gloves or gowns in hospital corridors). There were some HCWs who fit both the 'appropriate' and 'unnecessary' categories.

Positive SARS-CoV-2 results were based on PCR assay testing at the COVID-19 occupational clinic in the hospital. In addition, those classified as having high or medium risk of exposure to SARS-CoV-2 virus were eligible to be tested, according to the local health authority criteria, and those with low risk exposure were not tested (see supplementary material- Figure S2 for details regarding risk stratification algorithm).

High risk HCWs were defined as those with prolonged, more than 25 minutes contact, within two metres and without wearing a mask with a positive COVID-19 patient who was not wearing a mask but with no physical contact. HCWs who were in physical

contact with COVID-19 patients or contact with their secretions/excretions without wearing a mask were also considered high risk. Also, HCWs who were not wearing an N95 respirator or eye protection while performing aerosol generating procedures on a patient who was not wearing a mask were considered high risk.

Results

In total, 720 health care workers were observed and evaluated randomly on a daily basis from the 10th of May 2020 to the 31st of August 2020 by the PPE inspectors' team. Nine random encounters were made daily by 3 different team members, a total of 45 HCW evaluated per week. Of the 720 health care workers, 389 (54%) were health care workers, 115 (16%) were patients, 78 (10.8%) were administration employees, 77 (10.7%) were porters, and 61 (8.5%) were cleaners (see figure 1).

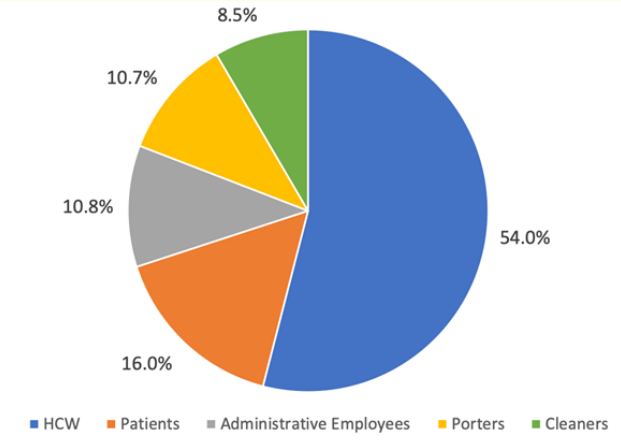

Figure 1: Percentage of healthcare workers/patient encounters who were evaluated.

During the first week of the study, appropriate usage of PPE according to the criteria mentioned above amounted to 25 HCWs (56%) out of 45. It was also found during the same time frame that 20 HCWs (44%) were missing PPEs as compared to 17 (38%) HCWs who wore unnecessary PPEs. At the end of the study period, August 31st 2020, the appropriate usage of PPE reached 40 HCWs (89%) out of 45 while missing PPE was 5 (11%) HCWs only. In the meantime, the unnecessary usage of PPE dropped to 8 HCWs (18 %) out of 45 (see Figure 2).

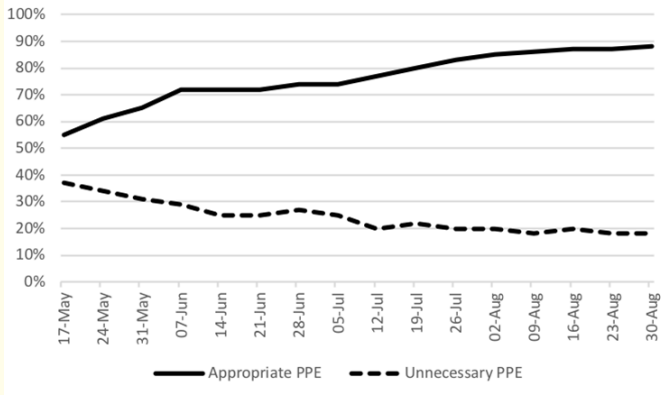

Figure 2: The percentage of appropriate vs unnecessary use of PPE among HCWs during the study period.

On April the 25th, 2020, the incidence of newly positive COVID-19 cases among hospital employees was 3 cases per day. It was increasing weekly until it peaked on the 18th of May 2020 with 31 cases per day. Since then, 8 days after the start of the inspectors' team, it has been declining until the 10th of August 2020 where the incidence of new cases continued to be below 5 cases per day until the end of the study period (see Figure 3).

