

PERCEPTION OF RISK OF EXPOSURE TO SARS-COV-2 (COVID-19) IN DIFFERENT SECTORS OF HEALTHCARE WORKERS: A CORRELATIONAL STUDY

Ahmed Tanveer, Rumeesha Zaheer*, Amal Farooq*, Maheen Khan**, Abdullah Jan*, Shireen Zaheer Awan***

Combined Military Hospital Lahore/National University of Medical Sciences (NUMS) Pakistan, *Armed Forces Institute of Dentistry/National University of Medical Sciences (NUMS) Rawalpindi Pakistan, **Khyber College of Dentistry, Peshawar Pakistan, ***Morrison Hospital, Swansea, United Kingdom

ABSTRACT

Objective: To compare the risk level of COVID-19 among different health care workers.

Study Design: Cross-sectional study.

Place and Duration of Study: The research was approved by the Ethics Committee, Armed Forces Institute of Dentistry, Combined Military Hospital, Rawalpindi (IRB form no.905/Trg-ABP 1K2). Study was carried out amongst health care workers of Pakistan, from 19th April 2020 to 7th June, 2020

Methodology: An online questionnaire was made on Google Forms Inc. and was distributed online as well as by hand amongst health care workers of Pakistan. The form was filled by 120 (57.1%) doctors and 36.2% dentists (n=76). A sample size of 210 was finalized. The responses were entered in and analyzed using SPSS version 23. Chi-square test was applied to test the relationship between risk level and different sectors of healthcare workers.

Results: Out of 210 responders, 130 were males (61.9%) and 80 were females (38%). According to our study, 64 (84.2%) dentists perceived themselves to be at the highest risk especially those involved in scaling procedures, while only 40% (n=48) doctors considered themselves to be at high risk. Amongst doctors, 61% of house officers (n=22 out of 36) perceived themselves to be at the greatest risk of exposure. 1-5 years of experience category perceived themselves to be at a very high risk (56.9%, n=78). Chi-square test was applied and *p*-value <0.05 was significant.

Conclusion: It was concluded that dentists, house officers and young doctors with experience of 1-5 years believed themselves to be at the highest risk. Hence, sustainable measures should be undertaken to protect the health care workers are needed.

Keywords: COVID-19, Health care workers, Risk assessment.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

As with the rest of the world, Pakistan has not been spared by SARS-Cov-2 (COVID-19). With healthcare professionals standing on the frontlines in the face of this pandemic, they are particularly vulnerable to this infection. The virus responsible for this disease, SARS-CoV-2 (Severe Acute Respiratory Distress Syndrome Coronavirus 2), is a positive-sense single-stranded RNA virus and is believed to have zoonotic origin. It was assumed to have first arisen from bat-to-human transmission at Huanan Seafood Whole-sale Market in Wuhan, China, in December 2019¹. The WHO declared the outbreak as a Public Health

Emergency of International Concern on 30th January 2020².

SARS-CoV-2 is among the seven of the coronaviruses known to have infected humans which also includes the original SARS-CoV and MERS-CoV (Middle East Respiratory Syndrome related Coronavirus)³. The latter two viruses have been implicated in the coronavirus outbreaks of 2003 and 2012 respectively, of which MERS-CoV is also believed to have zoonotic origin, having first arisen from camel-to-human transmission^{4,5}. While both SARS-CoV and SARS-Cov-2 are beta-coronaviruses of B lineage, MERS-CoV is of C lineage⁶. The difference between SARS-CoV and SARS-CoV-2 is that the latter incorporates a polybasic cleavage site in its structure which renders it more pathogenic and transmissible⁷.

Correspondence: Dr Rumeesha Zaheer, Department of Dentistry, Armed Forces Institute of Dentistry, Rawalpindi Pakistan

Received: 15 Jun 2020; revised received: 03 Jul 2020; accepted: 09 Jul 2020

A cluster of unexplained pneumonia cases first arose in Wuhan, China in December 2019, which was later identified as SARS-COV-2 and the human-to-human transmission of the virus was confirmed in January 2020^{8,9}. This human transmission led to the spread of the virus beyond China on a global scale. Later, it was declared a global pandemic on 11th March 2020 by the World Health Organization². In Pakistan, the first case was identified on 26th February 2020 and by 18th March 2020, all provinces, the two autonomous states and Federal territory of Islamabad had been exposed to the pandemic¹⁰. This resulted in declaration of a nation-wide lockdown on 1st April 2020, which lasted till 9th May 2020.

