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Review Article

Microbiology Section

Intellectual Use of Personal Protective Equipment in the View of COVID-19 Global Demand Crises

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ABSTRACT

A pandemic of an intense respiratory condition brought about by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) which started first in Wuhan, China, presently known as Coronavirus Disease 2019 (COVID-19), started in December 2019 has pulled in an exceptional measure of consideration around the world. A far-reaching knowledge on the prevention strategies is rudimentary for Health Care Providers (HCPs) when trying to ensure themselves, patients, associates and the overall population from this transmission of disease. Personal Protective Equipment (PPE) - which includes masks, coverall, aprons, and other additional outfits are one of the important prevention strategy and control for all healthcare staff including attendants. Understanding the usage of PPE will help HCPs to properly utilise PPE thereby, lessening redundant expense. A convenient comprehension on ideal utilisation of PPE and executing compelling preventive measures are critical for a good control of the disease and can assist clinicians with mitigating further transmission by taking appropriate measures.

Keywords: Apron, Health care professionals, Mask, Transmission

INTRODUCTION

The World Health Organisation (WHO) on 11 March, 2020 proclaimed "Coronavirus Disease 2019" (Covid-19) as a worldwide pandemic [1]. The worldwide medicinal services frameworks have become overpowered with possibly irresistible patients looking for testing and care and inspite of significant advances in the counteraction and treatment, there are presently no authorised immunisations, demonstrated powerful antiviral treatments, or demonstrated post-exposure prophylaxis strategies for COVID [2,3]. Though there are various infection control strategies to minimise the transmission of the disease, still PPE accounts for a main part in minimising the chance of exposure to infected body fluids by HCP in the treatment of COVID-patients [4].

WORKFORCE CHALLENGES

In the midst of this disease all through the world, the Health Care Workers (HCWs) remain the primary people engaged with the screening and treatment of this condition all through, which might prompt dissatisfaction, weakness, disgrace and dread of segregation among them [5]. The significance of PPE was perceived during the episode of SARS, where HCP represented approximately 20% of people infected with SARS [6]. PPE shortages are at present representing a huge threat to many healthcare systems in view of the COVID-19 pandemic [7]. HCPs are experiencing issues getting to the required PPE and are identifying alternate forms of providing health care [8].

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Regardless of the fast transmission of the virus and its lethal capacity, the disease can still be prevented. In earlier flare-ups, disease of HCPs was significantly diminished with organisation of barrier precaution [9,10]. In spite of the fact that the PPE is the most important facet of controlling the disease, it has to be still used as a fragment of superior infection control strategy which integrates ecological and organisational controls, comprising physically different settings for donning and doffing from area where definite clinical treatment is given, instruction on proper usage of PPE, provision of sufficient quantity of all PPE components; and hiring a certified coach on donning and doffing. In Canada, PPE are now classified as medical devices and they are further categorised as Class I medical devices which includes medical masks, N95 respirators, medical gowns, face shields and medical goggles and Class II medical devices which includes medical gloves [11]. In addition, clear outline on risk categorisation and at what time PPE is required and not required is important to ensure whether PPE is properly utilised in reducing risk of HCPs in getting exposed to the infection [12]. Behavioural controls are additionally a major part of infection control systems. Normally an individual will contact their mucosal surface (eyes, nostrils, lips) at a pace of 15.7 times each hour [13,14]. Ceasing from contacting one's own face, usage of surgical or medical mask, face shields along with regular washing of hands is advised to lessen the possibility of self-contamination. While medical or surgical mask have constrained durability and minimal potential for reprocessing, face shields can be reused uncertainly and are handily cleaned with disinfectants. They are agreeable to wear and also decrease the potential for self-contamination by keeping the wearer from contacting their face.

CURRENT STRATEGY OF USE OF PPE IN INDIA

Various components of PPE include goggles, head cover, face shield, mask, gloves, coverall or gowns and shoe cover [15,16]. The rationale for its use are:

- Face shield and goggles prevents the contamination of mucous membrane (eyes, nose, mouth) and serves as an intrinsic part of standard and contact precautions.
- The usage of medical or surgical mask has got regular and is omnipresent in hospitals and community. Indeed, even without fundamentally requiring them, the overall population is overusing N95 or Filtering Facepiece Respirator (FFP2) regardless of their specificity [15-17]. The WHO has suggested that a N95 or FFP2 mask be worn while dealing with patients who perform some Aerosol Generating Procedure (AGP) on a suspected COVID-19 positive patient [4].
- Gloves prevent the risk of exposure to virus when a HCPs comes in contact with an object or material contaminated by COVID-19 virus.
- Coverall/Gowns protect the HCPs by providing 360 degree coverage which is designed to cover the full body and thereby,

act as a barrier in eliminating or reducing the exposure to virus.

