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Review Article

COVID-19 among Healthcare Workers: Risk of Exposure, Impacts and Biosafety Measures – A Review

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Healthcare workers are the frontline armies in the fight against the Coronavirus Disease –2019 (COVID-19) pandemic; and their safety should be an urgent focus in the global response to the pandemic. The virus has infected more than 4.6 million people, leaving more than 310,000 people dead in about 188 countries across the globe. Since, the fight against the pandemic started, thousands of healthcare workers have been infected, with many paying the ultimate price with their lives in a bid to provide healthcare services to COVID-19 patients. Currently, many are either in quarantine or isolation. Still, many are working in fear of the virus and under poor conditions, without adequate protection or life insurance. The potential for high exposure to COVID-19 is generally higher for healthcare workers due to increased hospitalization, long-time exposure, failure to implement effective personal protection, shortage of personal protective equipment (PPE), lack of training, supervision and monitoring of infection prevention and control mechanisms. Globally, the loss of some health care workers to COVID-19 has further compounded the problem of shortage of workforce in the health sector. Preventing exposure to COVID-19 in the healthcare settings depends on the healthcare workers understanding of the infectious nature of the virus, the routes by which the virus is acquired, the techniques that are the most hazardous and the safe working practices required. This review is therefore aimed at providing relevant information on the risk of exposure, the impacts of the virus on healthcare workers and the required biosafety measures needed to keep the health care workers safe in the fight against the pandemic.

Key words: Biosafety, COVID-19, Exposure, Healthcare workers, Impacts, Risk.

INTRODUCTION

Healthcare workers consists of all paid and unpaid persons serving in healthcare settings who have the potential for direct or indirect exposure to patients or their infectious secretions and materials (e.g., doctors, nurses, medical laboratory scientists, maintenance staff, clinical trainees, volunteers etc.) (CDC, 2020a). These are the armies in the frontline of the fight against the Coronavirus Disease – 2019 (COVID-19) and their safety should be an urgent focus in the global response to pandemic (Nigeria Health Watch, 2020). The Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) has infected about more than 4.6 million people, leaving more than 310,000 people dead in about 188 countries across the globe (JHU-CSSE, 2020). Globally, healthcare workers have been in the spotlight since the fight against the COVID-19 pandemic started and every country experiencing the onslaught of the virus now consider their healthcare workers as national heroes for the gallant role they are playing in combating the pandemic. One of the cardinal principles of hospital and healthcare is that it should cause no harm to the patient or to the healthcare giver. However, for many healthcare workers in the frontline of the COVID-19 outbreak response, the outcome is different (Joob and Wiwanitkit, 2020). They stand the risk of acquiring infection directly, while attending to patients or indirectly, while handling and testing patient's specimens (Schwikowski, 2020; Minder and Peltier, 2020; Nadarajanet al., 2020; Imai et al., 2020; Majumdar and Mandl, 2020).

At the moment, COVID-19 is not only zoonotic in nature, it has become both community and hospital-acquired infection. The potential for exposure to COVID-19 is generally higher for healthcare workers than other members of the society because of the nature of their work (They work in hospital environment where sick people are being tested, treated and monitored). If they escape exposure to COVID-19 back at home, their work in the hospital environment put them in the harms-way (Ağalarand Engin, 2020; All Africa, 2020; Nadarajan et al., 2020). Considering the infectiousness of SARCoV-2, it has become very expedient for health workers to be fully informed, equipped, and strictly adopt the required biosafety measures so as to stay safe from the disease (Wang et al., 2019; CDC, 2020b; WHO 2020a). Preventing exposure to COVID-19 in the healthcare settings depends on healthcare workers understanding of the followings: The infectious nature of SARCoV-2, the routes by which SARCoV-2 is acquired, the techniques that are the most hazardous and safe working practices.