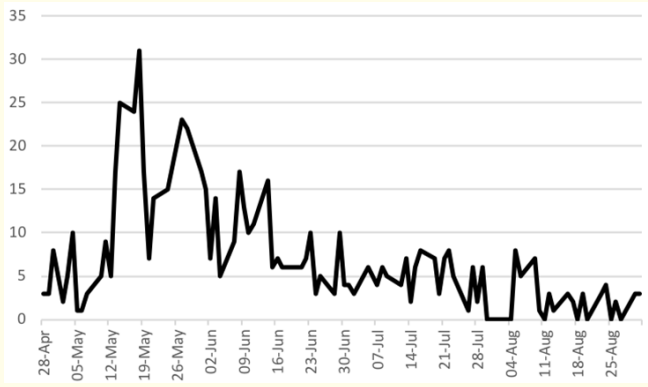

Figure 3: The number of HCWs who were tested positive for SARCOV2 by PCR.

Discussion

During the COVID-19 era, it was evident that HCWs were amongst the highest groups at risk of contracting the virus due to the nature of their work which mitigates direct, close and prolonged contact with patients. [8-10]. If not properly protected, HCWs can serve as potential sources/carriers of infection to their fellow HCWs as well as patients [11]. This is paramount, as protecting HCWs could serve as an essential milestone in controlling the outbreak [12]. In addition, HCWs themselves could fall victims to infection from patients they come in contact with. If this is not attended to, HCWs might be at stake which could further exacerbate public panic [13].

Modes of infection vary from nosocomial to public transmission [14]. Reports from U.S. public health authorities based on a limited cross section of data suggest that 10-20% of documented COVID-19 infections occur among HCWs [15,16]. This only makes the pandemic harder to contain. Hence, the appropriate usage of PPE remains one of the most effective measures in infection control in hospitals [17]. For that reason, PPE inspectors serve well in alleviating the burden of COVID-19 spread as seen in our study. Proper HCWs education is necessary but enforcement strategy through the use of PPE inspectors could have positive attributes.

During the crisis, knowledge concerning COVID-19 was continuously changing, thus through the presence of PPE inspectors, HCWs would be able to adapt and adhere to new guidelines concerning their own safety. For example, many HCWs across the globe were not in consensus with one another or were not fully aware of the proper 'doffing and donning' techniques. Thus, PPE inspectors in such instances could serve to unify proper awareness amongst staff. This is crucial as previous studies showed that poor adherence with donning and doffing protocols lead to self-contamination [18,19]. More recently, evidence is pointing towards the possibility of airborne transmission of COVID-19; PPE inspectors in such occasion can serve to enforce facial masks as the chief mechanisms of safety against airborne transmission [20,21].

As evident from our study, infection rates among HCWs declined with the appropriate usage of PPE; in comparison to the peak during May 18th, a substantial drop was experienced towards the end of the study period. This in part can be explained by the influence that the PPE inspectors had on HCWs on a daily basis. A vital role was served by their presence as they were able to intervene and prevent reuse of PPE which could be a source of COVID-19 transmission in itself. The same was experienced in the UK and US whereby in one prospective cohort study, HCWs who reused PPE or possessed inadequate PPE, were associated with a subsequent 31–46% increased risk of COVID-19 [22]. The reuse of PPE especially masks was observed particularly during the peak period; where supply was running low as compared to the demand of PPE [23]. In such occurrences, the responsibility of PPE Inspectors is extensive.

The success of our study was similarly patterned in one centre in Chicago that utilized 'PPE Spotters' to distribute and allocate PPE to patients according to their level of needs. Moreover, they supervised the usage of PPE and provided updated information to doctors whenever needed [24]. They played a vital role in supply chain management and fulfilled the intended educational and PPE preservation goals. This sheds light onto the magnitude of impact that PPE and its proper utilization can have in terms of infection control.

There were some limitations to our study. The low risk employees were not tested as they did not meet the criteria mentioned above. As a result, there is a low chance that some of those may have been vectors of the virus as well as some asymptomatic HCWs. In addition, our study is an observational, single arm study, which makes controlling for multiple confounding factors difficult.

