Epidemiology of SARS-CoV-2 with Implications of Reinfection Update After 01 Year of Ongoing Pandemic: Cross Sectional Study From Tertiary Care Hospital From Southern Region of Pakistan

Abeera Ahmed, Fatima Sana, M. Yasir, Hamid Jamal*, Shagufta Yousaf, Aysha Khan

Karachi Institute of Medical Sciences, Karachi/National University of Medical Sciences (NUMS) Pakistan, *Combined Military Hospital Malir/National University of Medical Sciences (NUMS) Pakistan

ABSTRACT

Objective: To share the epidemiological, clinical and laboratory -based evidence of severe acute respiratory syndrome Corona Virus-2 with focus on the cases of re-infection; an update after one year of the ongoing pandemic.

Study Design: Prospective observational study.

Place and Duration of Study: Department of Pathology, in collaboration with Department of Medicine, Combined Military Hospital, Malir, from Mar 2020 to Feb 2021.

Methodology: Total 5190 nasopharyngeal swabs were collected and transported to the laboratory in viral transport media for severe acute respiratory syndrome Corona Virus-2, from all symptomatic patients with a history of exposure/traveling from endemic areas and those requiring admission in hospital and were screened for COVID-19 as per hospital standing protocols.

Results: 561(10.8%) patients were PCR positive for severe acute respiratory syndrome Corona Virus-2. The mean age of patients was 39.45±31.9 years and a majority of patients were males 426 (76%). The most common symptoms were fever and dry cough followed by myalgia and shortness of breath. 37 (9%) patients died due to the severity of the illness. Total 6 (1.46%) cases of laboratory-confirmed reinfection of severe acute respiratory syndrome Corona Virus-2 were reported. 2(33%) cases of reinfection were observed in health care workers, mortality was seen in a single patient associated with old age and comorbidities.

Conclusion: In our study, the severity of the disease was directly related to the age of patients and underlying comorbidities. Reinfection was associated with increased viral load and exposure to the infected environment.

Keywords: Coronavirus disease 2019 (COVID-19), Polymerase chain reaction (PCR), Re infection, Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

How to Cite This Article: *Ahmed A, Sana F, Yasir M, Jamal H, Yousaf H, Khan A. Epidemiology of Sars-Cov-2 with Implications of Reinfection Update After 01 Year of Ongoing Pandemic: Cross Sectional Study from Tertiary Care Hospital from Southern Region of Pakistan. Pak Armed Forces Med J 2022; 72(1): 91-96 Doi: https://doi.org/10.51253/pafmj.v72i1.7060*

INTRODUCTION

In December 2019, SARS-CoV-2 outbreak started as a respiratory illness of unknown origin in Wuhan.[1] The World Health Organization (WHO) declared this outbreak as the sixth public health emergency of international concern (PHEIC) on January 30, 2020 and on March 11, 2020, SARS-CoV-2 infection was recognized as a global pandemic crisis with increased mortality.[2] On February 26, 2020, the first established case of COVID-19 disease was reported from Karachi,[3] afterwards, rapid viral transmissibility was observed in various parts of Pakistan and became an epidemic in the country.[4] According to the latest update on Oct 28, 2021 - 07:31 am Islamabad, confirmed-COVID-19 cases were 1,271,027 with 28,414 deaths reported so far.[5]

The COVID-19 disease pathogen (SARS-CoV-2) continues to spread in various parts of the world.[6,7] However, essential aspects, including the epidemiology of the virus along its clinical spectrum and laboratory diagnosis, were not known much.8 Moreover, Corona viruses, including SARS-CoV-2, can mutate and thus increasing the chances of reinfection.[9,10] This study systematically summarized the findings on the natural history, clinical features, transmission pattern and related risk factors of COVID-19 disease along with different laboratory parameters and reinfection cases observed in our hospital, serving as a major tertiary care hospital of Karachi, Pakistan.

