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COMMENTARY

Personal Protective Equipment (PPE) Guidelines, adaptations and lessons during the COVID-19 pandemic



Lignes directrices sur l'équipement de protection individuelle (EPI) pendant la pandémie COVID-19: leçons et adaptations

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Received 7 June 2020; accepted 11 June 2020

Available online 17 June 2020

KEYWORDS

COVID-19;
Coronavirus;
Personal protective
equipment;
PPE

Summary The COVID-19 pandemic has placed unprecedented strain on the American health-care system. Personal protective equipment (PPE) remains critical in keeping healthcare providers healthy and safe. The sudden increase in demand as well as the limited availability places increased risk on providers which may inhibit their ability to effectively manage patients. The purpose of this brief article is to review the recommended guidelines for PPE usage and compare them to how medical societies have adapted and responded to decreased supply, as well as public response.

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MOTS CLÉS

COVID-19 ;
Coronavirus ;

Résumé La pandémie de COVID-19 a exercé une pression sans précédent sur le système de santé américain. Les équipements de protection individuelle (EPI) restent essentiels pour assurer la santé et la sécurité des prestataires de soins de santé. L'augmentation soudaine de la demande ainsi que la disponibilité limitée font courir un risque accru aux prestataires,

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Équipement de protection individuelle ; EPI

ce qui peut entraver leur capacité à gérer efficacement les patients. L'objectif de ce bref article est de passer en revue les lignes directrices recommandées pour l'utilisation des EPI et de les comparer à la manière dont les sociétés médicales se sont adaptées et ont réagi à la diminution de l'offre, ainsi qu'à la réaction du public.

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Introduction

A novel strain of corona virus was found in December 2019 in Wuhan, China, Hubei province [1–3]. These first cases were connected to a wet animal market in Wuhan [4]. The World Health Organization (WHO) declared this a global pandemic on March 12 2020 [5]. At the time of writing (May 14, 2020) the number of global cases continues to climb with 4,408,618 total confirmed, 1,405,961 of which are in the United States. At this time, there have been 300,315 deaths globally, with the United States ranked first [6]. There is currently no vaccine or cure for infected individuals and medical intervention is largely supportive. The virus is particularly dangerous because it is transmittable by asymptomatic people [7].

The virus gains entry through the mucous membranes and the main routes of transmission include: virus infected droplets and aerosols, or contact with contaminated fomites on skin, surfaces, or other items [2,7,8]. The virus may survive on various surfaces for hours to days, depending on the conditions, and in aerosolized droplets for up to 3 hours, making it a necessity to use personal protective equipment (PPE) while treating infected patients [7–9]. PPE protects health care providers (HCP) from infection and reduces exposure risk in addition to enabling them to provide effective care to patients.

The first known occupational transmission of COVID-19 to a HCP likely occurred in Solano County, California on February 2020 [10]. At this early stage, PPE precautions were not yet in effect, so none of the HCPs wore the PPE recommended for COVID-19. Consequently, 121 HCP were identified as having either high, medium, or low risk to exposure to the patient. Of these at-risk HCP, 43 (36%) became symptomatic and 3 (7%) tested positive for COVID-19 [10]. Not only is PPE critical to protect HCP and to enable safe, effective patient care, but it is also essential to minimize further spread of the virus.

Undoubtedly, the global spread of the COVID-19 pandemic warrant universal precautions to slow the rate of infection. Hand hygiene, social distancing, regular disinfection of potential fomite containing surfaces, and avoidance of touching one's face have been used to attempt to decrease exponential disease spread [1,8]. Effective public participation is critical to "flatten the curve" and prevent overwhelming the healthcare system with the unprecedented number of cases. The unexpected volume of sick patients with COVID-19 have depleted the PPE supply chain, in addition to other life-saving health care resources, due

to a system that was not adequately equipped with supply to accommodate the surge in demand. The purpose of this brief article is to review the recommended guidelines for PPE usage and compare them to how medical societies have adapted them in this COVID-19 outbreak.

Personal Protective Equipment

PPE includes hand hygiene, gown, mask, goggles, face shield, and gloves [7]. There are several different levels of PPE including: standard, contact, droplet, and airborne precautions [2].