Conclusion

The institution of a PPE inspectors' team is an effective quality improvement method to increase HCWs' compliance with PPE usage and was associated with reduced incidence of newly infected HCWs with COVID-19. The weekly virtual meeting with hospital staff was also an effective adjuvant tool to provide them with feedback and up-to-date results during the COVID-19 crisis in the hospital. Undeniably, larger prospective studies are advised to confirm these findings.

Acknowledgment

To all the staff who kindly volunteered to work in COVID19 occupational clinic and to the inspectors' team who made tremendous sacrifices to make the healthcare workers environment safer.

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Declaration of Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary material no. 1: PPE rationale use of PPE for COVID 19

Summary of changes to the guidance as of the 20th of April, 2020.

- Implemented universal source control for everyone entering the facility, regardless of symptoms (healthcare workers and patients) at inpatient and outpatient areas at all times.
- Changed the recommended PPE at preliminary screening to include face shield.
- Permission of the conditional use of coverall during care of COVID patient.

No. of HCWs with COVID19					
Date	**Covid19 +**	**Date**	**Covid19 +**	**Date**	**Covid19 +**
28-Apr	3	10-Jun	10	22-Jul	8
29-Apr	3	11-Jun	11	23-Jul	5
30-Apr	8	14-Jun	16	26-Jul	1
2-May	2	15-Jun	6	27-Jul	6
3-May	5	16-Jun	7	28-Jul	2
4-May	10	17-Jun	6	29-Jul	6
5-May	1	18-Jun	6	30-Jul	0
6-May	1	21-Jun	6	2-Aug	0
7-May	3	22-Jun	7	3-Aug	0
10-May	5	23-Jun	10	4-Aug	0
11-May	9	24-Jun	3	5-Aug	8
12-May	5	25-Jun	5	6-Aug	5
13-May	17	28-Jun	3	9-Aug	7
14-May	25	29-Jun	10	10-Aug	1
17-May	24	30-Jun	4	11-Aug	0
18-May	31	1-Jul	4	12-Aug	3
19-May	17	2-Jul	3	13-Aug	1
20-May	7	5-Jul	6	16-Aug	3
21-May	14	6-Jul	5	17-Aug	2
24-May	15	7-Jul	4	18-Aug	0
27-May	23	8-Jul	6	19-Aug	3
28-May	22	9-Jul	5	20-Aug	0
31-May	17	12-Jul	4	23-Aug	3
1-Jun	15	13-Jul	7	24-Aug	4
2-Jun	7	14-Jul	2	25-Aug	0
3-Jun	14	15-Jul	6	26-Aug	2
4-Jun	5	16-Jul	8	27-Aug	0
7-Jun	9	19-Jul	7	30-Aug	3
8-Jun	17	20-Jul	3	31-Aug	3
9-Jun	13	21-Jul	7		

Table 1: HCW positive schedule.

PPE Compliance Chart						
Week	**Appropriate PPE%**	**Unnecessary PPE%**	**No. of evaluations**	**Appropriate No.**	**Missing No.**	**Unnecessary No.**
17-May	56%	38%	45	25	20	17
24-May	60%	33%	45	27	18	15
31-May	64%	31%	45	29	16	14
7-Jun	71%	29%	45	32	13	13
14-Jun	71%	24%	45	32	13	11
21-Jun	71%	24%	45	32	13	11
28-Jun	73%	27%	45	33	12	12
5-Jul	73%	24%	45	33	12	11
12-Jul	76%	20%	45	34	11	9
19-Jul	80%	22%	45	36	9	10
26-Jul	82%	20%	45	37	8	9
2-Aug	84%	20%	45	38	7	9
9-Aug	84%	18%	45	38	7	8
16-Aug	87%	20%	45	39	6	9
23-Aug	87%	18%	45	39	6	8
30-Aug	89%	18%	45	40	5	8
				9 per day	45 per week	Total 720

Table 2: PPE Evaluations weekly.