METHODOLOGY

This prospective observational study was conducted at the Department of Pathology in collaboration with Department of Medicine, in a Tertiary Care Hospital Karachi Pakistan, from March 2020 to February 2021 after getting approval from Hospital Ethical Committee (IRB no. 16/TRG/ADM). The informed

Correspondence: Dr Abeera Ahmed, Department of Pathology, Combined Military Hospital, Malir Cantt, Karachi Pakistan

Received: 10 Jul 2021; revision received: 23 Oct 2021; accepted: 29 Oct 2021

consent was taken from the patients or families. During ongoing pandemic as per hospital standing order procedure (SOP), all the patients requiring admission in hospital were taken as suspected case of COVID-19 by undergoing RT-PCR testing for SARS- CoV-2.

Inclusion Criteria: Laboratory confirmed COVID-19 disease cases were included in study along with those asymptomatic individuals who were contacts of confirmed COVID-19 diseased patients and were tested PCR positive. Contacts of COVID positive cases were called telephonically and their samples were collected.

Exclusion Criteria: COVID-19 PCR negative patients were excluded from the study irrespective of their sign and symptoms.

Confidentiality of the patients was maintained by using coding system. Sample size was calculated using World Health Organization (WHO) calculator keeping prevalence of COVID-19 disease at 7.9%.[11]

Nasopharyngeal swabs were collected in viral transport media (VTM) and transported to the microbiology laboratory to process theSARS-CoV-2RT-PCR. If samples were not processed upon arrival, they were stored for 6 hours at 18-25◦C and for 24 hours at 2-7◦C. SARS-COV-2-R-GENE® Real-time detection kit were used for the qualitative detection of virus RNA.[12] The nucleic acid extraction and the amplification process were carried as per manufacturer protocol. This assay targets both N-gene and RdRp genes, unique to SARS-COV-2. Generally, the cycle threshold value (Ct-value) ≤34 was categorized as the positive test result. The negative test reslut was considered on ≥ 34 Ct-value and clinical correlation of the disease.[13] Those patients with a strong history and positive clinical findings with even high Ct value were reported as positive. Other laboratory parameters include complete blood picture (CBC), coagulation profile (PT, APTT and D-Dimers), liver function test (LFT), renal function test (RFT) and infectivity markers (C-reactive protein [CRP], serum ferritin and serum lactate dehydrogenase [LDH] were collected in EDTA anti-coagulated tube and Vacctue-TM gel tubes respectively. The samples were processed as per standard laboratory protocol in their respective automated hematology and chemistry analyzers. The latex agglutination method detected D-dimers with a cut-off value of 200 ng/ml.

Clinical outcomes of the patients were followed till March 3rd, 2021. PCR was repeated after one week once the patient became asymptomatic. Asymptomatic patients with negative nasopharyngeal swabs, collected 24 hours apart were considered recovered. Data was recorded once RT-PCR was performed. The time duration of viral shedding after initial positive PCR was also recorded (total days till PCR remained positive). Additionally, in patients with reinfection, total COVID antibodies (Abs) were performed by Electro Chemiluminescence (ECLIA) method on Cobas e-411 against nucleocapsid protein (N) along with confirmation by another diagnostic kit of KHB®RT- PCR which detected ORF ab1 region, N, and E gene.

Statistical Package for Social Sciences (SPSS) version 25 was used for the data analysis. Qualitative variables like epidemiological details, clinical characteristics, and comorbidities were presented as frequency and percentages. The quantitative variables like age and length of hospital stay were presented as mean and standard deviation. Chi-square test was applied to find out the association. The *p*-value of ≤0.05 was considered statistically significant.

RESULTS

A total of 5190 SARS-CoV-2 RT PCR tests were performed. Out of which, 561 (10.8%) tests turned out to be positive, while 4,629 (89.2%) tests were found negative. The mean age of patients was 39.45 ± 31.9 years. There were 445 (79%) were males and 118 (21%) were female patients. Depending upon the severity of disease among PCR-positive patients, 151 (27%) patients were isolated at home as they were either asymptomatic 117 (21%) or 34 (7%) patients had mild symptoms. At the same time, 410 (92.34%) patients with moderate to critical disease based on their dyspnea status and radiological findings, required hospital care. Our study population was mainly non-medical staff 517 (92%) and medical staff 44 (8%). Only 2 (4.5%) patients contracted the COVID-19 while working as first-line responders among the medical staff. The rest, of the cases 42 (95.5%), were associated with the history of traveling or contact with their COVID-19 positive family members (Table-I). Only eight HCW developed the moderate disease and required hospital care, while the rest of 36 HCW had mild disease and were quarantined at home. None of our HCW was placed on ventilator support or required continuous oxygen inhalation and showed smooth recovery.