The infection is contagious, primarily spreading by inhalation of droplets produced by infected individuals through coughing, sneezing or talking. It may also spread through contact with a contaminated surface and then touching one's nose, mouth or eyes with the contaminated hands. The incubation period of the virus is typically 4 to 5 days, though is found to occasionally extend to up to 14 days. Aside from the more common symptoms of fever, dry cough and myalgia, the more serious complications include pneumonia, acute respiratory distress syndrome and death¹¹. Infected individuals may be asymptomatic as well.

Unsurprisingly with this mode of transmission, healthcare workers account for a great percentage of population at risk of exposure to this infection. This risk is directly associated with the direct contact that healthcare workers have with patients infected with COVID-19. These healthcare professionals incorporate a range of workers including doctors, dentists, nurses, assisting staff, interns etc. Inadequate personal protection of these workers coupled with long term exposure to the viruses in their workplace settings pose a great hazard to their health¹². Implementation of proper infection control, availability of Personal Protective Equipment (PPE) and the work intensity are amongst the varying factors

that affect the risk of exposure to this infection amongst healthcare workers¹².

This study attempts to assess the risks of COVID-19 infection among a diverse range of healthcare workers. A questionnaire-based survey was used to glean information about the level of awareness among healthcare workers regarding personal protection and the level of exposure they face in their workplace settings. This was in the interest of determining which sector of healthcare is most at risk of infection.

METHODOLOGY

A cross-sectional study was performed to quantify the perception of risk of exposure associated with COVID-19 among different sectors of healthcare workers in order to correlate this risk level. This was done making use of a study carried out among different healthcare workers in different cities of Pakistan between the period of 19th April to 7th June 2020. The research was approved by the Ethics Committee, Armed Forces Institute of Dentistry, Combined Military Hospital, Rawalpindi (IRB form no.905/Trg-ABP 1K2). The study was prepared using Google Forms Inc. It was uploaded on social media formats such as WhatsApp, Facebook, Instagram etc. and was also delivered by hand and emailed to numerous healthcare workers. No patient consent form was required as the participants were limited to healthcare professionals only and no patients were involved. All participation was voluntary and anonymous. WHO calculator was used to finalize the sample size. With margin of error of 5%, confidence interval of 90%, estimated population size of 1500 and response distribution of 50%, a sample size of 230 was calculated. The questionnaire was sent to an estimated 500 individuals and upon reaching 230 responses, the questionnaire was closed. However, 20 responses had to be discarded because of incorrectly filled responses and 210 completed and correct surveys were selected for our sample. Our criteria for participation in the research included being a healthcare worker such as doctors, dental surgeons, nurses, medical students, dental students,

medical assistants, dental assistants and pharmacists.

Consecutive sampling technique was used for data collection. The first section of the survey consisted of general socio-demographic questions. The second section of the survey comprised of questions that were targeted towards the participants' profession. Here, the individuals were queried about the level of risk of exposure to COVID-19 associated with their field. They were also questioned about the various procedures

performed. Chi-square test was applied to correlate the level of risk between different sectors of healthcare workers.

RESULTS

A total of 210 completed survey were recorded, of which 130 males (61.9%) and 80 females (38%) participated (table-I). Our participants were grouped on the basis of their age into the following categories [1] <25 years (31.9%, n=67) [2] 25-35 years 85 (40.5%) [3] >35 years 58 (27.6) (table-I). Dentists were further categorized into the following specialties (1) general dentistry, (2) oral and maxillofacial surgery, (3) prosthodontics, (4) periodontology, (5) operative dentistry, and (6) orthodontics. Meanwhile, doctors were categorized into the following specialties (1) house officers (2) general physicians (3) medicine (4) surgery, and (6) pathology. Most of the

Table-I: Distribution on the basis of gender and age.