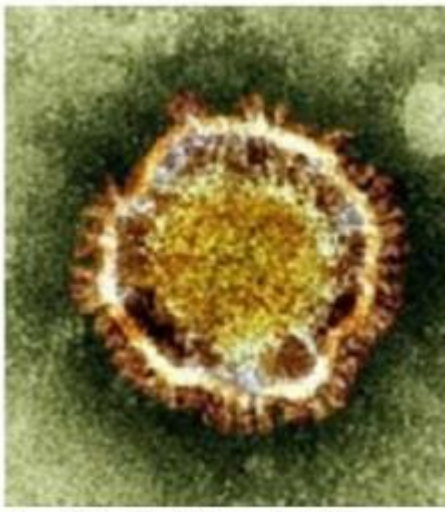
Coronavirus Disease-2019

The Coronavirus Disease-2019 (COVID-19) is caused by a novel Coronavirus, called the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2). It is an enveloped non-segmented positive sense single-stranded RNA virus in the family Coronaviridae. In appearance, the virus looks like a crown under the electron microscope (Figure 1), hence the name, "Corona". Like other coronaviruses, the COVID-19 virus genome is about 400-500nm in size and encodes structural proteins (e.g spike glycoprotein and accessory proteins), as well as non-structural proteins such as RNAdependent RNA polymerase, helicase, papain-like protease and 3 chymotrypsin-like protease. The virus is believed to be more infectious than its counterparts: SARS and MERS (Enitan et al., 2020; Ibeh et al., 2020; Guamer, 2020).

As of May 16, 2020, the COVID-19 virus has spread to 188 countries and territories, with 4,614,135 total confirmed cases and 310,520 total deaths globally (Figure 2). The top 14 most hit countries as indicated by Johns Hopkins University Center for Systems Science and Engineering (JHU-CSSE, 2020) are: US (1,463,350), Russia (272,043), United Kingdom (241,455), Spain (230,698), Italy (224,760), Brazil (222,877), France (179,630), Germany (175,752), Turkey (148,067), Iran (118,392), India (90,648), Peru (88,541) and China (84,038) and Canada (77,082).

Mode of transmission of COVID-19

Human-to-human transmission of SARS-CoV-2 is mainly through respiratory droplets from infected individuals, contact with contaminated objects and surfaces and social activities like hand-shaking and hugging (Enitan et al., 2020). The virus is spread in droplets or droplet nuclei released from the nose and mouth of an infected person when they sneeze or cough. Once the virus becomes airborne, it may remain suspended in the air for up to 8 hours depending on the prevailing environmental conditions such as temperature and relative humidity



Credit: Pasieka/Science Photo Library

Figure 1. Coronavirus as seen under the electron microscope.

