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Sars-Cov-2 and COVID-19: Epidemiological, Diagnostic, and Therapeutic Aspects in Pointe-Noire, Republic of the Congo

Luc Magloire Anicet Boumba[1,2,3,7*], Aubièrge Victoire Kimpamboundi-Matondo[6], Parfait Christy Nganga[1,7], Colombe Sagesse Luzayisu[1,7], Ragive Parode Takale[1,7], Jordan Aladin Batchy Atandi[1,7], Gerald Launay Evrard Missamou[1,7], Sarturnin Freddy Pouki[1,7], Freddy Kibouilou[1,7], Christ Kouanga Balanda[1,7], Brunel Monic Angounda[5], Odilon Mouanba-Nzembe[1,7], Donatien Moukassa[1,4] and Fmmg[7]

[1]Department of Biology, Faculty of Health Sciences, Marien NGOUABI University, BP 69, Brazzaville, Republic of the Congo

[2]Pointe-Noire Research Area, National Institute for Research in Health Sciences (IRSSA), Pointe-Noire, Republic of the Congo

[3]Loandjili General Hospital, Medical and Morphological Analysis Laboratory, Pointe-Noire, Republic of the Congo

[4]Edith Lucie Bongo Ondimba D'Oyo General Hospital, OYO, Republic of the Congo

[5]Faculty of Science and Technology, Marien NGOUABI University, BP 69, Brazzaville, Republic of the Congo

[6]Departmental Directorate of Health Care and Services of Pointe-Noire, Republic of the Congo

[7]Laboratory of Virology and Molecular Biology of the Marie Madeleine NGOMBES Foundation, Pointe-Noire, Republic of the Congo

ABSTRACT

Introduction: The novel coronavirus also called SARS-COV-2 was declared a global pandemic by the WHO in March 2020. In the Republic of Congo, the first imported case was introduced on March 14, 2020. Pointe-Noire, whose 1st case was reported on March 17, 2020, is described as the second epicenter of the disease after Brazzaville the capital.

Objective: In this work, the authors described the epidemiological, diagnostic and therapeutic aspects that contributed to the management of COVID-19 patients in Pointe-Noire.

Material and Method: This was a cross-sectional descriptive study. The situational analysis was based on the situation report (SITREP) n°: 434 including COVID-19 data from the department of Pointe-Noire since the declaration of the first case until June 19, 2021, a period of 15 months. The biological diagnosis was exclusively based on RT-PCR from a nasopharyngeal swab. The extraction was carried out using two processes: filter column extraction and magnetic ball extraction using different kits. Amplification was performed on five types of PCR instruments.

Results: At the last SITREP n°: 434 of the Pointe-Noire department, 61,083 patients were screened for COVID-19, of which 3,829 patients or 6.27% of cases were declared positive. Men accounted for 75.31% of cases. The average age of the patients was 45 ± 14 years. Pointe-Noire has recorded 62 COVID-19 deaths since the declaration of the first case with a fatality rate of 1.6%. The following instruments were used for amplification in different laboratories: MIC qPCR (Bio molecular System), GeneXpert (Cepheid), Q Tower 3G (Analytikjena), QIAquant 96 (QIAGEN) and DNA Technology DT prime 4 (DNA Technology). In total, 7 different types of kits were used (2019-nCoV TaqMan RT-PCR Kit (Norgen), DaAn Gene nCov RNA Kit (Daagen), Logix Smart™ Coronavirus 2019 (COVID-19) Test Kit (Logix Smart), SD Biosensor COVID 19 RT PCR Test Kit (nCoVBiosensor), Real-Time Fluorescent RT-PCR Test Kit for Detecting SARS-CoV-2 (BGI), Novel Coronavirus (2019-nCoV) Nucleic acid diagnostic kit (SANSURE BIOTECH)). Extractions were done with: Total Nucleic Acid Preservation (Norgen), QIAamp Viral RNA Mini Kit (250) (Qiagen), Favorgen Plant Total RNA Mini Kit (Favorgen), Nucleic Aci Isolation or Purification Reagent (Daagen), AccuPrep ® DxViral RNA Extraction Kit (Bioneer) and Magnetic Viral RNA Extraction Kit (GALENVS).