According to the Center for Disease Control and Prevention (CDC) standard precautions include: hand hygiene, respiratory hygiene with cough etiquette, proper patient placement and handling/cleaning of equipment, devices, environment, and laundry, as well as following sharps safety procedures [11]. Contact precautions are used when transmission is through direct contact with an infected individual or with contaminated items or bodily fluids [2]. MRSA, norovirus, *C. difficile*, SARS, and MERS are some examples of pathogens that are spread through contact [2]. The CDC recommends that PPE includes gloves and gown, in addition to the standard precautions referenced previously [12]. Droplet precautions are initiated in instances when infection is spread through direct contact with contaminated droplets—i.e. talking, sneezing, coughing. Droplets are large, and therefore, do not remain in the air for very long or travel very far when projected from an infected patient. Influenza, meningococcus, Haemophilus influenza, mycoplasma, pertussis, mumps, and rubella are all pathogens that may be transmitted by droplets. The CDC recommends PPE that includes mask, eye protection, gloves, and gown [12]. It was initially thought that COVID-19 was spread through droplet transmission like influenza, however, the rapid spread of COVID-19 indicated that it may spread via airborne particles [2,12]. Airborne precautions are necessary for airborne transmissible illnesses. Smaller pathogenic droplets or particles can travel further and remain suspended longer in the air than droplets, constituting a separate set of recommendations from droplet precautions. Airborne transmissible diseases such as COVID-19, tuberculosis, varicella, and measles require patients to be in negative pressure rooms. PPE recommended by the CDC include: N95 masks/respirator, eye protection, gloves, and gowns [8,12].

In order to be effective, PPE must be donned and doffed correctly. The N95 respiratory fit test should be performed prior to use to confirm proper size and seal and facial hair must be shaved [5,8]. Additionally, glove cuffs must extend and cover the sleeve of the gown [5]. While doffing PPE pathogens may be transferred, negating the protective purpose of the equipment. A study observing doffing practices found 90% to be incorrect in either sequence, technique, or type of PPE. The most common faults observed include insufficient PPE, incorrect gown removal, touching non-sterile surfaces, and not utilizing the face shield of the mask [13]. Incorrectly doffing the gloves, masks, or gown may pose a breach in biosafety and lead to contamination [5].

Recommendations

Currently the CDC, World Health Organization (WHO) and Occupational Safety and Health Administration (OSHA) recommend standard precautions for all patients, and droplet and contact precautions for all HCP who are not likely to encounter aerosols. Airborne, droplet, and contact precautions are recommended when there is a potential aerosol production. According to Lockhart et al. procedures that have a high risk to generate aerosols include: tracheal intubation, bag-mask manual ventilation, tracheotomy, placing a supraglottic airway device, extubating, and manipulating a BiPAP mask [8].

Currently the CDC and WHO recommend proper use of PPE with correct donning and doffing during exposure to infected patients. Both organizations recommend conservation strategies—limiting elective or non-urgent procedures, reducing the number of HCP in contact with patients, extended use, reprocessing of PPE—and use of PPE alternatives when none is available. The CDC recommends the use of an N95 or higher respiratory filter, but a facemask is an acceptable alternative [14]. Additionally, the WHO recommends the use of an apron for HCP during procedures that may generate aerosols, and does not recommend reusing gloves between patients or the use of cloth masks alternatives for HCP [15].

Action taken by physician societies

The American Society of Anesthesiologists (ASA) recommends eye protection that covers the front and sides of the face, gown, gloves and N95 respirators or powered air purifying respirators, since the Anesthesiology personnel commonly perform aerosol generating procedures [16]. They recommend that anesthesiologists wear powered air purifying respirators if N95 respirators are unavailable or unable to fit. The ASA believes that clinical anesthesia team members should receive priority in availability of these supplies and if there is a shortage, to defer to CDC recommendations to create plans for allocation of resources [16]. Lockhart et al. proposed increased PPE requirements for these HCP which include: airborne, droplet, and contact precautions as well as an AAMI level-3 gown, neck cover, and 2 pairs of gloves [8].

Additional barriers have been proposed for added protection during endotracheal intubation, namely the “aerosol

box.” The transparent box covers the patient’s head with two entry points for the clinician’s hands. Canelli et al. investigated mannequin simulated intubations with dye representing a simulated cough to compare particle spread with and without the box [17]. Without the box, dye was found on every component of PPE worn by the clinician, as well as on the floor and surrounding equipment more than 2 meters away. With the box, only the gloves and gown on the clinician’s forearms were contaminated, there was no dye found outside the box [17]. Although the box seems promising in decreasing particle spread during intubation, another study utilizing live patients found concerning results as to its practicality [18]. Begley et al. found that intubations took longer utilizing the box, with 58% taking longer than one minute, and 17% over 2 minutes [18]. All clinicians observed performing intubation without the box had success on a first pass, whereas the first- and second-generation boxes only had 75% and 83% successful first passes respectively. Additionally, there were eight total breaches in PPE using the boxes [18]. Although the aerosol box may appear to limit aerosol spread, it may increase intubation time and lead to breaches in PPE. Further research is needed to investigate its efficacy in protection.

