

ORIGINAL RESEARCH ARTICLE

POTENTIAL RISKS OF COVID-19 AMONG HEALTHCARE WORKERS

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**ABSTRACT**

**Background:** Healthcare workers have a potential risk of COVID-19 as they are at the front line of the COVID-19 outbreak response. This study aimed to assess the potential risk of COVID-19 infection among healthcare workers at COVID-19 treatment center.

**Methods:** A hospital based cross-sectional study design was undertaken to conduct this study. A snowball networking sampling method was used to select the participants. Total 387 health care workers participated in the study from July 18, 2020 to September 22, 2020. The WHO COVID-19 risk assessment tool was used to collect data from study participants. Descriptive statistics and inferential statistics binary logistic regression were done through SPSS 16 version.

**Results:** There was a high level of occupational exposure (88.9%) to the COVID-19 virus and a higher potential risk of COVID-19 infection (75%) among exposed healthcare workers. Among those who had occupational exposure 7% and 21% did not use personal protective equipment during health-care interaction and performing aerosol generating procedures respectively. Male healthcare workers, registered nurses, medical doctors, and auxiliary nurse midwives were found the potential risk of COVID-19 infection. Healthcare workers with less supply of PPE had three times higher potential risk of COVID-19 infection.

**Conclusions:** Healthcare workers had a higher occupational exposure and higher potential risk of COVID-19 infection. Healthcare workers had poor adherence to infection prevention and control measures. Healthcare workers should ensure proper use of personal protective equipment and adherence to infection control measures and adequate supply of PPE must be there to protect the healthcare workers from COVID-19 infection.

**INTRODUCTION**

Coronavirus disease 2019 (COVID-19) is a global pandemic, first detected in December 2019 in Wuhan, China.<sup>1</sup> Healthcare workers (HCWs) are at the front line of the COVID-19 outbreak response that put them at potential risk of infection.<sup>2,3</sup> COVID-19 infections in HCWs have been reported since early in the outbreak: 1716 HCWs were infected by COVID-19 in Wuhan, China.<sup>4</sup> International Council of Nurses reported that over 90000 HCWs infected with COVID-19 on the 6<sup>th</sup> May 2020.<sup>5</sup> WHO announced 1.4 million HCWs were infected with COVID-19 globally (10%) as of July 2020.<sup>6</sup> The prevalence of COVID-19 among HCWs was 11% in India.<sup>7</sup> In Nepal, HCWs infections has risen from 91 to more than 800 till 3<sup>rd</sup> September 2020<sup>8,9</sup> and Ministry of Health and Population reported 4085 frontline HCWs at high risk of infection.<sup>10</sup>

COVID-19 is the most serious threat to HCWs due to close contact with the infected patients.<sup>11, 12</sup> HCWs are strongly recommended to adhere to appropriate infection prevention and control (IPC) measures to minimize the risk of COVID-19 virus infection.<sup>13</sup> However, the inadequacy of IPC logistics, workload, long duty hours and working in critical care unit,

emergency unit poses a serious challenge to adhere strictly to IPC measures.<sup>2, 12, 14, 15</sup> HCWs are vital resources; their health and safety are decisive. The measures to decrease HCWs' risk of COVID-19 infection support the attempt to combat the pandemic and protect the health system. Therefore, the study aimed to assess the potential risk of HCWs getting COVID-19 infection during caring for the patient with COVID-19 or suspected cases.

**METHODS**

A hospital based cross-sectional study design was conducted to assess the potential risk of COVID-19 infection among health care workers from July 18 to September 22, 2020. The ethical permission was taken from the Institutional Review Committee of Manipal Teaching Hospital (Ref: MEMG/IRC/358/GA). The study population included all healthcare workers who are working in the designated COVID-19 treatment center in Nepal and who can fill the form online. The sample size was calculated using Cochran's formula on the assumption of 50% prevalence of the risk of COVID-19 infection among HCWs since no such studies being conducted yet regarding the assessment of risk of COVID-19 infection among HCWs. The sample size

was calculated with 95% CI and 5% degree of precision by using formula,

$$n = Z^2 \times p \times q / d^2$$

$$= (1.96)^2 \times (0.5) \times (1 - 0.5) / (0.05)^2$$

$$= 384$$

By adding 10 % non – response error the final sample size of this study was 424.