Gender	Age n (%)		
	<25 Years	25-35 Years	>35 Years
Males	28 (21.5)	48 (36.9)	54 (41.5)
Females	39 (48.8)	37 (46.3)	4 (5)
Total	67 (31.9)	85 (40.5)	58 (27.6)

Table-II: Cross-tabulation between HCWs and risk of exposure to COVID-19.

Category	Perception of Risk n (%)					p-value
	Very High Risk	High Risk	Average Risk	Minimal Risk	Total	
Dentists	64 (84.2)	11 (14.5)	0 (0)	1 (1.3)	76 (100)	1.976E-8
Doctors	48 (40)	45 (37.5)	21 (17.5)	6 (5)	120 (100)	
Nurse	1 (100)	-	-	-	1 (100)	
Medical Assistant	3 (60)	1 (20)	1 (20)	-	5 (100)	
Dental Assistants	1 (50)	1 (50)	-	-	2(100)	
Medical Students	-	4 (100)	-	-	4 (100)	
Dental Students	1 (100)	-	-	-	1 (100)	
Pharmacists	-	-	-	1 (3.8)	1 (100)	

Table-III: Cross-tabulation between years of experience and risk of exposure to COVID-19.

Years of Experience	Perception of Risk n (%)				p-value
	Very High Risk	High Risk	Average Risk	Minimal Risk	
1-5 years	78 (56.9)	42 (30.7)	13 (9.5)	4 (2.9)	0.040
5-10 years	15 (75)	4 (20)	1 (5)	-	
10-20 years	9 (69.2)	4 (30.8)	-	-	
20-30 years	8 (44.4)	5 (27.8)	2 (11.1)	3 (16.7)	
>30 years	8 (36.4)	7 (31.8)	6 (27.3)	1 (4.5)	

that increased the risk of exposure to this disease.

The final responses were imported and analyzed on SPSS-23. Subgroups were classified on the basis of profession (doctors, dentists, nurses, dental assistants, medical assistants, medical students, dental students and pharmacists). Further subgroups were made with regards to specialty and years of experience among the partici-

healthcare workers belonged from Punjab 128 (61%), followed by Federal Territory 32 (15%). Of 210 healthcare workers, doctors comprised 120 (57.1%) of the responders whereas dentists made up 76 (36.2%) of the total.

In our questionnaire, different healthcare workers were asked about the level of risk of exposure to COVID-19, in accordance to them, in

their respective fields. According to this, 84.2% dentists (n=64) perceived themselves to be at the highest risk, while only 40% doctors (n=48) considered themselves to be at high risk. Chi square

Dentists were further asked to state the elective dental procedures that have a greater risk of exposure to COVID-19 and 35.4% participants (n=64) stated that scaling has the greatest risk while both major and minor surgical procedures 28 (15.5%) as well as root canal therapy (RCT) procedures 29 (16%) were also considered to have a greater risk of exposure (fig-1). When asked, 39.4% dentists stated that elective dental procedures should be delayed till the situation subsides (n=30 out of 76).

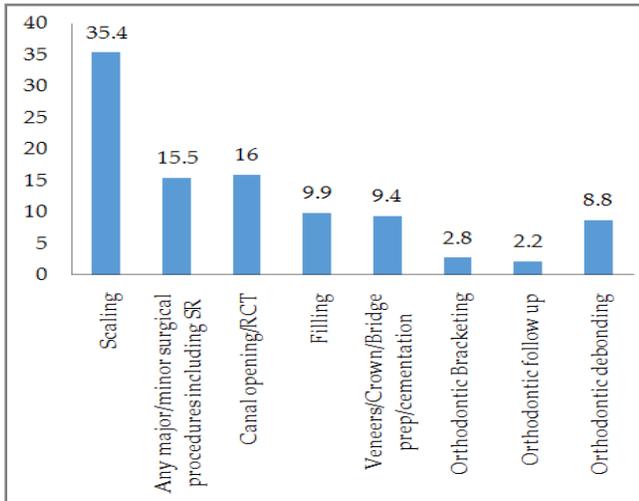


Figure-1: Risk of Exposure associated with different elective dental procedures.

