A Medical Student’s Guide for Maximizing Personal Protective Equipment during Clinical Rotations in a COVID-19 World

Asim S. Ghani, Lark A. Steafo, Angeli E. Torres, Iltefat H. Hamzavi, MD


Abstract

The COVID-19 pandemic has undoubtedly challenged medical training throughout the United States (US), particularly for medical students who are beginning their clerkship rotations in the hospital. In addition to potentially compromising the quality of clinical rotations, this pandemic has revealed the detrimental effects of personal protective equipment (PPE) shortage and highlighted the importance of maximizing their use. This paper aims to serve as a guide for medical students entering their clerkship rotations in order to ensure patient and medical student safety, and maximize PPE use. Different PPE protocols for different clinical settings, including patient, consultation, and operating rooms, will be introduced. Furthermore, in an effort to attenuate the global shortage, the various techniques that can be used to repurpose N95 respirators, as well as the efficacy of masks made from other materials, will be highlighted.

Introduction

Amidst the COVID-19 global pandemic, medical schools across the United States (US) temporarily suspended various in-person clerkship rotations for current 3rd and 4th year medical students. Clerkship rotations are arguably one of the most critical stages of the medical school curriculum, as students apply the didactic knowledge they gained during their pre-clerkship years of medical school and challenge themselves to build experiential knowledge in the clinics and hospitals. However, a rapidly evolving pandemic has undoubtedly introduced many obstacles, revolutionizing the status quo, and ultimately, compromising the quality of the clerkship education. Some of these challenges include the lack of personal protective equipment (PPE) as well as the lack of availability of testing. In light of these continuously rising challenges, many hospitals plan to implement more strict regulations to maximize the use of PPE as precautionary measures for future potential global disasters. Hence, in a COVID-19 world, medical students need to be aware of these regulations prior to the start of their clerkship years. This paper aims to educate medical students about ways to protect themselves in different clinical settings and help medical students gain insight about how to re-purpose PPE to maximize its use.

Virology and Replication Cycle

The causative agent of COVID-19 is Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), an RNA virus from the Coronaviridae family (Cascella et al., 2020). This family of viruses caused two epidemics in the past, including Severe Acute Respiratory Syndrome Coronavirus 1 (SARS-CoV-1) and (Middle Eastern Respiratory Syndrome Coronavirus (MERS-CoV) outbreaks in 2003 and 2012, respectively (Cascella et al., 2020). This virus, unlike other RNA viruses, contains multiple open reading frames, particularly replicase, which translates into proteins that serve as building blocks for more viral particles (Rengasamy et al.,2010). In addition, coronaviruses have one of the highest frequencies of recombination, meaning it can mutate and modify at a high rate (Rohde, 2020). Both the replication process and recombination frequency of this virus allow it to rapidly spread within a patient’s body and from person to person. Viral transmission takes place via respiratory droplets or direct contact with an infected individual or fomites (Cascella et al., 2020). Once it spreads to another individual, it replicates in the oropharynx, and ultimately affects the upper and lower respiratory tracts(Cascella el al., 2020). Of note, SARS-CoV-2 virus particles range in size from 60-140 nm (Cascella et al., 2020). This is a very important consideration as it becomes crucial for determining the appropriate type of PPE to use in different clinical settings.

Importance of Testing
One of the major diagnostic challenges of COVID-19 has been its recognition. Some of the major symptoms of COVID-19 include fever, cough, and shortness of breath (Cascella et al., 2020). This combination of symptoms is non-specific and can overlap with many other illnesses. In addition, the manifestation of a SARS-CoV-2 infection has been shown to vary widely from person to person, ranging from no symptoms at all to those that are severe enough to warrant hospitalization and even intensive care (Rose, 2020). Asymptomatic carriers can be a very critical source for the rapid spread of this virus. Therefore, medical students who are entering hospitals for clinical rotations need to be conscious about being a potential asymptomatic shedder that can facilitate the spread of the disease. In order to ensure that medical students do not contribute to the possible spread of the virus, they should continuously monitor their health status on a daily basis through temperature and symptom checks. If a medical student develops any of the aforementioned symptoms and suspects themselves of being exposed to SARS-CoV-2, they need to get a definitive diagnosis through a viral polymerase chain reaction (PCR) test. According to the US Food and Drug Administration (FDA), viral PCR is the most reliable testing method currently implemented in the US with a sensitivity of 95% (FDA, 2020). However, in an effort to conserve valuable resources, PCR testing is often limited to individuals who develop symptoms that may suggest a SARS-CoV-2 infection; hence, medical students need to consciously think about how they can still contribute to the spread of this virus as asymptomatic shedders. A useful adage is to treat oneself and everyone else as asymptomatic SARS-CoV-2 carriers until proven otherwise.

**Shortage of PPE**

The rise of a global pandemic unmasked and revealed the issues surrounding the shortage of PPE, and it is an issue that will continue to unfold for many years in the event of a global health emergency. The limited supply of PPE across the US has forced providers to reuse and repurpose PPE, especially face masks. Since the virus is primarily spread through the oropharynx and ultimately affects the respiratory tract, face masks are logically the most effective PPE (Cascella et al., 2020). As a medical student, you need to consider different ways to secure your own chain of PPE during various clinical rotations. In other words, it is crucial for a medical student to not only understand the proper PPE that is used in different clinical settings, but also how to facilitate reuse of a mask using a variety of decontamination techniques, especially in cases where masks are not always readily available.

**Maximizing PPE and Reusing Masks**

One way medical students can maximize PPE use is to understand what type of PPE is appropriate in different clinical settings depending on a patient’s COVID-19 status (Table 1), and be aware of institution-specific policies relevant to their clinical rotation (Figure 1). In almost every setting, hand hygiene, gloves, and a protective mask is encouraged.