A semi-structured questionnaire was developed on the basis of research objectives by reviewing the literature. The tool consisted of two sections. The first section of the questionnaire included socio-demographic information of HCW and organization related information: age, sex, type of organization, type of health care workers, working units, working hours, and training on IPC related to COVID-19, supply of PPE, multiple confirmed cases present in the organization. The second section of the questionnaire consisted of HCWs' exposure with COVID-19 patients and adherence to IPC during health care interaction and during aerosol generating procedure which was based on the WHO COVID-19 risk assessment tool.<sup>16</sup> Permission was taken to use the tool in the study. Exposure to COVID-19 virus was assessed by a “yes” response to performing any of the following activities on a COVID-19 patient: providing direct care to a COVID-19 patient, face to face contact (within 1 meter) with a confirmed COVID-19 patient, performed aerosol-generating procedures /present when aerosol-generating procedures (AGP) were performed on COVID-19 patients and had direct contact with the environment where confirmed COVID-19 patient was cared for. Healthcare worker was considered high risk for COVID-19 if he/she did not respond “always, as recommended” during healthcare interaction and during aerosol generating procedures with a confirmed COVID-19 patient to IPC measures and who had any type of accident with body fluid/respiratory secretions of a COVID-19 patient. “Low risk to COVID-19” was defined as HCWs who do not fulfill the above criteria. Pre testing of the tool was done among 10% of total sample i.e., 42 healthcare workers to check the practicability and understandability. Reliability was checked with Cronbach alpha which was rated 0.91.

A snowball networking sampling technique was used to recruit the participants. Social media (messenger, mail, viber) was used to send the link of the online questionnaire to HCWs from the portal of Google form. Consent was obtained through an anonymous online information sheet describing the study background, objectives, procedure, risk and benefits. Approximately 15 minutes were required to complete the form.

The data was retrieved from Google form in excel. Then data checking, cleaning and coding were done and exported to Statistical Package for Social Sciences (SPSS) software version 20. The data was presented using descriptive statistics that include frequencies, percent, means and standard deviation. Chi-square test was used to examine the association between the risk of infection and socio-demographic and organization related information of HCWs. Binary logistic regression was used to identify the factors associated with risk of COVID-19 infection. A confidence interval of 95% was taken and P values

<0.05 were considered statistically significant.

## RESULTS

Out of 424 respondents, 387 respondents agreed to participate in the study (response rate 91%). A total of 387 HCWs comprised registered nurse 278 (71.8%), medical doctor 44(11.4%), ANM (Auxiliary Nurse Midwife) 28(7.2%), laboratory personnel 18(4.7%), health assistant 8(2.1%), and others HCWs 11(2.7%). Most of the HCWs 155(40.1%) was in age group of 25–35 years. The mean age of respondents was 31.28±8.61 ranging from 19 to 58 years. More female 335(86.6%) than male 52(13.4%) HCWs participated in the study. Most of them 249(64.3%) worked in government health facility, 138(35.7%) worked in the inpatient department. Most of the HCWs 244(63.0%) had 6-8 hours duty. More than half of HCWs got training on IPC, 265 (68.5%) of HCWs' health facility had a sufficient supply of PPE. Most of the HCWs 339(87.6%) reported multiple confirmed COVID-19 patients in their organization.

Table 1 depicted 88.9% HCWs exposed to COVID-19 virus in which 74.9% HCWs provided direct care to confirmed COVID 19 patient and had face to face contact with confirmed COVID- 19 patient, 87.3% HCWs were present during AGP performed on the COVID-19 patients; 70.0% of HCWs had direct contact with the environment where the confirmed COVID-19 patient cared and 16 % of HCWs exposed the biological fluids and respiratory secretion accidentally.