On routine screening, there were only 4 (0.96%) pregnant females found to be SARS-CoV-2 PCR positive who reported for Cesarean section/spontaneous vaginal delivery (SVD) but remained asymptomatic throughout her PCR positivity period. Of these four deliveries, the positive PCR test was noted in two neonates only. About 7 (1.24%) patients admitted for other

surgical procedures were found to be SARS- COV-2 PCR positive. The majority of them 298 (53%), had a positive history of traveling to COVID-19 disease-endemic areas, followed by 139 (24.8%) patients who had known exposure to COVID-19 confirmed cases. While 113 (20%) patients had no history of exposure or traveling. The time duration of positive PCR after initial positive PCR varied between 8 days to 52 days with an average of 13 ± 5 days (Table-I).

Table-I: Demographic data and clinical details of SARS-COV- 2 PCR tested study populaction (n=5190).

Study parameters	n (%)
Total PCR Performed	5190
Gender Distribution	
Male	4148 (80%)
Female	1042 (20%)
Total PCR positive	561 (10.8%)
Gender Distribution	
Male	445 (79%)
Female	118 (21%)
Mean age	39.45 ± 31.9
Occupational History	
Non-medical staff	517 (92%)
Medical staff	44 (8%)
Paramedics	34 (77.3%)
Doctors	10 (22.7%)
Healthcare associated	2 (4.5%)
PCR Positive After Exposure to COVID 19 patients	
Travel to endemic areas	139 (24.8%)
Initial symptom	298 (53%)
Viral shedding	Mean=7 ± 2 days
On Routine Screening	
Before surgery	7 (4 (0.96%)
Before cesarean/SVD	(1.24%)
Clinical Presentation	
Asymptomatic Patients	117 (21%)
Symptomatic Patients	444 (79%)
Mild disease	34 (7.66%)
Moderate to Critical disease	410 (92.34%)
Management	
Home isolation	151 (27%)
Hospital requirement	410 (73%)

Among 410 admitted patients, 301 (73.4%) presented with moderate disease and were treated in the isolation ward, while 59 (14.4%) patients were categorized in the severe disease category and 50 (12.2%) with very severe /critical disease. They were managed in a high dependency unit (HDU) and Intensive care unit (ICU), respectively. Fifty ICU patients admitted with ≥50% bilateral lung involvement on chest imaging were critical. Amongst them, 13 (26%) patients required ventilators, while the remaining 37 (74%) patients were on continuous high flow nasal prong oxygen inhalation to maintain their oxygen saturation (SaO2 at least 94%). Out of 59 patients in HDU, 27 (45.7%) patients were also placed on oxygen support at some point whenever their SaO2 dropped below 94% on room air (Table-II).

Table-II: Details of Hospitalized patients with COVID-19 disease (n=410).

	n	%
Gender Distribution		
Male (M)	331	81%
Female (F)	79	19%
Age Group Distribution		
0-20 years	17	4.14%
21-39 years	125	30.48%
40-59 years	206	50.24%
60-89 years	62	15.15%
Mean age (year)	39.37 ± 31.9	
Comorbid Conditions		
Single Comorbidities *(HTN, COPD, Asthma, IHD, DCM, Pul TB)	134	32.7%
More than one comorbidities	97	23.65%
No Comorbidities	179	43.65%
On Respiratory support n= 159 (38.78%)		
Intermittent Oxygen support (HDU)	27/59	45.76% (6.6% in 410 patients)
High flow oxygen support (continuous)/ICU	37/50	74% (9% in 410 patients)
Ventilators support (ICU)	13/50	26% (3.2% in 410 patients)
Total Hospital Stay		
Minimum days (2-14days)	289	70.5%
Maximum days (15-35days)	121	29.5%
Patients Outcome		
Total Discharged (home isolation)	214	52.2%
Total Recovered	99	24.14%
Under treatment/ monitoring	54	13.2%
Reinfection cases	6	1.46%
Total Deaths	37	9%

