Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Presenting Symptoms and Predictors of Poor Outcomes Among 2,184 Patients with COVID-19 in Lagos State, Nigeria

Akin Abayomi1, Oluwakemi Odukoya2, Akin Osibogun2,3,4,*, Ololade Wright5, Bisola Adebayo5, Mobolane Balogun2, Ismael Abdus-Salam1, Abimbola Bowale6, Bamidele Mutiu7, Babatunde Saka7, Moyosore Adejumo8, Sam Yeni9, Rotimi Agbolagorite1, Oluwatosin Onasanya3, Eniola Erinosho5, Joshua Obasanya9, Olu Adejumo6, Sunday Adesola8, Yewande Oshodi2,4, Iorhen E. Akase4, Shina Ogunbiyi6, Dayo Lajide1, Femi Erinoso10, Hussein Abdur-Razzaq1

1 Lagos State Ministry of Health
2 College of Medicine University of Lagos
3 Lagos State Primary Health Care Board
4 Lagos University Teaching Hospital
5 Lagos State University College of Medicine
6 Mainland Hospital, Yaba, Lagos
7 Lagos State Biobank
8 World Health Organization, Nigeria Office
9 Nigeria Centre for Disease Control
10 Lagos State University Teaching Hospital

A R T I C L E   I N F O
Article history:
Received 2 September 2020
Received in revised form 6 October 2020
Accepted 8 October 2020

Keywords:
COVID-19
Symptoms
Death
Nigeria

A B S T R A C T
Introduction: Lagos state remains the epicentre of COVID-19 in Nigeria. We describe the symptoms and signs of the first 2,184 PCR-confirmed COVID-19 patients admitted at COVID-19 treatment centers in Lagos State. We also assessed the relationship between patients’ presenting symptoms, sociodemographic and clinical characteristics and COVID-19 deaths.

Methods: Medical records of PCR-confirmed COVID-19 patients were extracted and analyzed for their symptoms, symptom severity, presence of comorbidities and outcome.

Results: The ages of the patients ranged from 4 days to 98 years with a mean of 43.0 (16.0) years. Of the patients who presented with symptoms, cough (19.3%) was the most common presenting symptom. This was followed by fever (13.7%) and difficulty in breathing, (10.9%). The most significant clinical predictor of death was the severity of symptoms and signs at presentation. Difficulty in breathing was the most significant symptom predictor of COVID-19 death (OR: 19.26 95% CI 10.95–33.88). The case fatality rate was 4.3%.

Conclusion: Primary care physicians and COVID-19 frontline workers should maintain a high index of suspicion and prioritize the care of patients presenting with these symptoms. Community members should be educated on such predictors and ensure that patients with these symptoms seek care early to reduce the risk of deaths associated with COVID-19.

© 2020 The Author(s). Published by Elsevier Ltd on behalf of International Society for Infectious Diseases. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction
Since the discovery of the index case of COVID-19 in Nigeria in February 2020, (NCDC Coronavirus COVID-19 Microsite, 2020) the spread of the virus has increased exponentially due to community-based human-to-human transmission. (Odukoya et al., 2020) Lagos state was the first state to record and manage that case and has remained the epicentre of the pandemic, accounting for 36% of the cases and 22% of deaths as at July 26, 2020. (NCDC 2020, Odukoya et al., 2020)

COVID-19 is a novel disease with seemingly variable clinical presentation and progression. In several parts of the world, commonly reported symptoms include fever, dry cough, fatigue,
myalgia, headache, sore throat, abdominal pain and diarrhea. (Kim et al., 2020; Koh et al., 2020; Lapostolle et al., 2020; Lechien et al., 2020) There is limited research on the symptom profile of COVID-19 patients in Nigeria.