**Table 1: Occupational exposure of HCWs to COVID-19 virus (n= 387)**

| Exposure to COVID-19 Virus  | Number (%) |
|---|------------|
| <b>Direct care to a confirmed COVID 19 patient</b>  |            |
| Yes   | 290 (74.9) |
| No  | 85 (22.0)  |
| Unknown   | 12 (3.1%)  |
| <b>Face to face contact with confirmed COVID-19 patients</b>                              |            |
| Yes   | 290 (74.9) |
| No  | 83 (21.4)  |
| Unknown   | 14 (3.6)   |
| <b>Present on AGP performed on COVID-19 patient</b>                                       |            |
| Yes   | 338 (87.3) |
| No  | 45 (11.6)  |
| Unknown   | 4 (1.0)    |
| <b>Direct contact with the environment where the confirmed COVID-19 patient was cared</b> |            |
| Yes   | 271 (70.0) |
| No  | 94 (24.3)  |
| Unknown   | 22 (5.7)   |
| <b>Accident with biological fluid/ respiratory secretions</b>                             |            |
| Yes   | 62 (16.0)  |
| No  | 325 (84.0) |
| <b>Occupational Exposure</b>  |            |
| Present   | 344 (88.9) |
| Not present   | 43(11.1)   |

Table 2 revealed 320(93%) respondents used PPE and 24(7%) respondents didn't use PPE among occupational exposure HCWs during health care interaction with COVID-19 infection. Among PPE used HCWs, 263(82.2%), 277(86.5%), 246(76.9%), 250(78.1%) of the study respondents had always used gloves, N95, or equivalent mask, face shield or goggles/protective glasses and disposable gown, respectively. Among occupational exposure HCWs, 266(77.3%) and 210(61.0%) of respondents

always remove and replace the PPE according to protocol and high touch surfaces decontaminated frequently, respectively. The study showed 274(79.7%), 282(82.0%), 272(79.1%) and 263(76.5%) of the respondents always performed hand hygiene before and after touching patients with COVID-19, before and after any clean or aseptic procedure, after exposure to body fluid, after touching the COVID-19 patient's surroundings respectively.

**Table 2: Adherence to IPC during health care interaction with COVID-19 patient among HCWs (n= 344)**

| IPC Measure   | Always as recommended<br>n (%) | Most of the time<br>n (%) | Occasionally<br>n (%) | Rarely<br>n (%) |
|---|--------------------------------|---------------------------|-----------------------|-----------------|
| <b>PPE Use (320)</b>  |                                |                           |                       |                 |
| Single Gloves   | 263 (82.2)                     | 41 (12.8)                 | 11 (3.4)              | 5 (1.6)         |
| N95 Mask or Equivalent  | 277 (86.5)                     | 26 (8.1)                  | 12 (3.8)              | 5 (1.6)         |
| Face Shield or Goggles/Protective glasses   | 246 (76.9)                     | 44 (13.8)                 | 19 (5.9)              | 11(3.4)         |
| Disposal Gown   | 250 (78.1)                     | 42 (13.1)                 | 12 (3.8)              | 16 (5)          |
| Remove and replace PPE according to protocol  | 266 (77.3)                     | 51 (14.8)                 | 16 (4.7)              | 11 (3.2)        |
| Perform hand hygiene before and after touching the COVID-19 patient                               | 274 (79.7)                     | 55 (16)                   | 13 (3.8)              | 2 (0.6)         |
| Perform hand hygiene before and after any clean or aseptic procedure was performed                | 282 (82.0)                     | 41 (11.9)                 | 13 (3.8)              | 8 (2.3)         |
| Perform hand hygiene after exposure to body fluid   | 272 ( 79.1)                    | 50 (14.5)                 | 18 (5.2)              | 4 (1.2)         |
| Perform hand hygiene after touching the COVID-19 patient's surroundings                           | 263 (76.5)                     | 57 (16.6)                 | 18 (5.2)              | 6 (1.7)         |
| High touch surfaces (bed rails, iv poles, bedside tables, station etc.) decontaminated frequently | 210 (61.0)                     | 87 (25.3)                 | 21 (6.1)              | 26 (7.6)        |