*II*Hypertension(HTN), Diabetes Mellitus (DM), Ischemic heart disease (IHD),Dilated cardiomyopathy(DCM), Asthma, Chronic obstructive pulmonary disease (COPD),Pulmonary Tuberculosis(TB).*

Fever (55.85%) and dry coughs (44.1%) were the most common clinical features among COVID-19 symptomatic patients, followed by generalized weakness (41%), myalgias (36%), shortness of breath (30.63%), headache (26%) and sore throat (23%). About 37/410 (9%) hospitalized patients died of COVID-19 complications, primarily of the elderly age group with a history of comorbidities (89%). Ninety-nine patients (24%) recovered completely and 214 patients (52%) were discharged as they were stable and advised home quarantine. The minimum stay at the hospital was noted

as two days, while the maximum stay was calculated as 35 days. There was a significant association with COVID-19 disease in hospitalized patients with respect to gender and risk factors according to the severity of disease (*p*-value <0.02 & <0.05 respectively) mentioned in Table-III.

new symptoms with variable disease severity and were reported after they re-tested positive by PCR on the second occasion with negative total COVID Abs. All of them were previously admitted and discharged once fully recovered. Among them, 2 (33%) were health care workers who developed mild disease both

Table- III: Association of gender, risk factors and placement of patient in hospital in relation to severity of disease (n=410).

Gender, n (%)	Risk Factors in Hospitalized Patients			*p*-value
	Smokers (n=238)	Obesity (n=99)	Undernourished (n=74)	
Male Female	231 (56.34%) 5 (1.2%)	37 (9%) 62 (15%)	21 (5.1%) 54 (13.17%)	<0.02
Placement in hospital on the basis of severity of disease				
Gender	Moderate disease with mild dyspnea/Isolation ward (n=301)	Severe disease with moderate dyspnea/High dependency unit (HDU) (n=59)	Very severe with severe dyspnea/critical/Intensive Care Unit (ICU) (n=50)	*p*-value
Male Female	248 (82%) 53 (17.6%)	44 (74.5%) 15 (25.4%)	39 (78%) 11 (22%)	<0.05

Table-IV: Laboratory parameters and management of symptomatic patients with COVID-19 disease (n=444).

Variables	Mild (n=34)	Moderate (n=301)	Severe (n=59)	Critical (n=50)
S.Ferritin (24-336 nml/l)	≥336 nmol/l 9 (26.47%)	≥500 nmol/l 85 (28.23%)	≥ 800nml/l 28 (47.45%)	≥ 1000nml/l 31(62%)
S.CRP (6mg/l)	≥ 10-50 mg 15 (44%)	≥ 50–100 mg/l 195 (64.8%)	≥ 100 mg/l 45 (76%)	≥ 200mg/l 39(78%)
S.LDH (230-446 u/l)	230-446 u/l 34(Normal)	≥446 u/l 21 (7%)	≥500 u/l 15 (25.4%)	≥ 600 u/l 2 (44%)
S.LFT S.ALT=42U/L S.bilirubin = 3-18umol/l	Normal 34	Deranged 11 (3.65%)	Deranged 17 (28.8%)	Deranged 33 (66%)
S RFT S. urea (3.3- 6.7mmol/l) S. creatinine (62-120umol/l)	Normal 34	Deranged 9 (3%)	Deranged 11 (18.6%)	Deranged 22 (44%)
Thrombocytopenia	≤ 150×10^9/l 21(61.7%)	Mild ≤110×10^9/l 180 (60%)	Moderate ≤ 80× 10^9/l 31 (52.5%)	Severe ≤ 50× 10^9/l 22 (44%)
D-Dimers	≤ 200 (normal) 34	≥ 200 146 (48.5%)	≥ 400 21 (45.6%)	≥ 800 14 (28%)
Treatment options	Multivitamins +Zinc supplement +vitamin C+ observation	Same + Add inj low molecular wt heparin 0.5mg/kg body wt. inj Decadron 20mg stat then 80mg twice daily or Oxygen in some for 10 days	Same + Add Supplemental oxygen, InjToclizumab Inj Remdesvir Plasma exchange for 14-21days	Same + add ventilator support for variable duration

Patients who needed intensive care were presented with impaired liver function tests (LFTs), renal functions tests (RFTS) and coagulation profiles. In contrast, the rest of the patients with mild to moderate disease or asymptomatic have shown normal tests values (Table-IV).