The first and only study in Nigeria that reported the symptomatology of COVID-19 in Lagos State found that admitted early cases of COVID-19 had an average age of 38.1 years, were mostly male and had moderately severe symptoms (66%), while only 16% were asymptomatic. The validity of the findings of this study is limited by its small sample size (only 32 patients) and the fact that the data was obtained from a single isolation centre in Lagos state. (Bowale et al., 2020)

COVID-19 is a new and rapidly evolving disease. Understanding the symptoms profile of the infection is important in formulating a practicable approach to rapidly identify cases and assess the course of infection. This will improve treatment outcomes and reduce disease transmission and death rates. Assessing the relationship between symptom severity and COVID-19 outcomes may provide some insights into the understanding of the disease and its risk or protective factors. The objective of this study is to use data from a large cohort of the first 2184 patients with PCR confirmed COVID-19 admitted in nine isolation and treatment centres in Lagos State, to describe the pattern of symptoms and predictors of mortality from COVID-19. It is hoped that these findings will fill some critical gaps in research on COVID-19 in Nigeria and provide locally relevant evidence on COVID-19 among Nigerians. The findings will also inform state and national policy and decision-making to improve health outcomes for the rapidly rising number of COVID-19 patients in Nigeria.

2. METHODS

Study sites: The cases reported in this study were patients admitted at all of the nine treatment centres in Lagos state, Southwest Nigeria, though their places of residence were diverse in the Lagos Metropolis. Treatment centers refer to a place that provides in-patient hospital care specifically for COVID-19 cases.

Study design and population: This was a retrospective study using medical records of 2184 PCR confirmed COVID-19 patients. Laboratory confirmation of COVID-19 was done with naso- oropharyngeal and sputum specimens that tested positive for the SARS-CoV-2 virus using real-time reverse transcription-polymerase-chain-reaction (RT-PCR) assay for SARS-CoV-2 in accordance with the protocol established by the World Health Organisation. (WHO, 2020) Patients were considered negative and discharged after a negative PCR-based SARS-CoV-2 virus test. All patients were treated with Lopinavir-Ritonavir, Vitamin C, Vitamin D and Zinc.

Data extraction and analysis: Data were extracted from electronic medical records of the 2,184 patients as maintained by the case management teams at the hospital or isolation centres. We obtained data on patients age, gender, admitting facility, presenting symptoms, severity of initial presenting symptoms, the presence of co-morbidities and patient’s final outcome (i.e. Dead or Discharged).

Patient’s severity at presentation was based on clinical parameters and the need for oxygen and assisted ventilation. Mild patients are those who were asymptomatic at presentation; Moderate, if patient presented with fever, cough, respiratory rate <30breaths per minutes and peripheral capillary oxygen saturation (spo2) >90% for adults and >92% for children. A patient with grunting respiration, respiratory rate >30 breaths per minute, spo2 <90% for adults and <92% for children requiring oxygenation was classified as severe while a patient with respiratory failure requiring mechanical ventilation was classified as critical. Our case definition was adapted from a handbook on clinical experience in China (Yu, 2020) STATA version 16 (StataCorp, USA) was used to conduct the data analysis.

Normally distributed continuous variables were presented as means (SD) while categorical variables were presented in tables as frequencies and percentages. To determine the variables associated with COVID-19 deaths, we first of all conducted a bivariate analysis using the student’s T test and the Pearson’s chi square tests for continuous or categorical variables respectively. Thereafter, we conducted two multivariable logistic regression models using variables that were significant at p < 0.2. (Hosmer et al., 2013, Lee, 2014) The first model was designed to determine the socio-demographic and clinical predictors of COVID19 death, while the second model was designed to identify the presenting symptoms most predictive of COVID-19 death among our COVID-19 patients. Variables that were collinear were dropped from the analysis. Results were presented in adjusted odds ratios and 95% confidence intervals. p values of <0.05 were considered statistically significant.

Ethics: Ethical approval was obtained from the Health Research and Ethics Committee of the Lagos State University Teaching Hospital. All patient data was anonymized and handled only by authorized personnel in order to ensure confidentiality.