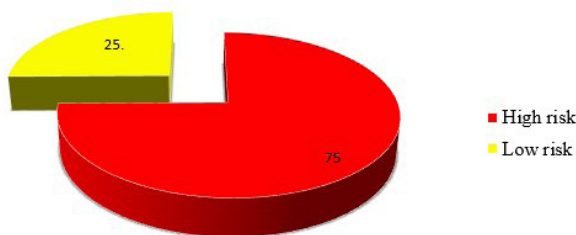
**Table 3: Adherence to IPC during aerosol generating procedure with COVID-19 patient among HCWs (n= 338)**

| IPC Measure   | Always as recommended<br>n (%) | Most of the time<br>n (%) | Occasionally<br>n (%) | Rarely<br>n (%) |
|---|--------------------------------|---------------------------|-----------------------|-----------------|
| <b>PPE Use (267)</b>  |                                |                           |                       |                 |
| Single Gloves   | 241(90.3)                      | 20 (5.2)                  | 4 (1.5)               | 2 (0.7)         |
| N95 Mask or Equivalent  | 225 (84.3)                     | 35 (13.1)                 | 3 (1.1)               | 4 (1.5)         |
| Face Shield or Goggles/Protective glasses   | 212 (79.4)                     | 37 (13.9)                 | 14 (5.2)              | 4 (1.5)         |
| Disposal Gown   | 205(76.8)                      | 33 (12.4)                 | 10 (3.7)              | 19 (7.1)        |
| Remove and replace PPE according to protocol  | 268 (79.3)                     | 57 (16.9)                 | 5 (1.5)               | 8 (2.4)         |
| Perform hand hygiene before and after touching the COVID-19 patient                               | 260 (76.9)                     | 59 (17.5)                 | 16 (4.7)              | 3 (0.9)         |
| Perform hand hygiene before and after any clean or aseptic procedure was performed                | 262 (77.5)                     | 57 (16.9)                 | 11 (3.3)              | 8 (2.4)         |
| Perform hand hygiene after exposure to body fluid   | 264 (78.1)                     | 57 (16.9)                 | 14 (4.1)              | 3 (0.9)         |
| Perform hand hygiene after touching the COVID-19 patient's surroundings                           | 257 (76.0)                     | 63 (18.6)                 | 15 (4.4)              | 3 (0.9)         |
| High touch surfaces (bed rails, iv poles, bedside tables, station etc.) decontaminated frequently | 201 (59.5)                     | 103 (30.5)                | 13 (3.4)              | 21 (6.2)        |

Table 3 depicted 267(79%) respondents used PPE and 71(21%) respondents didn't use PPE. among 338 HCWs who present or performed AGP with COVID-19 infected patient. Among PPE used HCWs, 241(90.3), 225 (84.3), 212 (79.4) and 205(76.8) of the study respondents had always used gloves, N95, or equivalent masks, face shields or goggles/protective glasses and disposable gown, respectively. Among HCWs who present or performed AGP with COVID-19 infected patients, 268 (79.3%), and 201(59.5%)of the respondents always remove and replace the PPE according to protocol and high touch surfaces decontaminated frequently, respectively.

Among them, 260(76.9%), 262 (77.5%), 264 (78.1%) and 257(76.0%) performed hand hygiene before and after touching patients with COVID-19, before and after any clean or aseptic procedure was performed, after exposure to body fluid, after touching the covid-19 patient's surroundings respectively.

Figure 1 showed among HCWs with occupational exposure (344) to the COVID-19 virus, a majority of them 258 (75%) were at high risk for COVID-19 virus infection, while 86 (25%) of HCWs were at low risk for COVID-19 virus infection.



**Figure 1: Risk of COVID-19 virus infection among exposed healthcare workers**

Table 4 showed the risk of COVID-19 infection was significantly associated with gender, type of HCWs and supply of PPE. Male HCWs were nine times higher risk of COVID-19 infection than female HCWs (OR: 9.39; 95%CI 1.89-46.46). Registered nurses, medical doctors and ANM were ten, fifteen- and thirty-one-times higher risk of COVID-19 infection than laboratory personnel (OR: 10.48; 95%CI 1.17-93.83) (OR: 15.20; 95%CI 1.77-130.57) and (OR: 31.04; 95%CI 2.45-392.77) respectively. HCWs with less supply of PPE were three times higher risk of COVID-19 infection (OR: 3.80; 95%CI 1.78-8.10). There was no significant association of working unit, multiple confirmed cases present in working health facility, duty hours with risk of COVID-19 infection.