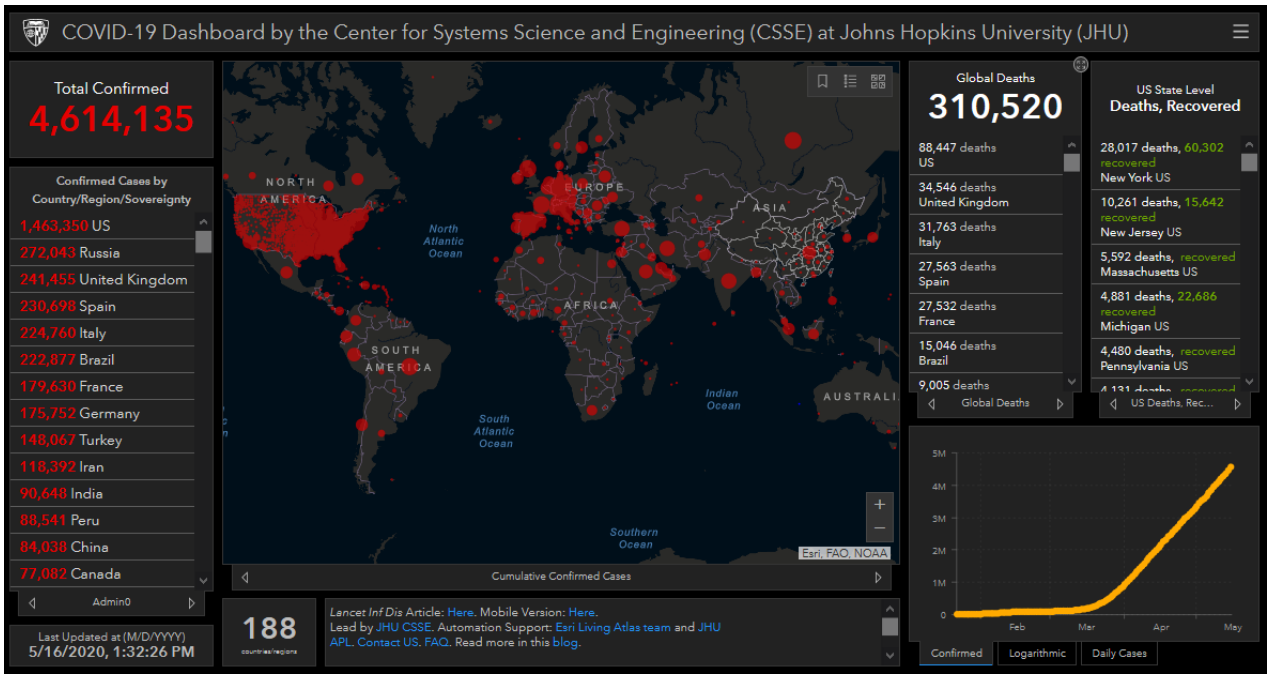


Figure 2. COVID-19 Global Cases by JHU-CSSE as of May 16, 2020.

(Ibeh et al., 2020). Anyone within two (2) meters of the cough or sneeze of an infected person may take in the respiratory droplets into his or her airway and become infected. Otherwise, the viral particle drops about 10 feet after been discharged from an infected person and may fall on other's people clothing and surfaces around them. The virus remains on these surfaces for the stipulated periods waiting to be picked up by people's hands when they touched such surfaces and then touch their eyes, ears, nose or

mouth, from there the virus can find its way into the respiratory tract of the victim, where it then initiates an infection (Berkeley, 2020; Imai et al., 2020; Majumdar and Mandi, 2020).

POTENTIAL SOURCES OF COVID-19

Healthcare workers may contract COVID-19 from either infected patients, infected colleagues, contaminated hospital environments or from carriers in high risk community (Chang et al., 2020a; Ağalar and Engin, 2020).

Patients

Every patient that present with fever, dry cough and chest pain at the hospital is seemly a suspect for COVID-19. However, it is very important for Health workers to be familiar with the approved case definitions in order to identify potential source of infection correctly and act accordingly (Nigeria Centre for Disease Control, 2020a).

Suspected case

- Person with fever, cough, difficulty in breathing and within 14 days before onset has travel or transit in country or state with widespread community transmission.
- Close contact with a confirmed or probable case
- Exposure to healthcare facility with reported COVID-19 case(s).

Probable case:

Any suspected case with:
- Indeterminate (inconclusive) results OR
- Positive test on pan-coronavirus assay OR
- Who dies before samples is collected.

Confirmed case:

Any person with laboratory confirmation of SARS-CoV-2 infection with or without signs and symptoms

A Contact:

A Person with history of exposure with probable or confirmed case within 2-14 days
- Face-to-face contact within 1 meter and for >15 minutes.
- Direct physical contact
- Direct care without using proper personal protective equipment (PPE)
- Other situations indicated by local risk assessments (Nigeria Centre for Disease Control, 2020a).

Colleagues

Professional colleagues who work in any of the following facility without using proper personal protective equipment (PPE) are potential sources of COVID-19, whether they provide direct or indirect care for COVID-19 patients; including those with exposure to healthcare facility with reported COVID-19 case(s):

- COVID-19 Response centres
- COVID-19 diagnostic/research laboratories,
- COVID-19 Isolation/Treatment centres etc (Nigeria Centre for Disease Control, 2020a)

Hospital environment

The hospital environment and its human occupants constitute an ecological unit. Surfaces of the hospital environment may be laden with unsuspecting infectious agents including SARS-CoV-2, waiting to be picked up by healthcare workers unknowingly while performing their statutory duties. Studies have shown that the virus is capable of surviving for a varied period of time depending on the surfaces: human hands (5-10 minutes), Paper (3-4 hours), Copper (4 hours), fabrics (6-12 hours), metal surface (12 hours), cardboard (up to 24 hours), and up to 72 hours on plastic and stainless steel (Berkeley, 2020, 2020; van Doremalen, 2020). The virus remains on these surfaces for the stipulated periods waiting to be picked up by the hands of healthcare workers when they touched such surfaces and then touch their eyes, ears, nose or mouth, from there the virus can find its way into the respiratory tract of the victim, where it then initiates an infection. (Nigeria Centre for Disease Control, 2020b).