3. Results

3.1. Patients socio-demographic and clinical presentation

Data from two thousand one hundred and eighty-four (2,184) laboratory confirmed COVID-19 patients presenting in nine treatment facilities in Lagos state. The ages of the patients ranged from 4 days to 98 years with a mean of 43.0(SD16.0) years. More than half (53.2%) were aged between 30 and 50 years. Only 2.9% were children (i.e. less than 18 years of age) while 3.8% were aged 70 years and older. The patients were mostly male (65.8%) and seen in government owned COVID-19 treatment facilities (97%). More than half (57.5%) were tested within a hospital setting while 42.4% were tested at designated ambulatory centre and thereafter referred to the isolaton and treatment centres.

At presentation, majority were considered to have mild disease, while 6.8% of them were either in severe or critical condition at presentation. Less than a quarter (22.5%) presented with at least one other comorbidity. Of these, 25.4% presented with more than one comorbidity. The cases fatality rate was 4.3% (Tables 1 and 2).

| Variable | Frequency | % |
|----------|-----------|---|
| Age in years (N = 2,175) | | |
| <10 | 52 | 2.4 |
| 10-19 | 69 | 3.2 |
| 20-29 | 365 | 16.8 |
| 30-39 | 631 | 29.0 |
| 40-49 | 526 | 24.2 |
| 50-59 | 321 | 14.8 |
| 60-69 | 128 | 5.9 |
| 70-79 | 55 | 2.5 |
| 80 and older | 28 | 1.3 |
| Mean age (SD) | 43.0(SD16.0) | 43.3–44.7* |
| Gender (N = 2182) | | |
| Female | 746 | 34.2 |
| Male | 1436 | 65.8 |
| Admitting facility (N = 2,184) | | |
| Government-owned | 2118 | 97.0 |
| Privately run | 66 | 3.0 |

95% Confidence interval
Table 2
Patients’ clinical presentation and outcomes of the COVID-19 patients.

| Variable                                      | Frequency | %   |
|-----------------------------------------------|-----------|-----|
| Initial presentation (N = 2170)               |           |     |
| Mild                                          | 1251      | 57.7|
| Moderate                                      | 770       | 35.5|
| Severe                                       | 107       | 4.9 |
| Critical                                     | 42        | 1.9 |
| The presence of symptoms at presentation (N = 2170) |           |     |
| Symptomatic                                   | 906       | 41.7|
| Asymptomatic                                  | 1264      | 58.3|
| Co-morbidity (N = 2184)                       |           |     |
| Yes                                           | 492       | 22.5|
| No                                            | 1692      | 77.5|
| Number of co-morbidities (n = 492)            |           |     |
| 1                                             | 367       | 74.6|
| 2                                             | 114       | 23.2|
| 3 or more                                    | 11        | 2.2 |
| Type of co-morbidities                        |           |     |
| Hypertension                                  | 365       | 16.7|
| Diabetes                                      | 149       | 6.8 |
| Asthma                                       | 50        | 2.3 |
| Cancer                                       | 9         | 0.4 |
| Kidney disease                                | 14        | 0.6 |
| Sickle cell disease                           | 7         | 0.3 |
| HIV                                           | 7         | 0.3 |
| Length of hospital stay (days)                |           |     |
| Less than 5                                   | 229       | 12.3|
| 6-10                                          | 475       | 25.4|
| 11-15                                        | 912       | 48.8|
| 16-20                                        | 165       | 8.83|
| > 20                                         | 88        | 4.71|
| Outcome (n = 1798)                            |           |     |
| Discharged                                    | 1725      | 95.9|
| Died                                          | 73        | 4.1 |

3.2. Pattern of presenting symptoms among COVID-19 laboratory confirmed cases

Of the patients who presented with symptoms, cough (19.3%) was the most common presenting symptom. This was followed by fever (13.7%), difficulty in breathing (10.9%) headaches (7.3%), weakness (6.3%), loss of sense of smell and taste (4.9%), throat irritation (4.9%), chest pain (3.8%), body pains (3.2%), nasal congestion (2.4%) and diarrhea (2.4%). All other symptoms were experienced by less than 1% of the patients.