During our study period, we noted a total of 6 (1.46%) reinfection cases. Reinfection was labeled once the patient was tested positive with the history of two negative consecutive PCR tests when recovered from their first course of illness. All of them presented with

times. On re-exposure to COVID-19 positive patients after 90 days of their recovery, 4/6 (67%) patients presented with a mild course of disease while 2 with the severe disease with oxygen dependency (Table-V).

DISCUSSION

In our single centered study from Karachi, Pakistan involving 561 lab-confirmed COVID-19 patients, the majority were aged between 40-59 (50.3%). These results were in concordance with a similar study from the United States, according to which more than half of patients (65%) were among 20 and 64 years of

age, and only 5% being under 19 years 8. The majority of admitted patients (81%) were males compared to females with female to male ratio (1:4), the studies from South Korea and Iceland results were in concordance, with male predominance.[9,10]

was raised in patients on ventilator or oxygen support indicative of poor prognosis; otherwise, it remains normal. These findings were similar to another study from China. They suggested that lactate dehydrogenase (44%), CRP (78%) and serum ferritin (62%) were

Table-V: Clinical details of the Six patients reported with reinfection.

Patient Details n= 6/410 (1.46%)	PCR Positive First Infection	PCR Positive After 90 Days Reinfection	Total COVID Antibody (Ab)	Outcome
Healthcare worker =2/6(33%) Gender: males Age: 25-30years Disease Severity: Mild (during both courses of illness) Comorbidities: Nil Admitted: In ward	1st patient: 19 June 20 2nd patient: 25th Aug 20	1st patient: 3rd Nov20 2nd patient: 17th Dec20	1st patient reactive: 11 July 20 & Non- reactive: 3Nov20 2nd patient reactive: 13th Sep 20 & Non-reactive: 17th Dec20	Both recovered & were discharged once symptom free and Ab reactive again after 2 weeks on repeat testing
Other patients: 4/6 (67%) Gender: females (2) Males (2) Age: 2 (between 40-60yrs) 2 (between 65-85yrs) Disease Severity Mild: 2 Severe: 2 Inwards: 2 Intensive Care: 2 (oxygen dependent) Comordities: 4	1st patient: 30th Aug 20 2nd patient: 4th Sept 20 3rd patient: 15th Sept20 4th patient: 20th Sept 5th patient: 28th Sept 20 6th patient:1st Oct20	1st patient: 10th Dec20 2nd patient: 25th Dec20 3rd patient: 1st Jan20 4th patient: 20th Jan 2021 5thpatient:1st feb 2021 6th patient: 15th feb 2021	1st patient reactive: 14th Sept 20 & Non- reactive: 10tH Dec20 2nd patient reactive: 23rd Sep20 & Non-reactive:25th Dec20. 3rd patient: 1st Oct20 Non- reactive:1st Jan20 4th patient: 15th Oct20 Non-reactive: 20th Jan 2021 5thpatient: 21st Oct20 Non-reactive: 1st feb 2021 6th patient: 23rd Nov20 & Non-reactive: 15th feb 2021	3/6 recovered & were discharged once symptom free and Ab reactive again on repeat testing after 21days Death: 1/6(16.7%) male (82yrs) with respiratory failure

The seven common symptoms noted in our study were fever (55.8%), dry cough (44%), generalized weakness (41%), myalgia's (36%), SOB (30.6%), headache (26%), and sore throat (23%). Whereas a study from China reported fever in 43.8% patients and a study from the United States observed dyspnea (76%) as the most common symptom.[14,15]