Patient's specimens (blood/body fluids), contaminated hand gloves, contaminated medical devices/equipment (e.g. thermometers, ventilators, monitors etc), contaminated electrical and water systems, contaminated Personal Protective Equipment (PPE), contaminated multi-dose vials, injections, sharps, cannula, catheter, bedpans, buckets for mopping floor, disinfectants, soiled

Figure 3. Picture illustrating the risk of hand and glove contamination after contact with a COVID-19 positive patient. X represents SARCoV-2 positive surfaces.

bed/linen, stationeries (books, files, pens etc), mobile phones, bags, sandals, hospital cabinets, refrigerators and medical consumables amongst others (Figure 3) have been implicated as potent vehicles of SARS-CoV-2 in hospital environment (Panigrahi et al., 2020; Kampf et al., 2020). In the laboratory, SARS-CoV-2 can be picked up on the hands from benches and equipment which have been accidentally contaminated by droplets or droplet nuclei from an infected Colleagues or patient's samples (CDC, 2020c, WHO, 2020b).

Medical Wastes

Medical waste is another critical source of COVID-19 to the healthcare workers. Increase hospitalization associated with the pandemic has heightened the generation of medical and hazardous wastes in hospitals across the globe (Figure 4). Public health experts are concern about the adverse effect that may result from Improper decontamination and waste disposal, both at the hospital and community levels as this poses serious threat, both to the health workers and the community at large (The Verge, 2020). The safe handling, and final disposal of this waste is therefore a vital element in an effective emergency response (The Verge, 2020; Waste 360; UN Environment Programme, 2020).

Carriers

Convalescent COVID-19 carriers in high risk community pose greater danger to healthcare workers (Feng et al., 2020; CIDRAP, 2020). These categories of individuals must be identified in order to halt the cycle of infection in the community if exposure to the healthcare workers must be minimized. If healthcare workers do not get infected while working within the healthcare settings, chances exist that they may become infected outside the hospital environment as they interact with asymptomatic carriers in the community in their day-

Photo Credit: Fnews.cgtn.com

Figure 4. Picture showing a medical waste handler collecting medical wastes amidst the pandemic.

to-day activities either at home or public places including: banks, markets, public transports etc (Bai et al., 2020; Chang et al., 2020a).

REASONS FOR HIGH EXPOSURE OF HEALTHCARE WORKERS TO COVID-19

There are many reasons why healthcare workers face risk of exposure to COVID-19 in the healthcare settings (CDC, 2020a; Wang et al., 2020). These include:

Increase Hospitalization

Pressure of testing and treatment, work intensity, crowded conditions, and lack of rest indirectly increased the probability of infection for healthcare workers (CDC, 2020a; Wang et al., 2020).

Long-time exposure

Patients with severe cases of COVID-19 place on ventilator tend to spend extended time in the Intensive Care Unit (ICU). Long-time exposure to large numbers of infected patients directly increased the risk of infection for healthcare workers (CDC, 2020a; Wang et al., 2020).

Shortage of personal protective equipment

Shortage of personal protective equipment (PPE) is a serious problem in the combat against the pandemic. Healthcare workers rely on personal protective equipment to protect themselves and their patients from being infected and infecting others. According to the World Health Organization, shortage of personal protective equipment endangers the lives of health workers. First-level emergency responses have been initiated in different countries of the world, and this has led to a rapid increase in the demand for PPE (WHO, 2020c; 2020d). This circumstance increases the risk of infection for healthcare workers due to lack of sufficient PPE.