Figure 1 displays symptoms profile of patients. We report all symptoms that were presented by at least 2 patients. All other symptoms were presented by only one patient and include: hoarse voice, tooth pain, easy satiety, dry mouth, dark urine, frequent urination, stained mucus, body rash, bleeding, hemeparesis, increased thirst, hiccups, hearing impairment, metallic taste, swollen feet, leg shaking, tingling sensations, anorexia, osteoarthritis, vaginal discharge, weight loss, anxiety, convulsion, ear heaviness, excessive sweating, constipation and body itching (Fig. 2).

3.3. Socio-demographic and clinical factors associated with COVID-19 deaths

The bivariate analysis showed that more deaths occurred among older patients, males and patients admitted in non-government treatment facilities (p < 0.05). Also, more deaths occurred in patients who were considered as being severe or critical at presentation also had more deaths. More deaths also occurred in persons with existing co-morbidities and this increased with increasing number of co-morbidities. The most significant predictor of death was the severity of initial presentation. Patients presenting in a severe/critical state were 153 times more likely to have died (95% CI: 30.74-766.35) while those presenting in a moderate state were 6.33 times (95% CI: 1.13-35.20) more likely to have died, compared to those presenting in as mild cases.

Patients with at least one co-existing morbidity were 2.45 more likely to have died, (95% CI: 1.26-4.76) compared to those without comorbidities. Males were 2.21 times (95% CI: 1.06-4.58) more likely to have died. For every additional year of life, the likelihood of death increased by 1.04 times (95% CI: 1.02-1.06) (Tables 3 and 5).

3.4. Presenting symptoms as predictors of COVID-19 deaths

A bivariate analysis showed that deaths occurred more in patients who presented with difficulty in breathing, weakness, loss of appetite, fever, cough, weakness, and hemoptysis. Of the symptoms, difficulty in breathing was the most significant predictor of COVID-19 death (OR: 19.26 95% CI 10.95-33.88). Patients who presented with body weakness were 3.04 times more likely to have died, while those presenting with cough were 1.87 times more likely to have died (Tables 4 and 6).

4. DISCUSSION

This is the first study that reports the pattern of presenting symptoms and predictors of death among a large cohort of PCR confirmed COVID-19 patients in Nigeria, and one of the first in sub Saharan Africa. COVID-19 patients with dyspnea may have a higher risk of severe and critical disease outcomes. In our study, difficulty in breathing was the most significant predictive symptom of COVID-19 death. Fu et al. observed that there was no statistically significant association between shortness of breath and COVID-19 severity although a systematic review and meta-analysis of risk factors for critical and morbid cases of COVID-19 indicated that shortness of breath/dyspnea was positively associated with the severe illness and death but with a lower odds than ours (OR = 4.16, 95% CI [3.13 – 5.53]) Fever on the other hand as reported by Zheng et al was negatively associated with severe illness and death (OR = 0.56, 95% CI [0.38 – 0.82], P = 0.003) though Fu et al and a systematic review by Shi et al reported no associations similar to our findings. Both systematic reviews however were predominated by studies in China with only one study from the UK and none from Africa.

More than half (58.3%) of patients in our study were asymptomatic and often reluctant to be admitted into isolation units. These patients though asymptomatic, can transmit the virus to others and as a result serve as an important source of hospital and community-based transmission. Two separate reviews of asymptomatic SARS-CoV-2 infections report slightly lower figures, ranging from 1.6% to 51.8% in the first review and 40%- 45% of asymptomatic cases in the second review. None of these reviews had patient representation from sub Saharan Africa. (Gao et al, 2020; Oran & Topol, 2020). Another systematic review and meta-analysis of asymptomatic COVID-19 patients showed that up to 40% of patients present with abnormal computed tomography (CT) findings. (Kronbihler et al, 2020) Public health messages tend to focus on symptoms as an indicator of COVID-19 disease. Our findings suggest that the focus of public health preventive measures should not be only placed on symptomatic persons, as the majority of COVID-19 cases may be asymptomatic. In addition, public health infection prevention guidelines for both the symptomatic of asymptomatic must be provided to the general public. Asymptomatic COVID-19 infection may be associated with sub-clinical CT lung abnormalities; however, CTs were not conducted for the asymptomatic cases in our study. National guidelines for the management COVID-19 cases should include
asymptomatic cases, as they may have undetected sub-clinical abnormalities. (Kronbichler et al., 2020; Singhal, 2020) To reduce the risk of nosocomial transmission, health care workers need to maintain a very high index of suspicion when treating their patients, as the majority may be asymptomatic. The role of asymptomatic carriers in community-based transmission is also important and public health messages designed to emphasize this should be prioritized.