- Shoe covers and head cover facilitate additional personal protection for HCPs when they are offering care to the patient.

PITFALLS OF USE OF PPE [18-20]

- Most of PPE kits which are given to HCPs are prone to tear and very often several components of PPE are found to be missing.
- Continuous usage of mask leads to increase in carbon dioxide level which succumb the HCPs to develop headache frequently.
- As most of the doctors have to use a single kit for an entire day, they have to avoid bathroom breaks and use adult diapers and sometimes they have to restrict water intake which may lead to dehydration.
- Prolonged use of PPE can retain sweat, which can cause allergies and fungal infections, especially in a hot and humid environment.
- Usage of PPE can lead to development of various injury like device-related pressure injuries and moisture-associated skin damage.

These pitfalls can be removed by increasing the man power so that HCPs can work in shifts and by using proper physically fitting PPE kit for only four hours, as it is meant to be [4].

RISK ASSESSMENT

Usually on first encounter with the patient, detailed history of their health condition may not be known to HCPs. So, HCPs should regularly practise control and prevention techniques while there is a chance of transmission of infection through arms or via their attire. The preference for proper selection of PPE before performing any procedure, relies upon on the character of the disease and its possible mode of transmission, with due attention to known or possible infectious diseases [21,22]. Ideal practice when utilising PPE includes the following:

- The HCPs should first do a risk assessment to choose different elements of PPE which is influenced by the circumstance and the probable kind of body fluids and the organism to which the HCPs may be exposed.
- The selection of PPE should be based on appropriate size for the individual utilising it.
- Once duty gets over, HCPs must expel the PPE and discard the PPE in respective colour coded bins. PPE must no longer be kept on the surface or left anywhere and should be removed without contaminating one's own arm.
- HCPs should make certain that any PPE elements must be placed in all clinical areas to permit brief and clean access.
- PPE is generally considered as single use only and should not be reused.

CLASSIFYING EXPOSURE RISK CATEGORY

To help guide management of patients with suspected exposure, Centres for Disease Control and Prevention (CDC) has added risk exposure categorisation with a structure for evaluating and overseeing danger of potential exposures to 2019-nCoV (novel Corona vius) and actualising general wellbeing activities dependent on an individual's level of exposure and clinical appearance of patients [4,23,24]. [Table/Fig-1] summaries the optimal choice of PPE based on different risk categorisation [23,24]. The indication for PPE use should be framed based on the risk categorisation and various activities undertaken which is illustrated in [Table/Fig-2] [17,24]. If possible, telecommunication can be used to contact the suspected patients and stable patients which will minimise the need for PPE.

Level	Exposure risk	PPE	Rational
A*	High risk	N95, coverall/gown, gloves (2 pair), eye protection	Indicated when there is risk of aerosols, including Aerosol Generating Procedures (AGP)
B	Moderate risk	3-ply mask, gown, gloves (1 pair), eye protection	Indicated when there is high risk of droplet and contact transmission
C	Moderate-low risk	3-ply mask, gloves	Indicated when there is low risk of droplet, but moderate risk for contact transmission
D	Low risk	3-ply mask	Indicated when there is low risk of droplet transmission
E	No risk	No PPE with social distancing	Indicated when there is no risk of transmission

[Table/Fig-1]: Optimal selection of PPE based on different risk categorisation [23,24]. *It is said that while performing AGP, number of people present in the room should be limited and they all should be considered as High-risk category. After 40 minutes of AGP, it is believed that the aerosols will settle down and the people present in that room can be considered as moderate risk category

General Points to be Remembered [4,9,16,17,21,22]