In our study, 50 (12.2%) patients needed ICU settings; among them, 13 (26%) of patients required ventilator support, whereas 37 (74%) patients were on high flow oxygen support; these findings were varying in different studies.[16,17]

Among our study population, there were relative leukocytosis (lymphocytosis) with mild thrombocytopenia (60%) initially followed by lymphopenia, which was a common finding seen in various other viral illnesses. Patients who needed intensive care presented with impaired liver function tests (LFTs), renal functions tests (RFTs) and coagulation profiles. In contrast, the rest of the patients with mild to moderate disease have shown normal values. CRP and serum ferritin, along with thrombocytopenia, were important infectivity parameters indicative of disease progression with their increasing or decreasing patterns. Serum LDH taken as an important inflammatory markers used in assessing the severity of disease.[18]

Risk factors like smoking (58%), obesity (24%), undernourished (18%), single comorbid condition (32.7%) and more than one comorbidity (23.65%) were observed in our patients. Numerous studies showed a high mortality rate associated with increasing age and comorbid conditions.[19,20]

One of the important findings in our study was low healthcare-associated COVID-19 disease, which was mainly due to good infection control practices and a well-planned approach. The training of hospital staff in our set up was started well before an outbreak knocked our region, findings contrary to the regional study by Atiqa from Pakistan and studies from other parts of the world by Nguyen. They mentioned the estimated risk of HCA infection between 10-15% which was much higher than our recorded statistics.[21,22]

We categorized our patients based on disease severity and managed them accordingly in our hospital. Patients with mild dyspnoea requiring nebulization, admitted in the isolation ward were considered a moderate disease. In contrast, patients with moderate

dyspnoea requiring non-invasive ventilation support/ chest physiotherapy and oxygen saturation monitoring were kept in HDU and categorized as having severe disease. Very severe disease was defined as patients with critical condition with ≥50% bilateral lungs involvement on chest imaging were kept in the ICU. They required continuous oxygen inhalation at higher concentrations or ventilator support to maintain their oxygen saturation. Unfortunately, only two of our patients recovered and revived back from ventilators; a multicenter trial published in The Lancet in 2020 also showed a poor survival rate of patients who were placed on ventilator support.[23] As per global data reported so far, the aged people (over 60) were more prone to develop severe disease with poor prognosis.[24] We also observed the same findings in our study as mortality in our center was 9% and was higher among the male elderly group requiring ICU admission. These findings were in concordance with international statistics. After the second wave, we noticed 6/410(1.46%) confirmed reinfection cases out of the 2/6(33%) were HCW cases we reported earlier in our case report.[7] One (16.7%) elderly patient died with reinfection due to the severity of second attack and comorbidities. Similar cases were reported previously, both internationally and locally. In conclusion, increased surveillance efforts are required to improve screening and emphasis on skilled molecular testing with clinical correlation, which can aid in establishing accurate statistics of reinfection.

ACKNOWLEDGEMENT

The authors wish to thank the administration, Department of Medicine and laboratory technicians who supported us during this study. We are also thankful to Imam Shamil Khanzada for proof reading of our manuscript.

LIMITATIONS OF STUDY

Gene sequencing was not carried out in the samples to look for multiple variants present in this region.

CONCLUSION

In our study, the severity of the disease was directly related to the age of patients and underlying comorbidities. Reinfection was associated with increased viral load and exposure to the infected environment.

Conflict of Interest: None.

Authors' Contribution

AA: Direct contributin, FS, MY, HJ, SY, AK: intellectual contribution.