**Table 4: Factors associated with risk of COVID-19 virus infection among exposed healthcare workers (n = 344)**

| Variables   | Odd ratio | 95% CI      | p-value |
|---|-----------|-------------|---------|
| <b>Gender</b>                                       |           |             |         |
| Female  | Ref       |             |         |
| Male  | 9.39      | 1.89-46.46  | 0.006*  |
| <b>Type of Healthcare Worker</b>                    |           |             |         |
| Laboratory Personnel                                | Ref       |             |         |
| Registered Nurse                                    | 10.48     | 1.17-93.83  | 0.03*   |
| Medical Doctor                                      | 15.20     | 1.77-130.57 | 0.01*   |
| ANM   | 31.04     | 2.45-392.77 | 0.008*  |
| Others <sup>#</sup>                                 | 1.81      | 0.20-16.15  | 0.59    |
| <b>Working Unit</b>                                 |           |             |         |
| Critical Care Unit                                  | Ref       |             |         |
| Isolation Unit                                      | 1.32      | 0.58-2.99   | 0.50    |
| In Patient Department                               | 1.26      | 0.58-2.74   | 0.55    |
| Emergency Unit                                      | 0.88      | 0.20-3.77   | 0.86    |
| Others <sup>##</sup>                                | 2.46      | 0.56-11.96  | 0.26    |
| <b>Sufficient PPE</b>                               |           |             |         |
| Yes   | Ref       |             |         |
| No  | 3.80      | 1.78-8.10   | 0.001*  |
| <b>Multiple confirmed cases in working Hospital</b> |           |             |         |
| Yes   | Ref       |             |         |
| No  | 2.57      | 0.82-7.99   | 0.10    |
| <b>Duty Hours</b>                                   |           |             |         |
| 6-8 hours   | Ref       |             |         |
| ≥12 hours   | 0.60      | 0.33-1.10   | 0.10    |

<sup>#</sup>Health Assistant, CMA, AHW, Pharmacist, Physical Therapist, Radiology Technician

<sup>##</sup>Laboratory, Outpatient Department, Multiple Area

\*Significant p- <0.05

## DISCUSSION

Frontline HCWs are at increased risk of becoming infected with the COVID-19 virus since they provide direct care to COVID-19 patients.<sup>17</sup> The study findings showed high exposure (88.9%) to the COVID-19 virus which is supported by the study from Ghana and Ethiopia where 80.4% and 76% had occupational exposure to COVID-19 virus respectively.<sup>15, 18</sup> The high exposure to COVID-19 virus in the current study was predictable since the study was done among the HCWs working in the COVID-19 centers. Among the exposure group, 75% HCWs were at high risk of acquiring COVID-19 infection. Contrary, the study was

done in Ghana and the US found only 14% HCWs at high risk of COVID-19 virus infection.<sup>18, 19</sup> This might be due to differences in health care system as well as affordability and availability of PPE.

In current study, 24 (7%) of the HCWs had not used PPE during healthcare interaction to patients with COVID-19. Among those who used PPE, 17.8%, 13.5%, 23.1%, 21.9% of HCWs were not always used gloves, N95 Mask or equivalent, Face shield or goggles/protective glasses and disposable gown during health-care interaction to patients with COVID-19. Similarly 71 (21%) of HCWs didn't use PPE during performing AGP with COVID-19 infected patient. Among them, 7.4%, 15.7%, 20.6% and 23.2% of HCWs did not always use gloves, N95 Mask or equivalent,

Face shield or goggles/protective glasses and disposable gown. This finding stressed that HCWs are not seriously following IPC measures. A previous study done in Bangladesh showed the appropriate PPE used during caring the patient with COVID-19 protects the HCWs from infection.<sup>20</sup>