- Glove must be changed in-between patients and must be removed after the last patient care or specimen transport.
- PPE need to be changed in-between suspected patients, whereas need not to be changed in-between confirmed patients, except the gloves.
- Housekeeping staff in any set up and laundry staff must wear boot, heavy-duty gloves in addition. If working in high risk area, they should wear N95, instead of 3-ply mask.
- Laboratory staff in molecular laboratory should doff the PPE after denaturation step. During the remaining procedure, they should only wear the new pair of nitrile gloves.
- These are minimum PPE recommendations. HCWs may wear additional PPEs depending upon availability.
- EBOLA PPE set up such as 2 pairs of gloves, coverall with hood, PPE supervisor etc., are not essential for COVID infection. HCWs may wear additional PPEs depending upon availability.
- In suspected ward/ICU, ideally PPEs should be changed between patients. If not possible, a plastic apron can be worn in addition to gown so that the plastic apron along with gloves, and face shield can be changed between patients. Mask and gown may be retained.
- Cloth mask does not protect against COVID (effectiveness is doubtful). Therefore, SOCIAL DISTANCING and HAND HYGIENE needs to maintained even if wearing cloth mask.
- General public and 3-ply/N95 mask: There is no evidence that 3-ply or N95 mask would prevent COVID transmission when worn by general public. Therefore, general public should not wear 3-ply/N95 mask, these should strictly be reserved for HCWs. The only exceptions are: (i) symptomatic patients (at home or going out) or (ii) elderly with high risk (when going out)-can wear 3-ply mask along with social distancing. However, it is to be kept in mind that both symptomatic patients and elderly with high risk are strictly prohibited to go out.
- Aerosol Generating Procedures (AGPs): Aerosols may be produced during AGPs endotracheal intubation, extubation and related procedures such as manual ventilation and open suctioning, tracheotomy/tracheostomy procedures (insertion/open suctioning/removal), bronchoscopy, surgery and post-mortem procedures involving high speed devices, some dental procedures (such as high speed drilling), Non-Invasive Ventilation (NIV) such as Bi-Level Positive Airway Pressure (BiPAP) and Continuous Positive Airway Pressure Ventilation (CPAP), High-Frequency Oscillating Ventilation (HFOV), High Flow Nasal Oxygen (HFNO), also called high flow nasal cannula, induction of sputum, upper ENT airway procedures including nasal endoscopy which involves suctioning.

COVID Setup and Related Areas							
Location	**Activity**	**Level**	**Risk of exposure**	**Mask**	**Gloves**	**Gown/Coverall**	**Goggles/Face shield**
Registration counter	Provide information to patients	C	Low	3-ply	—	—	—
Doctors chamber/ resuscitation room	Clinical management of patient without AGP	B	Moderate	3-ply	√	√	√
	Clinical management of patient with AGP	A	High	N95	√	√	√
COVID ICU	Any one who is working inside	A	High	N95	√	√	√
	Outside area including corridor or nursing station	C	Low	3-ply	—	—	—
COVID OT	Within operation room	A	High	N95	√	√	√
	Outside operating room	C	Low	3-ply	—	—	—
COVID Isolation room or ward	Near patient zone	B	Moderate	ply	√	√	√
	Near patient zone (during AGP are performed)	A	High	N95	√	√	√
	Outside, in nursing station, corridor	C	Low	3-ply	—	—	—
Labor room	If from hot spot area, COVID-19 status unknown	A	High	N95	√	√	√
COVID screen area/ triage	Examining a unstable/SARI COVID-19 suspect, or on ventilator	A	High	N95	√	√	√
	Examining a stable COVID-19 suspect	B	Moderate	3-ply	√	√	√
	History taking, interacting, temperature recording	C	Moderate-Low	3-ply	√	—	—
	Patient attendant	D	Low	3-ply	—	—	—
Any COVID setup	House keeping	B	Moderate	3-ply	√	√	√
	Patient, if symptomatic	D	Low	3-ply	—	—	—
Labaratory	Respiratory specimen collection from COVID-19 suspects	A	High	N95	√	√	√
	Collecting non-respiratory specimens from COVID-19 suspects	B	Moderate	3-ply	√	√	√
	Specimen transport, specimen reception	C	Moderate-Low	3-ply	√	—	—
	Respiratory specimen processing	A	High	N95	√	√	√
	Processing of non-respiratory specimens from COVID-19 suspects	B	Moderate	3-ply	√	√	√
	Other staff, not involved in specimen processing	E	No risk	—	—	—	—
Ambulance/In-house transport	SARI patient, or on ventilator- managing or transferring	A	High	N95	√	√	√
	Stable patient, not on ventilator- managing or transferring	B	Moderate	3-ply	√	√	√
Ambulance	Driver, not involved in patient transfer	D	Low	3-ply	—	—	—
Dead body management	Packaging or transporting	B	Moderate	3-ply	√	√	√
	Mortuary care	B	Moderate	3-ply	√	√	√
	Autopsy room	A	High	N95	√	√	√
	Family members handling the body	B	Moderate	3-ply	√	√	√
Quarantine facility	Person being quarantined, if symptomatic (social distancing)	D	Low	3-ply	—	—	—
	Person being quarantined, if asymptomatic (social distancing)	E	No risk	—	—	—	—
	Person being quarantined, if going out (ideally not allowed)	D	Low	3-ply	—	—	—
	HCPs, when examining symptomatic patient	B	Moderate	3-ply	√	√	√
	Support staff	D	Low	3-ply	—	—	—
Laundry	Linen transport	C	Moderate-Low	3-ply	√	—	—
	Linen cleaning and disinfection	A	High	N95	√	√	√
	Calendaring and folding, issuing linen	D	Low risk	3-ply	—	—	—
CSSD	Instrument cleaning and drying	B	Moderate	3-ply	√	√	√
	Preparing dressing material	B	Moderate	3-ply	√	√	√
	Arranging trays and packing	D	Low risk	3-ply	—	—	—
Kitchen	Washing the utensils	E	No risk	—	—	—	—
Non-COVID setup							
Location	**Activity**	**Level**	**Risk of expsoure**	**Mask**	**Gloves**	**Gown**	**Googgles/Face shield**
ICU, Ward, Emergency	Performing Aerosol Generating Procedures (AGPs)	B	Moderate	3-ply	√	√	√
	Performing Aerosol Generating Procedures (AGPs), if tuberculosis or any other respiratory infection is suspected	A	High	N95	√	√	√
ICU, Ward	Direct contact with respiratory patients, bed making	D	Low	3-ply	—	—	—
	No direct contact with respiratory patients and direct contact with non-respiratory patients	E	No risk	—	—	—	—