REFERENCES

1. Van Bavel JJ, Baicker K, Boggio PS, Capraro V, Cichocka A, Cikara M, et al. Using social and behavioural science to support COVID-19 pandemic response. Nat Hum Behav 2020; 4(5): 460-471.
2. World Health Organization. corona virus disease (COVID-19) dashboard. [Internet] Available at: https://covid19.who.int/ (Accessed May 5 2020).
3. Abid K, Bari YA, Younas M, Javaid ST, Imran A. Progress of COVID-19 Epidemic in Pakistan. Asia-Pac J Public Health 2020; 32(4): 154-156.
4. World Health Organization (WHO). Pakistan: COVID-19-Situation update as of 7 April 2020 (3:00 pm). Updates: Ministry of National Health Services Regulations and Coordination Dashboard. 2020, [Internet] Available from: https://covid19. who.int/region/emro/country/pk (Accessed on March 16, 2020)
5. Government of Pakistan. Coronavirus in Pakistan. [Internet] Available from: http://covid. gov.pk/ (Accessed on Oct 02, 2020).
6. Xie Y, Wang Z, Liao H, Marley G, Wu D, Tang W. Epidemiologic, clinical, and laboratory findings of the COVID-19 in the current pandemic: systematic review and meta-analysis. BMC Infect Dis 2020; 20(1): 1-2.
7. Ahmed A, Sana F, Ikram A, Yousaf S, Khan A. Reinfection or relapse of COVID-19 in health care workers; case series of 2 patients from Pakistan. New Microbes New Infect 2021; 42(1): 100896.
8. COVID TC, Team R. Severe outcomes among patients with coronavirus disease 2019 (COVID-19)-United States, February 12-March 16, 2020. MMWR Morb Mortal Wkly Rep 2020; 69(12): 343-346.
9. Gudbjartsson DF, Helgason A, Jonsson H, Magnusson OT, Melsted P, Norddahl GL, et al. Spread of SARS-CoV-2 in the Icelandic population. N Engl J Med 2020; 382(24): 2302-2315.
10. Jeong EK, Park O, Park YJ, Park SY, Kim YM, Kim J, et al. Coronavirus disease-19: The first 7,755 cases in the Republic of Korea. Osong Public Health Res Perspect 2020; 2(1): 85-90.
11. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med 2020; 382(18): 1708-1720.
12. Salacup G, Lo KB, Gul F, Peterson E, De Joy R, Bhargav R, et al. Characteristics and clinical outcomes of COVID-19 patients in an underserved-inner city population: a single tertiary center cohort. J Med Virol 2021; 93(1): 416-423.
13. Gomes C. Report of the WHO-China Joint Mission on Corona-virus Disease 2019 (COVID-19). [Internet] Available from: https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf (Accessed on Oct 02, 2020).
14. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al.Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet 2020; 395(10223): 507-513
15. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020; 395(10223): 497–450.
16. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult in patients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet 2020; 395(10229): 1054–1062.
17. Yang X, Yu Y, Xu J, Shu H, Liu H, Wu Y, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. Lancet Respir Med 2020; 8(5): 475–481.
18. Lee TH, Junhao Lin R, Lin RT, Barkham T, Rao P, Leo YS, et al. National centre for infectious diseases COVID-19 outbreak research team. Testing for SARS-CoV-2: can we stop at 2? Clin Infect Dis 2020; 71(16): 2246-2248.
19. Xu K, Chen Y, Yuan J, Yi P, Ding C, Wu W, et al. Factors associated with prolonged viral RNA shedding in patients with coronavirus disease 2019 (COVID-19). Clin Infect Dis 2020; 71(15): 799-806.
20. Xiao AT, Tong YX, Zhang S. Profile of RT-PCR for SARS-CoV-2: a preliminary study from 56 COVID-19 patients. Clin Infect Dis 2020; 16(19): 249-251.
21. Nguyen LH, Drew DA, Graham MS, Joshi AD, Guo CG, Ma W, et al. Risk of COVID-19 among front-line health-care workers and the general community: a prospective cohort study. Lancet Public Health 2020; 5(9): e475-e483.
22. Atiqa K, Ali S. COVID-19 and its Challenges for the Healthcare System in Pakistan. Asian Bioeth Rev 2020; 12(4): 551-564.
23. Wang Y, Zhang D, Du G, Du R, Zhao J, Jin Y, et al. Remdesivir in adults with severe COVID-19: a randomised, double-blind, placebo-controlled, multicentre trial. Lancet 2020; 395(10236): 1569-1578.
24. Zhang B, Zhou X, Qiu Y, Feng F, Feng J, Jia Y, et al. Clinical characteristics of 82 death cases with COVID-19. PLoS One 2020; 15(7): e0235458.