The therapeutic regimen with mainly 3 molecules (paracetamol, azitromicine and hydroxychloroquine) consisted of a treatment over 10 days with PCR controls on the 15th and 21st days

Conclusion: The government's response mechanism against COVID-19 has had a positive impact on the evolution of the disease in Congo. The combination of good compliance with barrier measures, the screening and management strategy have been the means that have effectively curbed the disease in our country.

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***Corresponding author**
Dr Luc Magloire Anicet Boumba, Hospitalo-University Biologist, Virology, Molecular Biology and Oncology, Brazzaville, Republic of the Congo. Tel No: +242066131401/ +242056601040; E-mail: anicetboumba1974@gmail.com

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Introduction

The new coronavirus (2019-nCoV), named Sars-CoV-2 by the International Committee on Viral Taxonomy (ICTV), belongs to the family Coronaviridae [1,2]. It appeared in a seafood market in Wuhan, Hubei province, China, in December 2019 [3]. Approximately 96 million cases have been directly reported to this infection in 218 countries or territories worldwide, including 2 million fatal cases in 2020 [4,5].

In January 2020, the entire genome of the virus was sequenced and made available to the international scientific community by China [6]. The RNA genome of SARS-CoV-2 showed approximately 82% sequence homology with that of SARS-CoV (severe acute respiratory syndrome-CoronaVirus), which was itself responsible for an epidemic of pneumonia between November 2002 and July 2003, the epicenter of which was South-East Asia [7].

Thus, on 30 January 2020, COVID-19 was designated as a respiratory disease caused by Sars-CoV-2 and declared by WHO as a public health emergency of international concern [8-10]. For the Congo, it was in March 2020 that the first case was detected and confirmed in Brazzaville on a subject who had stayed abroad. The same month, on March 17, 2020, four days after Brazzaville, Pointe-Noire reported its first case of COVID-19, also imported [11]. These two cities were subsequently the two epicenters of the pandemic in Congo.

Indeed, a national coordination was instituted by the government whose role was to develop a general policy for the response to COVID-19 in Congo. Technical commissions were created and special access was given to: Diagnosis, which was based on mass screening and screening of symptomatic or asymptomatic persons, contact cases and suspect cases by RT-PCR on nasopharyngeal swabs.

Therapeutic management, which was based on a protocol mainly consisting of three molecules: paracetamol, azithromycin and hydroxychloroquine. The aim of this study was to describe the epidemiological, diagnostic and therapeutic features that contributed to the management of COVID-19 patients in Pointe-Noire.

Materials and Method

This was a cross-sectional descriptive study. The situational analysis was based on the situation report (SITREP) No. 434, which includes data from the Pointe-Noire department since the declaration of the first case on March 17, 2020 until June 19, 2021, i.e. a period of 15 months.

Five (05) laboratories in the department were authorized and involved in the diagnosis of COVID-19, including: a public laboratory which is the branch of the National Public Health Laboratory housed in the laboratory of the General Hospital of Loandjili and four (04) private laboratories, namely: the HDL molecular biology laboratory of the Marie Madeleine GOMBES Foundation, the laboratory of the net-care clinic, the laboratory of the GUENIN clinic and the DEL laboratory The biological diagnosis was exclusively based on RT-PCR by combining the following steps:

Sampling

The sampling method was exclusively nasopharyngeal using different sampling kits such as: Transport Medium (MAN TACC, Miraclean technology Co., Ltd); NEST Disposable Sampler (Wuxi NEST Biotechnology Co., LTD); Total Nucleic Acid Preservation Tubes (Norgen BioTek CORP). In practice, a separable swab was introduced into the patient's nose by turning 2 to 3 times counterclockwise to collect nasopharyngeal cells. As soon as it was removed, the swab was placed in a tube containing a solution for transporting and storing viruses while waiting for extraction.