Majority of the symptomatic cases in our study had mild symptoms. This is consistent with findings observed in other places like Beijing, (Tian et al., 2020) Hubei province of China, (Novel, 2020) and South Korea, (Kim et al., 2020) Cough, fever and difficulty in breathing were the most common symptoms observed in the patients in this study. Similar findings were observed in France where cough and fever were reported in more than 90% of cases (Lapostolle et al., 2020). Body pains, headaches, shortness of breath, ear-nose-throat symptoms and chest pain were also common symptoms as the French among patients in France (Lapostolle et al., 2020). Similarly, only 3% of patients presented with haemoptysis in the French study, comparable to our study findings. Consistent with the literature, COVID-19 symptoms among the patients in our study are primarily respiratory, ear-nose and throat, gastrointestinal and generalised symptoms. (Lapostolle et al., 2020; Lechein et al., 2020; Koh et al., 2020)

Loss of smell and taste was the most peculiar symptom observed among the COVID-19 patients. However, this occurred in less than 5% of our of the patients in our study. Studies in other parts of the world suggest that such peculiar symptoms may serve as an important clue for the diagnosis of the infection. (Lee et al., 2020; Jan et al., 2020) In Korea and the United States, up to 15.3% of patients presented with acute loss of smell and taste, (Lee et al., 2020; Moein et al., 2020) and this was more common in females and young individuals at the early stages of the infection. (Lee et al., 2020) Further research is needed to determine whether loss of taste and smell may also serve as important early signs of COVID-19 among patients in sub Saharan African settings.

Of the symptoms, difficulty in breathing was the most significant predictor of COVID-19 deaths. This is consistent with studies in Wuhan, Guangzhou and Italy (Wang et al., 2020; Liang et al., 2020; De Vito et al., 2020) Also consistent with the literature, increasing age, male gender, and the presence of co-existing morbidities are strong predictors of COVID 19 deaths in Nigeria. (Figliozzi et al., 2020; Galloway et al., 2020; Imam et al., 2020; Du et al., 2020)

Late presentation appears to be the most significant predictor of poor outcomes as patients presenting in severe or critical states were more likely to have died compared to those presenting in mild clinical states. Effective home management of COVID-19 may therefore play a critical role in reducing late presentations and deaths as suggested by McCullough et al. Targeted and consistent public sensitization on effects of late presentation should be considered in social mobilisation and communication drive to achieve the needed behavioural change in a pandemic as this. Majority of testing in this study was in treatment centers, and not done earlier. This is congruent with the early American experience that a majority of patients waited until becoming very ill to have testing done at the hospital. (McCullough et al., 2020)
Furthermore, in Lagos, where this study was conducted, poor hospital seeking practices and late presentation occur commonly (Roberts et al., 2015; Awofeso et al., 2018; Anorlu et al., 2004; Ugochukwu et al., 2019). Strong public health advisories encouraging people to seek care early, and guidelines for the effective home management of COVID-19 should be instituted to prevent COVID-19 deaths.

5. Study strengths and limitations

To our knowledge, this is the first study in Nigeria and one of the first in sub-Saharan Africa to explore the symptomatology and predictors of mortality using data from a large cohort of COVID-19 patients in several treatment facilities. It however has some important limitations and the findings should be interpreted with...
some caution. First, data on symptoms was obtained by self-report and may be subject to recall or reporting bias. Secondly, inferences on causality cannot be made due to the cross-sectional nature of data extraction. Thirdly, this represents finding from the early stages of a dynamic and rapidly changing pandemic and the evidence provided may change over time or as more data becomes available. Nevertheless, this study provides valuable evidence on the symptom profile and predictors of mortality for COVID-19 at a time where evidence from Africa is sparse.