This study showed males HCWs were at more risk than females which was not consistent with the findings from Ghana as the study showed gender had no effect on the risk of COVID-19 infection.<sup>18</sup>The present study is supported by the study done in Denmark which found more male HCWs were COVID-19 positive than female HCWs.<sup>21</sup> Our study findings revealed that registered nurses, medical doctors and ANM were more risks than laboratory personnel which in line with the finding from Denmark which showed lower COVID-19 positive among laboratory personnel.<sup>21</sup>Contradictorily to study done in Ghana where registered nurses were at lower risk than assistant nurses and other healthcare workers.<sup>18</sup>This might be due to fact that registered nurses, ANM and medical doctors were directly involved in care of the patient with COVID-19 for longer hours. In this study, there was no difference in risk among HCWs according to the working unit. In contrast, the study done in Denmark, Ethiopia, Bangladesh showed HCWs working in COVID dedicated ward, Emergency ward and Intensive care unit had more possibility of infection.<sup>15, 20, 21</sup>

The study found 31.5% of HCWs had an insufficient supply of PPE. HCWs who reported insufficient supply of PPE in their health facility had more risk of COVID-19 infection. This finding was supported by WHO situation report and review articles in which the shortage of PPE could put the HCWs at the substantial risk of becoming infected with COVID 19.<sup>2,23</sup> In this study there was no statistically significant association between duty hours and risk of COVID 19 infection which was

contrast to study done in China which reported HCWs who did longer duty hours were at higher risk of COVID 19 infection.<sup>12</sup>

The study has potential limitations. The first limitation, exposure to the COVID-19 virus was self-reported which could be probable to recall bias. The second limitation, we could not establish how exposure translates into COVID-19 infection. The third limitation, since the study was web based and data was collected online system using snow-ball sampling; there would be chance of selection bias.

## CONCLUSION

The study concluded that HCWs were at higher occupational exposure to COVID-19 virus and at higher risk to COVID-19 infection. Poor adherence to IPC measures during healthcare interaction with patients with COVID-19 was identified. Male HCWs, registered nurses, medical doctors, ANM were at higher risk to get infection to COVID-19 infection. Inadequate supply of PPE was another major factor for higher risk of COVID-19 infection to HCWs. It is emphasized that the HCWs should ensure proper use of PPE and adherence to IPC measures. The adequate supply of PPE is of utmost importance to protect the HCWs from COVID-19 infection.

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## REFERENCES:

1. Zhu H, Wei L, Niu P. The novel coronavirus outbreak in Wuhan, China. *Global health research and policy*. 2020 Mar;5(6):1-3. [DOI]
2. World Health Organization. Coronavirus disease 2019 (COVID-19): situation report, 82 [online]. 11 April 2020 [cited 28 June 2020]; Available from: <https://reliefweb.int/report/world/coronavirus-disease-2019-covid-19-situation-report-82-11-april-2020>
3. Dzinamarira T, Mhango M, Dzobo M, Ngaro B, Chitungo I, Makanda P, et al. Risk factors for COVID-19 among healthcare workers. A protocol for a systematic review and meta-analysis. *Plos one*. 2021 May 4;16(5):1-16. [DOI]
4. IDSA Contributor. China discloses 1,716 healthcare workers with COVID-19 [online]. 14 Feb 2020 [cited 13 June 2020]; Available from: <https://sciencespeaksblog.org/2020/02/14/china-discloses-1716-healthcare-workers-with-covid-19-feb-14-2020/>
5. International Council of Nurses. ICN calls for data on healthcare worker infection rates [online]. 6 May 2020 [cited 28 June 2020]; Available from: <https://www.icn.ch/news/icn-calls-data-healthcare-worker-infection-rates-and-deaths>
6. Coronavirus latest: WHO says health workers account for 10% of global infections [online]. 17 July 2020 [cited 18 July 2020]; Available form: <https://www.dw.com/en/coronavirus-latest-who-says-health-workers-account-for-10-of-global-infections/a-54208221>
7. Mahajan NN, Mathe A, Patokar GA, Bahirat S, Lokhande PD, Rakh V, et al. Prevalence and clinical presentation of COVID-19 among healthcare workers at a dedicated hospital in India. *J Assoc Physicians India*. 2020 Dec;68(12):16-21. [PMID]
8. Poudel A. 91 health workers across the country have been infected with coronavirus so far. *The Kathmandu Post* [online]. 3 July, 2020 [cited 4 July 2020]; Available form: <https://kathmandupost.com/health/2020/07/03/91-health-workers-across-the-country-have-been-infected-with-coronavirus-so-far>
9. Poudel A. As Covid-19 affects healthcare workers, non-Covid patients left in limbo. *The Kathmandu Post* [online]. 3 September, 2020 [cited 8 September 2020]; Available form: <https://kathmandupost.com/health/2020/09/03/as-covid-19-affects-healthcare-workers-non-covid-patients-left-in-limbo>
10. The Himalayan Times. 14 health workers infected with coronavirus so far [online]. 10 June, 2020 [cited 29 June 2020]; Available form: <https://thehimalayantimes.com/nepal/14-health-workers-infected-with-coronavirus-so-far>
11. World Health Organization. Coronavirus disease (COVID-19) outbreak: rights, roles and responsibilities of health workers, including key considerations for occupational safety and health: interim guidance [online].