RNA Extraction

With filter column

Filter column extraction was performed using the following kits: Total Nucleic Acid Preservation (Norgen), QIAamp Viral RNA Mini Kit (250) (Qiagen), Favorgen Plant Total RNA Mini Kit (Favorgen), Nucleic Aci Isolation or Purification Reagent (Daagen), AccuPrep® DxViral RNA Extraction Kit (Bioneer).

These different nucleic acid extraction kits simplify the isolation of viral RNA from a wide range of sample types through a fast vacuum procedure. Nucleic acids bind specifically to the silica gel membrane while contaminants pass through. PCR inhibitors, such as divalent cations and proteins, are completely eliminated in three effective washing steps, leaving pure nucleic acids eluted in water or a buffer provided with the kit.

Optimized buffers lyze samples, stabilize nucleic acids and improve selective nucleic acid adsorption on the membrane. The alcohol is then added, and then the washing pads are used to remove impurities. Viral nucleic acids, genomic DNA and cellular RNA are eluted and ready for use in amplification or storage reactions at –20°C. Purified nucleic acids are free of proteins, nucleases and other impurities.

The filter column extraction was performed in five phases: Preparation of cell lysate from a viral suspension, binding of RNA to the column, washing of the column, RNA elution and storage of the RNA at -20°C for a few days or at -70°C for long term storage.

With Magnetic Ball

Magnetic ball extraction was performed using the Magnetic Viral RNA Extraction Kit (GALENVS) which is a fast and efficient method for the extraction and purification of viral RNA. The extraction procedure was performed in 3 steps: lysis/binding, washing and elution The Galenvs magnetiQ Viral Extraction Kit does not require the use of a lot of benchtop equipment. Only magnetic stand and RNase-free centrifuge tubes were needed to perform the RNA isolation protocol.

Extraction was performed as per the manufacturer's instructions by adding 100µl of nasopharyngeal sample into 1.5 ml microtubes provided in the kit.

RT-PCR amplification-Amplification Kits and Fluorochromes
The techniques are based on the principle of real-time RT-PCR, which involves two steps: reverse transcription of the RNA into complementary DNA using a reverse transcriptase (RT) and amplification of the viral target gene(s) using specific primers and probes labelled with different fluorochromes. The COVID-19 RT-PCR remains qualitative. The Ct (Cycle threshold) values or number of PCR cycles at which a fluorescent signal is detected during the reaction allows estimation of viral loads.

SARS COV-2 RNA amplifications were performed using seven (07) types of kits: 2019-nCoV TaqMan RT-PCR Kit (Norgen), DaAn Gene nCov RNA Kit (Daagen), Logix Smart™ Coronavirus 2019 (COVID-19) Test Kit (Logix Smart), SD Biosensor COVID 19 RT PCR Test Kit (nCoVBiosensor), Real-Time Fluorescent RT-PCR Test Kit for Detecting SARS-CoV-2 (BGI), Novel Coronavirus (2019-nCoV) Nucleic acid diagnostic kit (SANSURE BIOTECH). The different genes targeted were: ORF1ab, E, N, RdRP, and Fluorochromes were: FAM, HEX, VIC, Cy5, JOE, ROX and CF610.

Equipment Used
The following five types of instruments were used: MIC qPCR (Bio molecular System), GeneXpert (Cepheid), Q Tower 3G (Analytikjena), QIAquant 96 (QIAGEN) and DNA Technology DT prime 4 (DNA Technology).

MIC qPCR (Bio Molecular System)
Mic qPCR uses patented magnetic induction technology by heating samples and a forced air fan for cooling. All backed up with a robust 4-channel optical system. Each channel uses an independent high-intensity LED, photodetector, and filter assembly that combine to deliver unparalleled detection performance. With a fixed optical path and no moving parts, no optical alignment or calibration is required.