Table-III cross-tabulates the years of experience of the participants with the level of risk. The table shows that participants in the 1-5 years of experience category perceived themselves to be at a very high risk (n=78, 56.9%). This indicates that the young doctors consider themselves to be at a greater risk, as they are in direct contact with COVID-19 patients. Chi-square test was applied and *p*-value <0.05 (*p*=0.040) was considered to be significant.

test was applied and *p*-value of <0.05 (*p*=1.976 E-8) was significant (see table-II). Amongst dentists who stated that they were at very high risk, 45.3% (n=29 out of 64) comprised of general dentists.

When asked whether they had been exposed to any COVID-19 patient without any protective gear, 21.9% percent stated yes (n=46) while 78.1%

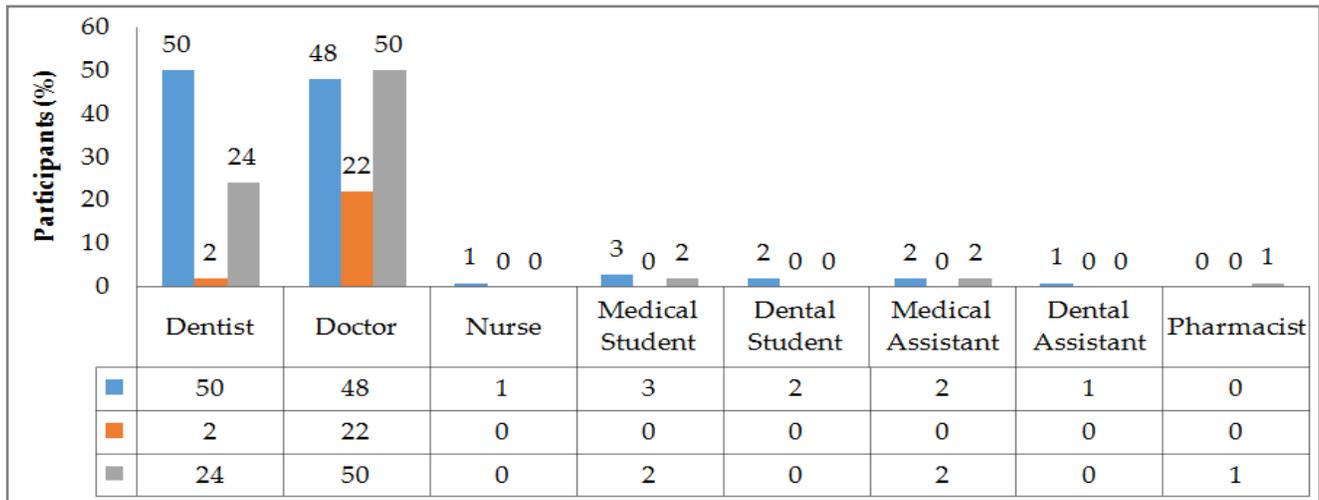


Figure-2: Distribution of participants on the basis of exposure to COVID-19 patient with/without protective gear.

Amongst doctors, house officers perceived themselves to be at a greater risk of exposure (61%, n=22 out of 36) while 44.4% general physicians were at a relatively high risk (n=20 out of 45).

stated no (n=164). The participants were also asked whether quarantine is necessary after every exposure to a positive COVID-19 patient and the results are compiled in fig-2.

DISCUSSION

The onslaught of the COVID-19 pandemic has been nothing short of devastating for the world. SARS-CoV-2, the viral agent responsible for this disease, that was first detected among the infected residents of Wuhan, China, has now branched its reach worldwide to disastrous results. The infected cases and the death toll see an increase every day and Pakistan is no exception. Our healthcare community is placed right at the frontlines of dealing with this disease, at great personal risk to themselves. This burden is by no means easy for healthcare workers, many of whom have succumbed to the peril they are daily exposed to. During the early stages of the spread of coronavirus, in an analysis of 138 COVID-19 hospitalized patients, 57 (41%) had been infected in the hospital of which 40 (29%) were healthcare workers¹³.