Lack of training, supervision and monitoring of infection prevention and control mechanisms

Lack of training on infection prevention and control by the front-line healthcare workers (except infectious disease physicians) is another reason for high exposure of COVID-19 among health workers. After initiation of emergency responses, there was no enough time for systematic training and practice for healthcare workers. This left them more vulnerable to respiratory-borne infectious diseases like the COVID-

Photo Credit: Fabcnews.go.com

Figure 5. Picture showing healthcare workers helping out their dying colleague amidst the COVID-19 pandemic.

19. Professional supervision and guidance, as well as monitoring mechanisms, were also lacking. This situation further amplified the risk of infection for healthcare workers (Wang et al., 2020). Rural healthcare workers are more at risk of exposure than their urban counterparts for the same reasons including: lacking of training, supervision, monitoring, lack of access to personal protective equipment (PPE) amongst others.

Impacts of COVID-19 on Healthcare Workers

The increased hospitalization associated with the COVID-19 pandemic is far over stretching the resilience of the health system of most countries. Hospital and healthcare workers (Doctors, Nurses, Medical Laboratory Scientists, etc) are already overwhelmed by the numbers of people requesting testing and treatment at the same time (Nigeria Health Watch, 2020). Besides the COVID-19 patients, they also have other category of patients to care for, including those with diabetes, cancer, liver failure, kidney failure, hypertensive etc (CDC, 2020b). This results in long and distressing work shifts to meet health services requirements. High prevalence rates of severe insomnia, anxiety, depression, somatization, and obsessive-compulsive symptoms have been reported among healthcare workers since the fight against COVID-19 started. Thus, the presence of these symptoms in addition to the life status of daily fighting against COVID-19 suggests that they must cope with psychological distress and are at risk of allostatic overload (Fava et al., 2019).

Stigmatization towards working with COVID-19 patients, stress from using strict biosecurity measures (such as physical strain of protective equipment, need for constant awareness and vigilance, strict procedures to follow, preventing autonomy, physical isolation, higher demands in the work setting (10 hours of shifts per day), reduced capacity to use social support due to physical distancing and stigma, insufficient capacity to give self-care and insufficient knowledge about the long-term exposure to individuals infected with COVID-19 place additional stress on frontline healthcare workers (International Council of Nurses, 2020). Furthermore; healthcare workers are afraid they might infect their family members and live-in relatives. Thus, hospitals are under pressure to provide additional accommodation at workplaces (Schwikowski, 2020). According to the WHO Director General (Dr. Tedros Ghebreyesus), nothing less than 3,000 health workers has been infected globally, with many paying the supreme price with their lives in a bid to provide health care to COVID-19 patients (Figure 5) (All Africa, 2020). Doctors and health workers, more especially in Africa, are protesting the poor working conditions, scarcity of personal protective equipment (PPE), poor hazards allowances, lack of life insurances and the fear of infection from the coronavirus (MacLeod, 2020). Some are staying away from work, yet they are urgently needed. As of May, 01 2020, the total

Figure 6. Personal Protective Equipment (PPE) for COVID-19 Healthcare Workers.

number of health workers infected with novel coronavirus outbreak in Nigeria has reached 113, according to the country's health minister (Dr. Osagie Ehanirein). Around 6% of the COVID-19 cases in the country composed of healthcare workers, with some of them working in private clinics without necessary training and necessary precautions. They have not only infected themselves, but have also become a source of infection to their families. Many exposed health workers are currently either in quarantine or isolation; while others have lost their lives since the fight against COVID-19 started. Consequent upon these, workflow is being disrupted with possible discontinuity of healthcare services in some cases (Anadolu Agency, 2020).

If COVID-19 cases continue to escalate, it will no doubt, put many healthcare personnel out of work, and more hospitals will be stretched thin – especially in communities that were already facing a shortage of healthcare workers and resources. For example, Idaho, New Mexico and Vermont all had fewer than 10 physicians and surgeons per 100,000 people in 2018, compared with about 5,883 per 100,000 people in New York and more than 1,200 each in Virginia and Massachusetts, according to an analysis by USA Facts (Galvin, 2020).