GeneXpert (Cepheid)
Sars-CoV-2 RNA identification was performed by real-time PCR using GeneXpert technology (CEPHEID), USA from the Xpert® HPV kit. The Xpert SARS-CoV-2 Assay is an automated test for the qualitative detection of SARS-CoV-2 RNA. These tests are designed to detect SARS-CoV-2. Xpert Xpress CoV-2/Flu/RSV plus and Xpert Xpress CoV-2 plus target the E, N2 and RdRP genes for robust sars-CoV-2 detection.

QIAquant 96 (QIAGEN), Q Tower 3G (Analytikjena), et DNA Technology DT Prime 4 (DNA Technology)
These qPCR instruments are high-performance real-time PCR systems that combine high-performance optical detection of qPCR products with a high-performance thermal block. The combination of high-quality thermal elements, fast heating and cooling rates and the fibre optic shuttle system allows shorter cycle times of up to 60 minutes for 40 cycles.

Interpretation of results
The results were interpreted taking into account the appearance of the different internal, positive and negative controls. Ct values were used to estimate the SARS-CoV-2 viral load in the sample. The lower the Ct value, the higher the estimated viral load.Thus, a result was considered positive when the Ct value was ≤ 35 according to the specific recommendations of our laboratory. A Ct value between 35> Ct≤38 was considered equivocal and a second sample was taken 2 days later, with the patient being quarantined pending confirmation of the diagnosis. A Ct >38 was considered to give a zero viral load and the result was negative.

Results

I-/Epidemiological situation
According to SITREP N°434 of June 19, 2021; 61,083 persons were tested for COVID-19 in the department of Pointe-Noire, of which 3,829 (6.27%) were declared positive.

COVID-19 Positive cases by age
Table I reports the distribution of positive cases according to age. The age groups of 30 to 39 years (25.1%) and that of 40 to 49 years (25.9%) are the most represented.

Table I: Age Distribution of COVID-19 Positive Cases

Age range (years)	Positive COVID-19 cases	
	N	%
Average age (years)	45 ± 14 years	
< 30	819	21,4
30-39	961	25,1
40-49	992	25,9
50-59	563	14,7
≥ 60	494	12,9
Total	3,829	100

1- COVID-19 positive cases by gender
Table II, represents the distribution of positive cases by sex, the male sex was the most represented gender with 75.3% of cases.

Table II: Distribution of positive cases by sex

Sex	COVID-19 Positive cases	
	N	%
Man	2,884	75,3
Wife	945	24,7
Total	3,829	100

2- Geolocation of COVID-19 positive cases by health district of the Pointe-Noire department
The department of Pointe-Noire is subdivided into 7 health districts still called health era. Figure 1 shows the distribution of COVID-19 positive cases according to the era of health.

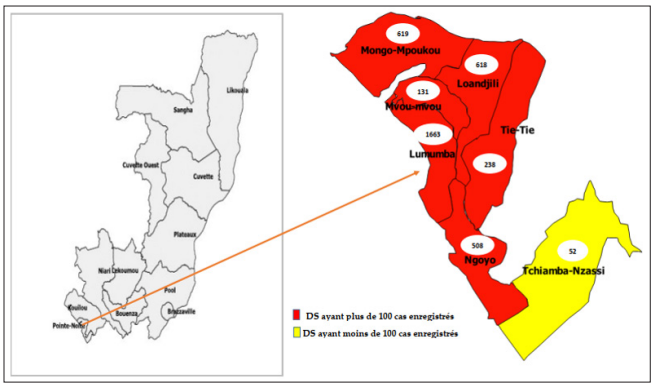

Figure 1: Geolocation of COVID-19 positives cases by health era in the department of Pointe-Noire from 17/03/2020 to 19/06/2021.

II-/ Molecular diagnosis

SARS-Cov-2 Extraction

Table III represents the different SARS COV-2 RNA extraction kits used in the 5 approved laboratories of the Pointe-Noire department.