The virus has a predominantly respiratory transmission through aerosol and droplets, importance of infection control is therefore crucial in limiting the effects of virus diffusion¹⁴. According to our study, dentists perceived themselves at a greater risk with about 62 dentists (84.2%) stating that they were at a very high risk of exposure and p -value <0.05 was significant. The major reason for this can be the large number of droplets and aerosols that are generated with each dental procedure and standard protective equipment is not sufficient to protect from such an increased level of exposure. According to the guidelines presented by CDC in March 2020, it was recommended that only urgent and emergency dental visits should be allowed while all elective visits and procedures must be avoided to protect staff and to preserve the protective personal equipment. However since then, as the pandemic has continued to evolve, CDC has recommended the start of non-emergency dental treatment within certain guideline¹⁵. Even so, aerosol generating dental procedures must be avoided at all cost. If necessary, dental dams and high evacuation suctions should be used¹⁵. All procedures must be performed with full personal protective equipment and clinics should be disinfected after every

patient. A study showed that healthcare workers who performed aerosol generating procedures wearing surgical masks or N-95 masks did not acquire the infection, therefore it was recommended that all healthcare workers must wear N-95 masks before performing an aerosol-generating procedure¹⁶.

Moreover, this production of aerosol facilitates the contamination of the environment and instruments, dental apparatuses, and surfaces¹⁷. Contact with these infected surfaces will raise the same concern of transmission of virus. Therefore, CDC and WHO recommends that surface decontamination should be performed after every patient. Even, the oral mucosa and saliva have been identified as a potentially high-risk routes of SARS-CoV-2 infection^{18,19}. In our study, among dentists, scaling was considered as the elective dental procedure with the greatest risk of exposure to COVID-19 followed by canal opening/RCT. An ultrasonic scaler and handpiece used in scaling and RCT respectively, facilitates diffusion of aerosol particles of saliva, blood, and secretions and SARS-CoV-2 can be readily transmitted during these procedures where inhalation of aerosol/droplets from infected individuals can occur.

Our study indicated that HCWs with just 1-5 years of experience considered themselves at high risk of infection and p -value <0.05 was significant. Amongst doctors, house officers perceived themselves at the greatest risk with 61% stating as such. The explanation behind this perception is based upon the nature of a house officer's job. They are rotated in all the departments such as emergency departments, intensive care units and isolation wards. This results in greater risk of exposure to COVID-19 as greater number of patients are seen by this category. Lancet *et al*, states that most healthcare workers are more anxious about passing infection to their families, along with personal safety concerns. Many HCWs around the world have avoided visiting their family since the pandemic has started²⁰.

With the rising number of cases all around the world, there has been a severe shortage of medical supplies with protective gowns, hazmat suits, and N-95 masks being the most affected. This has resulted in healthcare workers placing themselves in the lion's den without any protective gear. Lack of face masks and protective gowns has severely risen the rate of infection²¹. Our study states that greater than 20% HCWs exposed themselves to a COVID-19 patient without any protective gear. Greater efforts are required to protect our healthcare workers, by increasing the supply of PPEs as HCWs are forced to rely on precautionary measures to combat this disease due to unavailability of vaccine therefore they have reasonable ground to fear being at high risk for the disease.

Exercising proper quarantine measures may help in delaying the spread of disease in a highly infectious area. According to WHO, a person should self-isolate himself for 14 days after testing positive for COVID-19. Additionally, any individual who has had contact with a COVID-19 patient within 1 meter, was providing direct care to a patient without any protective equipment, or stayed/travelled in the same close environment with a COVID-19 patient or any other situation should also quarantine for up to 2 weeks²². The participants in our study agreed that quarantine is not required for every healthcare personnel exposed to a COVID-19 patient, rather that decision is dependent on several other risk factors.