OT	Operating team	B	Moderate	3-ply	√	√	√
	Not in operating team	E	No risk	—	—	—	—
OPD, Emergency	Direct contact with any patients	D	Low	3-ply	—	—	—
	No direct contact with any patients	E	No risk	—	—	—	—
Labaratory	Aerosol Generating Procedures (AGP) like centrifuge	A	High	N95	√	√	√
	Handling	B	Moderate	3-ply	√	√	√
Dead body management	Packaging or transporting	C	Low risk	3-ply	—	—	—
Labour room	Not from hot spot area	B	Moderate	3-ply	√	√	√
Pharmacy rounter	Distribution of drugs	D	Low	3-ply	—	—	—
Office staff, Administrative staff	Not involved in patient care	E	No risk	—	—	—	—
Community set up							
Location	**Activity**	**Level**	**Risk of exposure**	**MASK**	**Gloves**	**Gown**	**Goggles/Faceshield**
HCP in community settings	Asha/anganwadi staff, conducting field surveillance	D	Low	3-ply	—	—	—
	Doctors examining patients	B	Moderate	3-ply	√	√	√
General public in community settings	General public at home	E	No risk	—	—	—	—
	General public going outside (maintain social distancing)	E	No risk	—	—	—	—
	Symptomatic patients	D	Low	3-ply	—	—	—
	Elderly people with high risk (diabetes) when go out to market (ideally not allowed)	D	Low	3-ply	—	—	—

[Table/Fig-2]: Personal Protective Equipment (PPE) required when undertaking various healthcare activities in different setup.
SARI: Severe acute respiratory illness; CSSD: Central sterile supply department

Adherence to PPE Procedures

Adherence level of HCPs to PPE strategies is problematic and less, in spite of their knowledge on the potential transmission of pathogens [25-27]. Various causes for poor adherence include low awareness of danger amongst healthcare staff, time compressions, exhaustion, insufficient exercise and teaching, and scarcity of elements of PPE. Blunders while removing PPE are regularly said and have positioned HCPs to danger of self-contamination [28,29]. Usage of pictographic publications is considered as a useful aid for HCPs as they can streamline complicated information. HCPs should make certain that, they keep an eye on the appropriate technique when removing different elements of PPE from internationally documented sources like WHO or the Centers for Disease Control and Prevention (CDC).

CONCLUSION(S)

Understanding the justification behind proper utilisation of PPE empowers HCPs to follow proper technique while looking after patients. It is vital that HCPs must recognise their part while providing treatment and should be aware of their chance of getting exposed to body fluids and select the PPE accordingly. Proper utilisation of PPE offers protection to HCPs and thereby limits the spread of communicable infection. By understanding the appropriate use of PPE, HCPs should be able to undertake suitable risk assessments for making wise usage of PPE.

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