Table III: Extraction Kits Used and Manufactured

Extraction kits	Manufacturer
Total Nucleic Acid Preservation	Norgen
QIAamp Viral RNA Mini Kit (250)	Qiagen
Favorgen Plant Total RNA Mini Kit	Favorgen
Nucleic Aci Isolation or Purification Reagent	Daagen
AccuPrep® DxViral RNA Extraction Kit	Bioneer
Magnetic Viral RNA Extraction Kit	Galenvs

1- Sars-Cov-2 amplification

a. SARS-Cov-2 Amplification Kits

The kits that allowed the amplification of SARS –Cov-2 are shown in Table IV.

Table IV: Amplification kits, manufacturer, target genes and associated fluorochromes

Names of amplification kits	Manufacturers	Countries	Target genes	Fluorochrome
2019-nCoV TaqMan RT-PCR Kit	Norgen	Canada	E et RdRP	FAM, HEX
DaAn Gene nCov RNA Kit	Daagen	China	ORF1 ab and N	FAM, Vic, Cy5
Logix Smart™ Coronavirus 2019 (COVID-19) Test Kit	Logix Smart	USA	RdRP	FAM, CF610
SD Biosensor COVID 19 RT PCR Test Kit	nCoVBiosensor	Kore	ORF1ab, E	FAM, Joe, Cy5
Real-Time Fluorescent RT-PCR Test Kit for Detecting SARS-CoV-2	BGI	China	ORF1 from	FAM, Vic ou Hex
Novel Coronavirus (2019-nCoV) Nucleic acid diagnostic kit	Biotech Sansure	China	ORF1 ab and N	FAM, Rox, Cy5

b. RT-PCR controllers used

Table V shows the types of equipment used in the 5 approved laboratories of the Pointe-Noire department for the detection of SARS-Cov-2.

Table V: SARS-CoV-2 Detection thermocyclers

Devices	Manufacturers	Countries
MIC qPCR	Bio molecular System	Canada
GeneXpert	Cepheid	USA
Q Tower 3G	Analytikjena	Allemagne
QIAquant 96	Qiagen	Allemagne
DNA Technology DT prime 4	DNA-Technology	Russie

c. Interpretation of SARS-COV-2 RT-PCR results

Table VI, shows the interpretation of the RT-PCR results of SRAS-COV-2 according to target genes, fluorochromes and Ct.

Table VI: Interpretation of RT-PCR SRAS-COV-2 findings

Gene E, ORF1ab (FAM)	Gene RdRP (HEX)	Gene N(Cy5)	Results
Ct ≤ 35			SRAS-COV-2 Positive
+	+	+	Positive
+	-	+	Positive
-	+	-	Negative
-	-	-	PCR Invalid

III-/ Treatment approach

The treatment regimen consisted mainly of 3 molecules (paracetamol, azytromicin and hydroxychloroquine). The treatment was spread over 10 days with PCR checks on days 15 and 21, according to the national COVID-19 treatment guidelines. In the case of adjuvant therapy, checks were performed on day 22 and/or day 28. These guidelines are common to both asymptomatic (initially, often symptomatic) and non-severe symptomatic forms.

• Adult and child over 12 years old:

Table VII shows the molecules used, the doses and the duration of treatment administered.

Table VII: Molecules used, doses and duration of treatment in adults and children aged 12 years and over

Molecules	Doses	Duration of treatment
Hydroxychloroquine ou Chloroquine (per os)	200mg x3/d for 5 days; then 200mgx2/d for 10 days	15 days
Azithromycine (per os)	500mg x2/d for 5 days; then 500mgx2/d for 5 days	10 days
Aluvia 200/50 mg (Lopinavir/ Ritonavir)	2 tablets x 2/d for 15 days	15 days

• Adjuvant treatments

To be combined according to the comorbidity and the clinical/functional state of the patient: Heparins, Celestamine, Loperamide (in case of diarrhoea), antihistamines, digestive dressings, hot drinks.

At the end of the 15-day treatment, an immune restoration period of 7 days must be observed and the first PCR control will be carried out on day 22; the second control on day 28.

In case of failure of PCR negativation, compliance was checked before a possible resumption of the treatment for a period of seven (7) to ten (10) days.