According to a recent estimate by World Health Organization (WHO), approximately 22,073 healthcare professionals have been found COVID-19 positive in 52 nations²² whereas Ali *et al*, stated in his study that HCWs are being infected with COVID-19 increasingly ranging from 15% to 18% while in some cases up to 20%²³. Another study revealed that essential workers (EWs) are mostly at risk of exposure to COVID-19 (0.2% EWs tested positive). Amongst EWs, 0.7% were doctors and pharmacists, 0.8% were nursing assistants while 0.7% were nurses²⁴. According to Occupational Safety and Health Administration (OSHA), healthcare delivery, healthcare support,

medical transport, and mortuary workers were at the highest risk of exposure to SARS-COV-2. This was further augmented by a research conducted by David Koh which stated that initially workers and visitors to the market were high-risk groups (55% of the 47 cases before 1st January 2020) but as cases increased, healthcare workers were then identified as the next high-risk group to acquire the infection. Out of the 138 patients in Wuhan hospital, 40% were healthcare workers, of which 31 (77.5%) worked on general wards, 7 (17.5%) in the emergency department, and 2 (5%) in the intensive care unit (ICU)²⁵.

Aside from the occupational hazards that dentists and doctors face, the dynamic nature of the COVID-19 outbreak is a huge threat to our healthcare workers. Management of patients in the midst of this pandemic requires setting up of proper guidelines specifically to minimize the risk of transmission of this deadly virus. Healthcare workers play an essential role in the community to combat this public health crisis and placing them in the forefront carelessly with little regard to their mental, physical and emotional toll would be catastrophic for the nation.

The findings of this study can help the government and health care sector to regulate and introduce better guidelines in order to protect the healthcare workers, who are currently at the frontlines of this pandemic.

CONCLUSION

With regards to dealing with the COVID-19 pandemic, healthcare workers are at the frontlines. Majority of the healthcare workers in Pakistan consider themselves to be at extremely high risk for this infection with dentists found to contribute to the greatest percentage of people who fear they are at highest risk with scaling considered as the highest risk elective dental procedure. Meanwhile, young doctors and house officers with experience of 1-5 years also perceived themselves to be at high risk. With the bulk of the healthcare worker community tilting towards this perception, it is important we begin

rapid development of sustainable measures to protect the health care workers.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