6. Conclusion

Respiratory symptoms i.e. cough and difficulty in breathing, as well as fever are the most common presenting symptoms for the COVID-19 patients in our study. Difficulty in breathing is the most important symptom predictive of COVID-19 death. Body weakness and cough are also predictive symptoms of poor outcomes. Severe symptoms at presentation, which may be brought about by late presentation, is the most significant predictor of death. Males, patients with co-existing morbidities and increasing age have poorer COVID-19 outcomes. Primary care physicians and COVID-19 frontline workers should maintain a high index of suspicion and prioritize the care of patients presenting with these symptoms. Emphasis should be placed on older males with co-morbid conditions. Community members should ensure that patients with these symptoms seek care early to reduce the risk of deaths associated with COVID-19.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Table 5

| Variables                  | Adjusted OR | 95% CI     | p value |
|----------------------------|-------------|------------|---------|
| Age in years               | 1.04        | 1.02-1.06  | 0.000   |
| Male gender                | 2.21        | 1.06-4.58  | 0.034   |
| Is asymptomatic at presentation | 1.16     | 0.31-4.37  | 0.831   |
| Has at least one co-morbidity | 2.45    | 1.26-4.76  | 0.008   |
| Being admitted in a government own facility | 1.99    | 0.66-6.16  | 0.222   |

Table 6

| Variables                | Adjusted OR | 95% CI     | p value |
|--------------------------|-------------|------------|---------|
| Fever                    | 1.58        | 0.82-3.17  | 0.172   |
| Cough                    | 1.87        | 1.04-3.37  | 0.038   |
| Weakness                 | 3.04        | 1.44-6.42  | 0.003   |
| Loss of Appetite         | 1.87        | 0.44-7.91  | 0.397   |
| Headache                 | 0.48        | 0.10-2.32  | 0.000   |
| Difficulty in breathing  | 19.26       | 10.05-33.88| 0.000   |
| Diarrhoea                | 1.12        | 0.31-4.02  | 0.861   |
| Throat irritation         | 0.15        | 0.02-12.99 | 0.084   |
| Loss of taste/smell      | 0.36        | 0.04-3.09  | 0.321   |
| Other symptoms           | 1.85        | 0.18-19.40 | 0.069   |

Funding

The Lagos State Government funded the study but is not responsible for the design, results and discussions presented in this paper.

Acknowledgement

The authors wish to place on record the full support of the Incident Commander for the response to the COVID-19 outbreak in Lagos State, Mr Babajide Sanwo-Olu, Governor of Lagos State and the Deputy Governor Dr Kadiri Hamza by making available resources to conduct researches as part of the counter-measures to the outbreak. Several health workers in the frontline were responsible for caring for the patients and keeping the records.