**Table 1. Summary of Appropriate PPE for Each Clinical Setting**

<table>
<thead>
<tr>
<th>Setting</th>
<th>Patient without symptoms of SARS-CoV-2 infection</th>
<th>Patient with symptoms of SARS-CoV-2 infection</th>
<th>Patient with confirmed SARS-CoV-2 infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Room</td>
<td>PPE according to standard precautions and risk assessment.</td>
<td>Surgical mask, Gown, Gloves, Eye protection (goggles or face shield)</td>
<td>Surgical mask, Gown, Gloves, Eye protection (goggles or face shield)</td>
</tr>
<tr>
<td>Consultation room</td>
<td>PPE according to standard precautions and risk assessment.</td>
<td>Surgical mask, Gown, Gloves, Eye protection (goggles or face shield)</td>
<td>Surgical mask, Gown, Gloves, Eye protection (goggles or face shield)</td>
</tr>
</tbody>
</table>
Patients undergoing aerosol-producing procedures, such as endotracheal intubation and extubation, place the providers at a greater risk of contracting the virus (WHO, 2020). These situations require the providers to use an N95 or FFP2 mask instead of a standard surgical mask, in addition to the standard gown, gloves and eye protection. Furthermore, in the surgical setting, any patient suspected of SARS-CoV-2 infection is considered positive until proven otherwise (Coccolini et al. 2020). Therefore, the same PPE guidelines must be followed for both suspected and confirmed cases. When exiting the operating room, all PPE should be immediately discarded in dedicated areas.

**Figure 1: PPE Guidelines from Henry Ford Health System, one of our medical school’s clinical sites.**
In cases where PPEs need to be reused, it is useful for medical students to have an understanding of the mechanisms behind different sterilization techniques that are available in the hospital. One such method that has been widely used to decontaminate N-95 respirators is ultraviolet germicidal irradiation (UVGI) (Torres et al. 2020). Using the germicidal properties of ultraviolet C (UVC), this method inactivates SARS-CoV-1 viral particles by creating pyrimidine photoproducts that damage viral DNA and prevent its replication (Torres et al. 2020). UVGI is becoming more available as it is currently being implemented in hospitals around the US. Hydrogen peroxide is another way to decontaminate N-95 respirators (Torres et al. 2020). In this technique, hydrogen peroxide is used in a vapor or aerosol system to directly decontaminate surfaces through a “hands free” method (Torres et al. 2020). N95 respirators can withstand up to 30 cycles of this process without losing any structural or functional integrity (Torres et al. 2020); however, this method may not always be readily available. The third way is through microwave-generated steaming (Torres et al. 2020). This method uses the standard microwave readily found in the home or office setting and N95 respirators can withstand up to 3 cycles without losing any filtering capacity (Torres et al. 2020). An important factor of this method is that it requires steam to successfully work; hence, one limitation to this technique is the difficulty of having the steam spread uniformly. In light of PPE shortages during this global pandemic, these techniques are designed to facilitate N95 respirator reuse. Medical students who cannot secure a new set of PPE are encouraged to be informed of their hospital’s policies and standards with regards to decontamination of used PPEs and utilize them as necessary.

### Alternative Forms of Respiratory Protection

Although N95 respirators are the ideal form of protection and surgical masks are acceptable, there may be situations wherein neither of these are available. A study conducted by Konda et al. assessed different mask materials as possible means of protection (Konda et al. 2020). In order to measure filtration efficiency, particles less than 300 nm and greater than 300 nm were tested. (Konda et al. 2020). All of the different materials tested showed some capacity to filter, however, not all were similarly effective (Table 2). Of note, the SARS-CoV-2 virus particle size ranges from 60-140 nm (Cascella et al., 2020).

**Table 2. Filtration Efficiency of Masks Made from Various Materials**

<table>
<thead>
<tr>
<th>Sample/Fabric</th>
<th>Mean % Filtration Efficiency for &lt;300 nm ± Standard Deviation</th>
<th>Mean % Filtration Efficiency for &gt;300 nm ± Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>N95 (no gap)</td>
<td>85 ± 15</td>
<td>99.9 ± 0.1</td>
</tr>
<tr>
<td>N95 (with gap)</td>
<td>34 ± 15</td>
<td>12 ± 3</td>
</tr>
<tr>
<td>Surgical mask (no gap)</td>
<td>76 ± 22</td>
<td>99.6 ± 0.1</td>
</tr>
<tr>
<td>Surgical mask (with gap)</td>
<td>50 ± 7</td>
<td>44 ± 3</td>
</tr>
<tr>
<td>Cotton quilt</td>
<td>96 ± 2</td>
<td>96.1 ± 0.3</td>
</tr>
<tr>
<td>Quilter’s cotton (80 TPI), 1 layer</td>
<td>9 ± 13</td>
<td>14 ± 1</td>
</tr>
</tbody>
</table>
Conclusion

In an effort to educate medical students entering clerkship rotations amidst a global pandemic, this paper presented some of the fundamental techniques that can be employed to maximize PPE use. Each of the techniques undoubtedly has its strengths and weaknesses, and future research projects will involve taking additional steps to assess the utility of these methods. By recognizing these techniques and institution-specific policies with regards to their use, medical students will help mitigate the issues surrounding the shortage of PPE as well as maximize their safety and patient safety in the hospital.

Conflicts of Interest

Asim Ghani, Lark Steafo, and Angeli Torres have no relevant disclosures. Iltefat Hamzavi is an investigator for LITE study, which is funded by PCORI with phototherapy units provided by Daavlin.

References