Setting	Target personnel or patients	Activity	Type pf PPE or procedure
Outpatient healthcare facilities			
Triage areas/ waiting rooms	Healthcare workers	Preliminary screening not involving direct contact	Maintain spatial distance of at least 1 m Medical mask Eye protection (goggles or face shield)
		Triage personnel with direct patient contact (e.g. taking vital signs)	Medical mask Gown Gloves Eye protection (goggles or face shield)
	Patients without respiratory symptoms or visitors	Any	Maintain spatial distance of at least 1 m Provide medical mask if tolerated
	Patients with respiratory symptoms	Any	Provide medical mask If tolerated. Immediately move the patient to an Isolation room or separate area away from others; if this is not feasible, ensure spatial distance of at least 1 m from other patients.
Consultation room	Healthcare workers	Physical examination of patient with respiratory symptoms	Medical mask Gown Gloves Eye protection (goggles or face shield)
		Physical examination of patient without respiratory symptoms	Medical mask PPE according to standard precautions and risk assessment.
	Patients	Any	Provide medical mask if tolerated.
	Cleaners	After and between consultations with patients with respiratory symptoms	Medical mask Gown Heavy duty gloves Eye protection (If risk of splash) Closed work shoes
Administrative areas	All staff, including healthcare workers	Administrative tasks	Medical mask

Table a

Setting	Target personnel/ patients	Activity	Type pf PPE or procedure
Inpatient healthcare facilities			
Triage	Healthcare workers	Preliminary screening not involving direct contact	Maintain spatial distance of at least 1 m Medical mask Eye protection (goggles or face shield)
		Triage personnel with direct patient contact (e.g. taking vital signs)	Medical mask Gown Gloves Eye protection (goggles or face shield)
	Patients	Any	Maintain spatial distance of at least 1 m Provide medical mask if tolerated

Patient room	Healthcare workers	Providing direct care to COVID-19 patients	Medical mask Gown Gloves Eye protection (goggles or face shield)
		Aerosol-generating procedures performed on COVID-19 patients	Respirator N9S Gown Gloves Eye protection (goggles or face shield)
	Patients	Leaving their room/bed- space or when others (e.g., HCW, visitors) enter the room/bed space	Medical mask if tolerated by the patient (Patient may remove the mask when he is alone in the room/bed space)
	Cleaners	Entering the room of COVID-19 patients	Medical mask Gown Heavy duty gloves Eye protection (If risk of splash) Closed work shoes
Other areas of patient transit (e.g. wards, corridors).	All staff, including health-care workers	Any activity that does not involve contact with COVID-19 patients	Medical mask
Laboratory	Lab technician	Manipulation of respiratory samples	Medical mask Gown Gloves Eye protection (if risk of splash)
Administrative areas	All staff, including healthcare workers	Administrative tasks that do not involve contact with COVID-19 patients.	Medical mask

Table b

Target personnel/patients	Activity	Type of PPE
Ambulance and emergency medical services (EMS)		
Healthcare workers	Transporting suspected COVID 19 patients to the referral healthcare facility	Medical mask Gown Gloves Eye protection (goggles or face shield)

Driver	Involved only in driving the patient with suspected COVID- 19 and driver's compartment is separated from I he COVID- 19 patient.	Maintain spatial distance of at least 1 m. Medical mask
	Assisting with loading or unloading patient with suspected COVID - 19 disease.	Medical mask Gown Gloves Eye protection (goggles or face shield)
	No direct contact with suspected COVID-19 patient, but no separation between driver's and patient's compartments.	Medical mask
Patients	Transport to the referral healthcare facility.	Medical mask if tolerated
Cleaners	Cleaning after and between transport of patients with suspected COVID-19 disease to the referral healthcare facility.	Medical mask Gown Heavy duty gloves Eye protection (if risk of splash) Closed work shoes

Table c

Target personnel/patients	Activity	Type of PPE
Quarantine areas		
Healthcare workers and other staff e.g. Enforcement forces (military and national guard), IT and administrative personnel, Volunteer, Cleaners, Drivers Other auxiliary staff	All tasks that do not involve contact with patients.	Maintain spatial distance of at least 1 m. Medical mask
Healthcare workers	Preforming preliminary screening e.g. checking temperature	Maintain spatial distance of at least 1 m. Medical mask Eye protection (goggles or face shield)
	Preforming physical examination of quarantined people without respiratory symptoms.	Maintain spatial distance of at least 1 m. Medical mask
	Preforming physical examination of quarantined people with respiratory symptoms.	Medical mask Gown Gloves Eye protection
	Performing nasopharyngeal swab	Respirator N9S Gown Gloves Eye protection