The American College of Surgeons (ACS) recommends wearing N95 respirators in the operating room and if there are shortages, only providers wearing N95 respirators may be in the room during intubation and extubating. The ACS supports the extended use and reuse of masks if there is a shortage [19]. Holland et al. published recommendations for emergency physicians that align with CDC, WHO, and OSHA guidelines in addition to advocating for the use of a simple procedure mask with attached face shield on top of an N95 for eye protection [20].

The American College of Emergency Physicians (ACEP) has additional recommendations for HCP with varying levels of PPE who have been exposed to patients with COVID-19. They recommend a 14-day hiatus from work for HCP without PPE or mask who were exposed to patients with COVID-19 regardless of whether or not the patient was wearing a mask [21]. Additionally, if the patient is not wearing a mask, HCP who were not wearing eye protection are also excluded from work for 14 days [21].

Access, supply, and shortages

The shortage of equipment is a global phenomenon associated with the sudden increase in requirement. The Royal College of Surgeons of England conducted a survey regarding access to PPE from April 6th to 9th 2020. Of 1978 respondents, 32.5% did not trust that their available PPE was adequate to provide safety in their job. And 57% reported shortages of PPE in the last month [22]. In response to the recommendations to reuse PPE, the president of the Royal College of Surgeons of Edinburgh, Michael Griffin, stated, “Asking frontline staff to reuse equipment or work without full length gowns puts clinicians and patients at risk, particularly in surgical settings” [23]. This situation forces HCP to balance their health and the health of their patients.

The American College of Physicians (ACP) sent a letter to Washington DC on March 24, 2020, urging Congress to ensure that patients and HCP have access to appropriate

care and adequate supply of necessary equipment, including PPE [24,25]. A week later, both the ACP and the ACS announced support of physicians being in their own PPE if the health care system is unable to provide any. Both organizations also support physicians' ability to voice concerns about the conditions and caring for patients with COVID-19 without retribution [19,24].

In response to PPE recommendations and shortages, The American College of Emergency Physicians (ACEP) has started Project N95, the National Clearinghouse for PPE and other medical supplies. They connect suppliers and organizations to speed up the procurement process. According to Project N95, at the time of writing (April 30th, 2020), there are 3854 organizations requesting equipment, with 293,856, 635 units of equipment needed for the next 30 days [25].

Public Personal Protective Equipment usage

Early in April, the CDC added a universal mask recommendation, stating that all Americans should wear non-medical masks when out of the house. Shortly after, Brigham and women's Hospital reported a significant decrease in new COVID-19 cases in HCPs. This rule was initiated to help stop asymptomatic spread of the virus. Homemade masks were thought to stop large particles from asymptomatic carriers infecting nearby people, surfaces, and items. Homemade masks were not proven to be very effective at filtering smaller particles, medical-grade masks are design to do so. The CDC does not recommend medical-grade masks for the average person, but would rather save those for HCP or those caring for patients with COVID-19 [26]. Additionally, experts from the Johns Hopkins University Department of Environmental Health and Engineering note that non-HCP should not wear gloves in public. They may provide a false sense of security and are not typically used appropriately. This may lead to further contamination and even environmental damage [26]. In the hierarchy of infection control, PPE is the last resort. The public should maintain social distancing and standard precautions such as regular cleaning and washing hands, to most effectively stay healthy and decrease spread of COVID-19 [26].

Conclusions

The COVID-19 pandemic poses unprecedented strain on the American health care system. PPE remains critical for HCP to continue combating this virus. It is imperative that we coordinate nationally and efficiently share resources where they are needed most. Many medical societies have had to adapt PPE recommendations in the face of limited availability of medical supplies. The general public and non-healthcare personnel can help by observing social distancing, standard precautions, and by saving medical-grade equipment for HCP and those caring for patients with COVID-19. HCP need to be able to voice their concerns without retribution to seek solutions and assistance in acquiring much needed equipment.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgements

None.

Disclosure of interest

The authors declare that they have no competing interest.

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