REFERENCES

- Zhou P, Yang XL, Wang XG, Hu B, Zhang L, Zhang W, et al. A pneumonia outbreak associated with a new corona virus of probable bat origin. *Nature* 2020; 579(7798): 270-73.
- World Health Organization. COVID-19 Public Health Emergency of International Concern (PHEIC) Global research and innovation forum 2020 [updated February 12th, 2020; cited 2020 July 7th]. Available from: [https://www.who.int/publications/m/item/covid-19-public-health-emergency-of-international-concern-\(pheic\)-global-research-and-innovation-forum](https://www.who.int/publications/m/item/covid-19-public-health-emergency-of-international-concern-(pheic)-global-research-and-innovation-forum).
- Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. *N Engl J Med* 2020; 382(8): 727-33.
- De Groot RJ, Baker SC, Baric RS, Brown CS, Drosten C, Enjuanes L, et al. Middle East respiratory syndrome coronavirus (MERS-CoV): announcement of the Coronavirus Study Group. *J Virol* 2013; 87(14): 7790-92.
- Cotten M, Watson SJ, Kellam P, Al-Rabeeh AA, Makhdoom HQ, Assiri A, et al. Transmission and evolution of the Middle East respiratory syndrome coronavirus in Saudi Arabia: a descriptive genomic study. *Lancet* 2013; 382(9909): 1993-02.
- Memish ZA, Zumla AI, Al-Hakeem RF, Al-Rabeeh AA, Stephens GM. Family cluster of Middle East respiratory syndrome coronavirus infections. *N Engl J Med* 2013; 368(26): 2487-94.
- Coutard B, Valle C, de Lamballerie X, Canard B, Seidah NG, Decroly E. The spike glycoprotein of the new coronavirus 2019-nCoV contains a furin-like cleavage site absent in CoV of the same clade. *Antiviral Res* 2020; 176(1): 104742-46.
- Chan JF, Yuan S, Kok KH, To KK, Chu H, Yang J, et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *Lancet* 2020; 395(10223): 514-23.
- Hui DS, E IA, Madani TA, Ntoumi F, Kock R, Dar O, et al. The continuing 2019-nCoV epidemic threat of novel coronaviruses to global health - The latest 2019 novel coronavirus outbreak in Wuhan, China. *Int J Infect Dis* [Internet]. 2020 [cited 2020 July 02]; 91:[264-6 pp.]. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7128332/pdf/main.pdf> <https://pubmed.ncbi.nlm.nih.gov/pubmed/31953166>.
- Government of Pakistan. Pakistan cases details 2020 [cited 2020 July 1st]. Available from: <http://covid.gov.pk/stats/pakistan>.
- Chavez S, Long B, Koyfman A, Liang SY. Coronavirus Disease (COVID-19): A primer for emergency physicians. *Am J Emerg Med* [Internet]. 2020 [cited 2020 July 02]. Available from: [https://www.ajemjournal.com/article/S0735-6757\(20\)30178-9/fulltext](https://www.ajemjournal.com/article/S0735-6757(20)30178-9/fulltext).
- Wang J, Liu F, Tan JBX, Harbarth S, Pittet D, Zingg W. Implementation of infection prevention and control in acute care hospitals in Mainland China - a systematic review. *Antimicrob Resist Infect Control* 2019; 8(1): 32-35.
- Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. *JAMA* 2020; 323(11): 1061-69.
- Izzetti R, Nisi M, Gabriele M, Graziani F. COVID-19 Transmission in Dental Practice: Brief Review of Preventive Measures in Italy. *J Dent Res* 2020 [cited 2020 July 02]:[0022034520920580 p.]. Available from: <https://journals.sagepub.com/doi/pdf/10.1177/0022034520920580>.
- Centres of Disease Control and Prevention. Interim infection prevention and control guidance for dental settings during the COVID-19 response 2020 [updated May 3, 2020; cited 2020 June 11]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/dental-settings.html>.
- Ng K, Poon BH, Kiat Puar TH, Shan Quah JL, Loh WJ, Wong YJ, et al. COVID-19 and the Risk to Health Care Workers: A Case Report. *Ann Intern Med* 2020; 172(11): 766-67.
- Peng X, Xu X, Li Y, Cheng L, Zhou X, Ren B. Transmission routes of 2019-nCoV and controls in dental practice. *Int J Oral Sci* 2020; 12(1): 09-12.
- Xu H, Zhong L, Deng J, Peng J, Dan H, Zeng X, et al. High expression of ACE2 receptor of 2019-nCoV on the epithelial cells of oral mucosa. *Int J Oral Sci* 2020; 12(1): 08-14.
- Kampf G, Todt D, Pfaender S, Steinmann E. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *J Hosp Infect* 2020; 104(3): 246-51.
- The Lancet. COVID-19: protecting health-care workers. *Lancet* 2020; 395(10228): 922-28.
- Ranney ML, Griffith V, Jha AK. Critical Supply Shortages -The Need for Ventilators and Personal Protective Equipment during the Covid-19 Pandemic. *N Engl J Med* 2020; 382(18): e41-45.
- World Health Organization. Considerations for quarantine of individuals in the context of containment for coronavirus disease (COVID-19) 2020 [updated 19 March 2020; cited 2020 15 June]. Available from: [https://www.who.int/publications/i/item/considerations-for-quarantine-of-individuals-in-the-context-of-containment-for-coronavirus-disease-\(covid-19\)](https://www.who.int/publications/i/item/considerations-for-quarantine-of-individuals-in-the-context-of-containment-for-coronavirus-disease-(covid-19)).
- Ali S, Noreen S, Farooq I, Bugshan A, Vohra F. Risk Assessment of Healthcare Workers at the Frontline against COVID-19. *Pak J Med Sci* 2020; 36(COVID19-S4): S99-S103.
- Thomas L. Occupational risk for COVID-19: Medical News; [updated May 25, 2020; cited 2020 July 1st]. Available from: <https://www.news-medical.net/news/20200525/Occupational-risk-for-COVID-19.aspx>.
- Koh D. Occupational risks for COVID-19 infection. *Occup Med Lond* 2020; 70(1): 03-05.