As healthcare workers become increasingly infected, the burdens increase on healthcare systems already groaning under the strain of an expanding pandemic. Now, infected healthcare workers are increasingly being recognized as vectors for the spread of the virus. The risk of exposure to COVID-19, the accompanying health impacts and the need for biosafety measures among health workers remain critical as it affects the quality of testing, treatment and health care rendered, not only to COVID-19 patients, but also to other category of patients receiving healthcare services in the hospital for reasons other than COVID-19.

COVID-19 AND BIOSAFETY MEASURES

Personal Protective Equipment

Healthcare workers working in COVID-19 laboratories, clinics, isolation and treatment centres must be fully equipped with the necessary Personal Protective Equipment (PPE) (Figure 6) designed to protect wearer's skin, eyes, mucous membranes, airways and clothing contact with infectious agents (CDC, 2020c, WHO, 2020d). These include: 1) Gloves (Protect hands), 2), Gowns/aprons (Protect skin and/or clothing), 3) Masks (Protect mouth/nose), 4) Respirators (Protect respiratory tract from airborne infectious agents, 5) Goggles (Protect eyes), and 6) Face shields (Protect face, mouth, nose, and eyes). Risk consider include: nature of contact (direct or indirect) and duration of contact with patient or patient's specimens. Factors Influencing PPE Selection include: Type of exposure anticipated, potential splash/spray versus touch, category of isolation precautions, durability and appropriateness

for the task and lastly, fitness. The use of PPE is very critical in protecting healthcare professional against COVID-19; however, they are not substitute for proper infection prevention and control practice (WHO, 2002). Meanwhile, healthcare Workers must be familiar and proficient in wearing (donning) and removing (doffing) the PPE. This requires specific training (ECDC, 2020; WHO, 2020e). As a general rule, it is mandatory for health professional to perform hand hygiene (Wash hands with soap and water or use an alcohol-based hand sanitizer) between steps if hands get contaminated during and immediately after removal of PPE (CDC, 2020a; 2020c).

SAFETY PRECAUTION IN THE USE OF PPE

Gloves

Protective gloves should be worn before touching COVID-19 patients, when taking samples from patients and when handling patient's specimens for laboratory analyses.

- The hands should be clean before putting on gloves for a sterile procedure.
- Opportunities for "touch" contamination must be limited as much as possible.
- Touching the face or adjusting PPE with contaminated gloves must be avoided.
- Touching environmental surfaces during patient care should be avoided, except as necessary.
- Gloves should be changed during use if torn, and when heavily soiled (even during use on the same patient) and after use on each patient.
- Used gloves should be discarded in appropriate receptacle.
- Disposable gloves should never be washed or reused.
- Re-usable gloves must be properly decontaminated and washed, while on the hands and after removal (Nigeria Centre for Disease Control, 2020b).

Mask

Masks are made to guarantee one-way protection for healthcare workers (To capture their droplets).

- Mask must be checked to ensure it has no defects, such as a tear or torn strap or ear loop.
- The top ties should be brought to the crown of head and secure with a bow; while the bottom ties should be secured in a bow at the nape of neck.
- The mask should be removed when no longer in clinical space and the patient intervention is completed.
- For ear loop mask, the mask should be removed from the side with the head tilted forward.
- Mask should not be worn if wet or soiled; a new mask instead should be obtained.
- Mask should not be left hanging off one's ear or hanging around neck.
- Used mask should be discarded after wearing once.
- Touching the front of the mask should be avoided, as it is contaminated after use (WHO, 2020f).

N95 Respirator

Respirators are tight masks that must seal off the wearer's face and work in a bidirectional sense, in particular for the protection of the wearer (e.g. protect from dust or small particles present in the air).