References

Anorlu RI, Orahkwoe CO, Oyeneyin L, Abudu OO. Late presentation of patients with cervical cancer to a tertiary hospital in Lagos: what is responsible?. European journal of gynaecological oncology 2004;25(6):729–32.
Awoloso O, Roberts AA, Salako O, Balogun I, Okediji P. Prevalence and pattern of late-stage presentation in women with breast and cervical cancers in Lagos University Teaching Hospital Nigeria. Nigerian Medical Journal: Journal of the Nigeria Medical Association 2018;59(6):74.
Bowale A, Abayomi A, Ididi J, OmiLABO S, Abdus-Salam I, Adebayo B, Opawoye F, Finnih-Awokoya O, Zamba E, Abudir-Razzaq H, Enioso O. Clinical presentation, case management and outcomes for the first 32 COVID-19 patients in Nigeria. The Pan African Medical Journal 2020;35(24):May 6.
De Vito A, Geremia N, Fiore V, Princic E, Babudieri S, Madeddu G. Clinical features, laboratory findings and predictors of death in hospitalized patients with COVID-19 in Sardinia, Italy. Eur Rev Med Pharmacol Sci 2020;24(14):7861–8.
Du RH, Liang LR, Yang CQ, Wang W, Cao TZ, Li M, Guo GY, Du J, Zheng CL, Zhu Q, Hu M. Predictors of mortality for patients with COVID-19 pneumonia caused by SARS-CoV-2: a prospective cohort study. European Respiratory Journal 2020;55(5):May 1.
Figlizzi S, Masci PG, Ahmad N, Tondi L, Kouiti E, Aimo A, et al. Predictors of Adverse Outcomes in Covid-19: A Systematic Review and Meta-analysis. European Journal of Clinical Investigation 2020;e13362.
Galloway JB, Norton S, Barker BD, Brooks A, Carey I, Clarke BD, Jina R, Reid C, Russell MD, Sweep R, Sugarman L. A clinical risk score to identify patients with COVID-19 at high risk of critical care admission or death: an observational cohort study. Journal of Infection 2020; May 29.
Gao Z, Xu Y, Sun C, Wang X, Guo Y, Qiu S, Ma K. A systematic review of asymptomatic infections with COVID-19. Journal of Microbiology, Immunology and Infection 2020; May 15.
Hosnier DW, Lemeshow S, Sturdivant RX. Applied logistic regression. New York: Wiley; 2013.
Imam Z, Odish F, Gill I, O’Connor D, Armstrong J, Vanoo A, et al. Older age and comorbidity are independent mortality predictors in a large cohort of 1305 COVID-19 patients in Michigan. United States Journal of Internal Medicine 2020; Jun 4.
Jan H, Faisal S, Khan A, Khan S, Usman H, Liaqat R, Shah SA. COVID-19: Review of Epidemiology and Potential Treatments Against 2019 Novel Coronavirus. Discoveries 2020;8(2):Apr.
Kim GI, Kim MJ, Ra SH, Lee J, Bae S, Jung J, Kim SH. Clinical characteristics of asymptomatic and symptomatic patients with mild COVID-19. Clinical Microbiology and Infection 2020; May 1.
Koh J, Shah SU, Chua PE, Gui H, Pang J. Epidemiological and Clinical Characteristics of Cases During the Early Phase of COVID-19 Pandemic: A Systematic Review and Meta-Analysis. Frontiers in Medicine 2020;7:295 Jun 11.
Kronbichler A, Kresse D, Yoon S, Lee KH, Effenberger M, Shin JI. Asymptomatic patients as a source of COVID-19 infections: A systematic review and meta-analysis. International Journal of Infectious Diseases 2020; Jun 17.
Lapostolle F, Schneider E, Viana I, Dollet G, Roche B, Berdah J, et al. Clinical features of 1487 COVID-19 patients with outpatient management in the Greater Paris: the COVID-call study, Internal and Emergency Medicine 2020; May 30.
Lecjen JR, Chiesa-Estomba CM, Place S, Van Laethem Y, Cabarrou P, Mat Q, et al. Clinical and epidemiological characteristics of 1, 420 European patients with mild-to-moderate coronavirus disease 2019. Journal of internal medicine 2020; Apr 30.
Lee PH. Should we adjust for a confounder if empirical and theoretical criteria yield contradictory results?. A simulation study. Sci Rep 2014;4:6085, doi:http://dx.doi.org/10.1038/srep06085.
Lee Y, Min P, Lee S, Kim SW. Prevalence and duration of acute loss of smell or taste in COVID-19 patients. Journal of Korean medical science 2020;35(18) May 11.
Li W, Liang H, Ou L, Chen B, Chen A, Li C, Li Y, Yuan W, Sang L, Lu J, Xu Y. Development and validation of a clinical risk score to predict the occurrence of critical illness in hospitalized patients with COVID-19. JAMA Internal Medicine 2020; May 12.