Quarantined person with respiratory symptoms.	Any	Provide medical mask if tolerated
Cleaners	Cleaning quarantined people baggage	Gloves
	Cleaning quarantine rooms Cleaning clinics (if quarantined people are visiting)	Medical mask Gown Heavy duty gloves Eye protection (if risk of splash) Closed work shoes

Table d

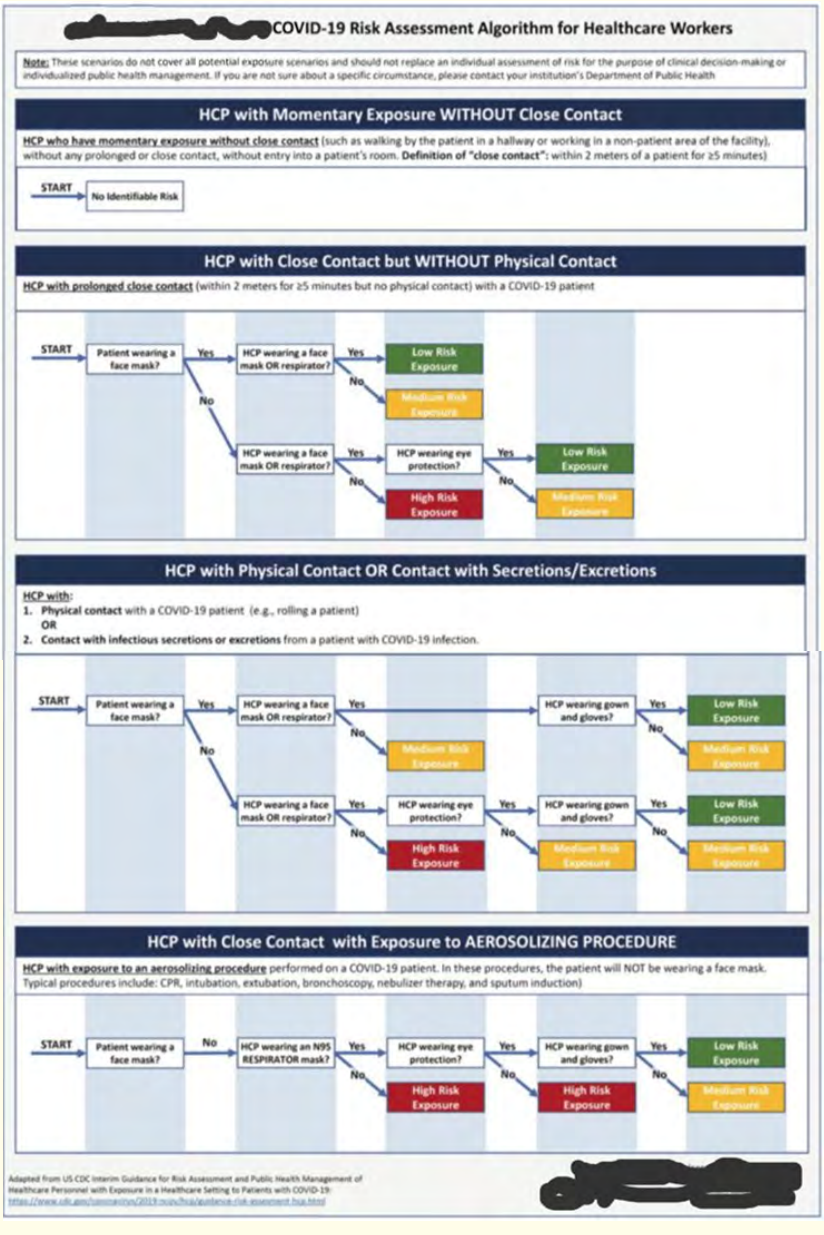

Figure a

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