- The N95 respirator should be checked to ensure it has no defects such as holes or torn straps.
- It should be worn for protection against very small particles that float in the air (e.g., Tuberculosis, measles, or chickenpox).
- The manufacturer's instructions must be followed during donning and doffing of the N95 respirator.
- The N95 respirator must be properly fitted -making sure the nose and mouth are completely covered. It must have a complete seal all around. Complete face seal check must be ensured, after donning the respirator.
- Wet or soiled N95 respirator should not be worn; a new one should be obtained instead.
- N95 respirator that hasn't been properly fit tested should not be worn. Proper fit is essential.
- N95 respirator with air leaks around the edges should not be worn.
- It should never be shared with others; pathogens can spread that way.
- The front of the N95 respirator should not be touched as it is contaminated after use. The straps should not be snapped, as that may spread pathogens (Nigeria Centre for Disease Control, 2020b).

Gown

- Gown should be secured at the base of the neck and at the waist or as indicated by manufacturer.
- Wearer must sure that the gown completely

Photo Credit: Nature.com

Figure 7. Picture showing Laboratory Personnel wearing Personal Protective Equipment (PPE) working in SARS-CoV-2 Maximum Containment Laboratory using a Biosafety Cabinet.

covers clothing-front to back-if design of gown allows or as indicated by manufacturer.

- Gown should be removed by slowly rolling it inside out and away from the body. Contaminated front and sleeves should be kept inside the bundle.
- Gown must not be re-use for the same or different patient. Disposable and reusable gowns are single time use items.
- Contaminated gowns must not be allowed to hang out of the garbage.
- Lastly, contaminated gown must not be worn outside of the patient care area or laboratory or taken home for the purpose of washing (Nigeria Centre for Disease Control, 2020b).

Maximum Containment Laboratory

Avoiding biohazards of all forms is very critical for health workers in the fight against any pandemic (Chang et al., 2020a). Work with pathogens in the various Risk Groups (1, 2, 3 and 4) requires different conditions for containment and different equipment and procedures to conduct work safely (WHO, 2004). To this end, there are four Biosafety Levels of laboratory: Basic, Biosafety Level 1, Basic, Biosafety Level 2, Containment, Biosafety Level 3 and Maximum Containment, Biosafety Level 4 (Cheesbrough, 2009). Assignment of an agent to a biosafety level for laboratory work is based on a risk assessment. The COVID-19 virus (SARCoV-2) falls into the Risk Group 4 category, just like it counterparts: SARS-CoV-1 and MERS (Guamer, 2020). The pathogens in this group are deadly and offer a high risk to the laboratory worker and to the community. They can cause serious disease and are readily transmitted from one individual to another. Effective treatment and preventive measures are not usually available. The Maximum Containment laboratory, Level 4 (Figure 7) is intended for work with viruses in Risk Group 4, for which the most-strict safety precautions are necessary (CDC, 2007). These laboratories are usually separate buildings with strictly controlled access through air locks and exit through decontaminant showers. They have pressure gradients between their various rooms and all air from rooms and safety cabinets is filtered twice before discharge to the atmosphere. All effluents from sinks, lavatories, etc. are decontaminated before discharge into the public sewer. The staff of these laboratories are specifically trained for the work they do (CDC, 2020d). However, in resource limited countries, where the Maximum Containment laboratory, Level 4 is lacking, it is required that any work done on COVID-19 virus must be carried out in Biosafety Level 3 (BSL-3) facility or at least a BSL-2 as required by International Standard Organization (International Standards Organization, 2014).

Biosafety Cabinets

Biosafety cabinets are intended to protect laboratory workers from aerosols and airborne particles (CDC, 2007; Tran et al., 2012). There are three kinds of safety cabinet, Classes I, II, and III. Class I and Class II cabinets are used in diagnostic and containment laboratories for work with Risk Group 3 organisms. Class III safety cabinets are used almost exclusively for Risk Group 4 organisms such as SARS-CoV-2 (CDC, 2020d). This type of cabinet is totally enclosed and is tested under pressure to ensure that no particles can leak from it into the room. The operator works with gloves which form part of the cabinet. Air enters through a filter and is exhausted to atmosphere through one or two more filters. Work should be done in the middle to rear of the cabinet, not near the front. The operator should avoid bringing the hands and arms out of the cabinet while working. After each set of manipulations and before withdrawing the hands, the operator should wait for 2–3 minutes to allow any aerosols to be swept into the filters. After finishing work in a safety cabinet, the hands and arms may be decontaminated and should be washed immediately. Safety cabinets should be swabbed out with a suitable disinfectant after use and regularly decontaminated with formaldehyde. Decontamination is essential before the filters are changed (Cheesbrough, 2009; WHO, 2004; 2020c).