- 19 March 2020 [cited 2 June 2020]; Available form:<https://apps.who.int/iris/handle/10665/331510>
12. Ran L, Chen X, Wang Y, Wu W, Zhang L, Tan Xl. Risk factors of healthcare workers with corona virus disease 2019: A retrospective cohort study in a designated hospital of Wuhan in China. *Clin Infect Dis*. 2020 Mar 19;71(16):2218-22. [DOI]
  13. World Health Organization. Infection prevention and control during health care when COVID-19 is suspected: interim guidance [online]. 19 March 2020 [cited 30 June 2020]; Available form:<https://www.who.int/publications/i/item/10665-331495>
  14. Lai J, Ma S, Wang Y, Cai Z, Hu J, Wei N, et al. Factors associated with mental health outcomes among health care workers exposed to coronavirus disease 2019. *JAMA Netw Open*. 2020 Mar 2;3(3):e203976. [DOI]
  15. Hussen H, Alemu ZA. Risk of covid-19 infection and associated factors among healthcare workers: A cross-sectional study at EkaKotebe Treatment Center in Ethiopia. *International Journal of General Medicine*. 2021;14:1763. [DOI]
  16. World Health Organization. Health workers exposure risk assessment and management in the context of COVID-19 virus: interim guidance [online]. 4 March 2020 [cited 15 June 2020]; Available from: <https://apps.who.int/iris/handle/10665/331340>
  17. Nguyen LH, Drew DA, Graham MS, Joshi AD, Guo C, Ma W, et al. Risk of COVID19 among frontline healthcare workers and the general community: a prospective cohort study. *Lancet Public Health*. 2020 Sep;5(9):475-483. [DOI]
  18. Ashinyo ME, Dubik SD, Duti V, Amegah KE, Ashinyo A, Larsen-Reindorf R, et al. Healthcare workers exposure risk assessment: a survey among front-line workers in designated COVID-19 Treatment Centers in Ghana. *Journal of primary care & community health*. 2020 Nov;11:2150132720969483. [DOI]
  19. Heinzerling A, Stuckey PM, Scheuer T, Xu K, Perkins KM, Resseger H, et al. Transmission of COVID-19 to health care personnel during exposures to a hospitalized patient—Solano County, California, February 2020. *Morbidity and Mortality Weekly Report*. 2020 Apr 17;69(15):472. [DOI]
  20. Khalil MM, Alam MM, Arefin MK, Chowdhury MR, Huq MR, Chowdhury JA, et al. Role of personal protective measures in prevention of COVID-19 spread among physicians in Bangladesh: a multicenter cross-sectional comparative study. *SN comprehensive clinical medicine*. 2020 Oct;2(10):1733-9. [DOI]
  21. Iversen K, Bundgaard H, Hasselbalch RB, Kristensen JH, Nielsen PB, Pries-Heje M, et al. Risk of COVID-19 in health-care workers in Denmark: an observational cohort study. *The Lancet Infectious Diseases*. 2020 Dec 1;20(12):1401-8. [DOI]
  22. Jain U. Risk of COVID-19 due to shortage of personal protective equipment. *Cureus*. 2020 Jun;12(6). [DOI]