Safe Transport of Specimens for COVID-19 Testing

Safety measures are needed to ensure specimens from suspected, probable or confirmed cases of COVID-19 are transported safely and with care. Transport of specimens within national borders should comply with applicable national regulations. While international transport of potentially COVID-19 virus containing samples should follow the United Nations (UN) Model Regulations, and any other applicable regulations depending on the mode of transport being used (Cheesbrough, 2009; WHO, 2019).

Management of Medical Wastes

Medical wastes should be segregated into non-infectious waste (e.g food reminants), infectious waste (e.g gloves), highly infectious waste (e.g test tube containing patient's specimen) and sharp waste (e.g needle and syringe), before being disposed.

Wastes from COVID-19 patients are considered highly infectious and must be handled with utmost caution. Solid and liquid medical wastes must be handled separately and according to existing safety rules for handling of medical wastes (Cheesbrough, 2009; Waste360, 2020).

DISPOSAL OF MEDICAL WASTES

Incineration

An effective disposal method is incineration (i.e., destruction by burning). This is a practical and effective method of disposing of laboratory waste including contaminated disposables and specimens in non-reusable containers, e.g. faeces from COVID-19 patient. Purpose-built incinerators are rarely available in resource-limited countries. Open burning is more common. The materials to be incinerated must be carried to the incineration site in closed leakproof puncture resistant containers (Cheesbrough, 2009; Waste360, 2020).

Burial in a deep pit or landfill

Burying medical wastes prevents it becoming a hazard provided the pit is: located in a safe fenced off area, is sufficiently deep (4–5 metres) and wide (1–2 metres), has a strengthened rim, and is kept covered. The disposal pit should not be used for items that do not decompose, e.g. plastic laboratory wares. These are best incinerated. Ideally all infectious medical wastes should be decontaminated or incinerated before it is discarded in a pit or landfill. Once a week the waste should be covered by a layer of quicklime, or if unavailable by soil or leaves. If a local landfill site is available, local health authority guidelines should be followed regarding its use (medical waste must never be disposed of with household waste).

Recommendations for COVID-19 exposed Healthcare Workers

- The exposed healthcare worker should be excluded from work and self-isolate immediately.
- Specimen for COVID-19 testing should be collected as soon as possible.
- Temperature and respiratory symptoms should be monitored daily for 14 days after the last day of exposure to a COVID-19 patient, while awaiting test result.
- The state COVID-19 response team should be

contacted immediately if symptoms suggestive of COVID-19 begin to appear.
- Treatment of confirmed cases should be initiated promptly following the recommended treatment protocol of the state (Self-medication should be avoided).
- Clinically recovered healthcare worker should only be discharged after confirmation of negative viral status usually by at least two consecutive polymerase chain reaction (PCR) tests (Chang et al., 2020b; Chen et al., 2020).
- Following laboratory confirmation of negative viral status, recovered healthcare worker may report back to his/her duty post and continue with his/her day-to-day activities.

CONCLUSION

As the COVID-19 pandemic continue to escalate globally, it is very important for the frontline armies to stay safe and healthy in the fight against the virus, and as such adherence to the recommended safety precautions remains paramount. The healthcare workers must insist on the provision and use of PPE before attending to any suspected or confirmed case, no matter the emergency. Meanwhile, the WHO should upscale efforts in assisting the low- and middle-income countries in protecting their healthcare workers by making PPE readily available and in sufficient numbers. The lack of protection is a very common challenge in resource limited countries, therefore necessary improvisation is highly desirable, in addition to boosting supply, easing export restrictions and putting measures in place to stop speculation and hoarding. The increase in awareness of personal protection, availability of sufficient PPE, adherence to biosafety guidelines, improved surveillance, proper preparedness and response would continue to play an important role in lowering the risk of infection among healthcare workers.

Conflict of interest

The authors declare no conflict of interest.

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