• Children under 12 years of age

Table VIII reports the molecules, the doses used and the duration of treatment in children under 12.

Table VIII: Molecules used, doses and duration of treatment in children under 12 years of age

Molecules	Dose	Duration of treatment
Hydroxychloroquine	200 to 300 mg/d	10 to 15 days
Azithromycine (per os)	250 to 500 mg/l	5 days
Azithromycine (per os)	250 mg/l	10 days
Lopinavir Ritonavir (if child > 5 years old)	1 tablet x 2 / days	15 days

Discussion

The COVID-19 pandemic has caused significant morbidity and mortality worldwide. The same fears and anxieties have been felt since its appearance in Congo. The aim of this study was to describe the epidemiological, diagnostic and therapeutic features that contributed to the management of COVID-19 patients in Pointe-Noire. The 30-39 and 40-49 age groups were the most infected with SARS-Cov-2, accounting for 25.1% and 25.9% of confirmed COVID-19 cases respectively. However, males were more infected than females accounting for 75.3% of cases. These data are similar to those reported by Yudong Yin et al, Sukhyun Ryu et al, and Amir et al [1, 12,13]. These data are contrary to that of F. Collart et al. in Belgium who reported that the two most affected age groups were 65-74 and 75-84 years [14]. The difference in age groups between Europe and Africa could be explained by the ageing of the European population in contrast to the very young African population. In addition, the weekly Epidemiological Surveillance Update on COVID-19 (SARS-CoV-2) from "Santé Publique France" reported that the risk of being hospitalized or dying from this virus increases exponentially with age. Compared to 40–44-year-olds, the risk of hospitalization is doubled in 60–64-year-olds, tripled in 70–74-year-olds, multiplied by 6 in 80–84-year-olds and by 12 in 90-year-olds and over [15].

Aging and age-related comorbidities that weaken people's immune systems are the most likely reasons for this difference.

This study established the distribution of confirmed cases of COVID-19 according to the seven (07) health districts of the Pointe-Noire department. Indeed, the Lumumba health district was the most infected with 43.43% of cases. This significant contamination can be explained by the fact that the District of Lumumba covers the city center of Pointe-Noire. This area alone concentrates most of the administrative and commercial, public and private structures of the city. These numerous human interactions would promote contamination and the spread of the virus.

The diagnosis of COVID-19 in the department of Pointe-Noire as in the rest of the country was carried out using the real-time RT-PCR technique. This allowed the viral genome of SARS-CoV-2 to be isolated with certainty from nasopharyngeal samples [16]. The SARS Cov-2 RNA extraction kits and RT-PCR amplification kits were the same as those used worldwide. These PCR kits targeted the same viral genes as those recommended by the WHO for the diagnosis of SARS-CoV-2 worldwide. Our real-time PCR equipment had the same characteristics as those used in the literature by several authors [17-22].

Reflecting the poor global knowledge level on the therapeutic management of COVID-19 positive patients, Congo had adopted a symptomatic treatment strategy based on knowledge to date. Thus, the therapeutic strategy in Congo included the following molecules: Hydroxychloroquine, Azithromicine and Lopinavir Ritonavir. To this can be added adjuvant treatments including heparin, celestamine, loperamide (in case of diarrhea), antihistamines, digestive dressings, hot drinks, which is associated according to the comorbidity and the clinical / functional state of the patient. Currently worldwide, there is a contrast in the use of hydroxychloroquine. Some studies have reported its effectiveness for its potential role in modulating inflammatory responses [23]. Thus, effective drugs described for managing patients with COVID-19 include remdesivir, lopinavir/ritonavir alone or in combination with beta interferon and monoclonal antibodies (MAbs) [23,24].

Conclusion

The government's response mechanism against COVID-19 has had a positive impact on the evolution of the disease in Congo. The combination of good compliance with barrier measures on the one hand, and the screening/diagnosis and management strategy on the other, have been the means that have effectively curbed the disease in our country.

Conflict of interest: None

References

1. Amir IJ, Lebar Z (2020) COVID-19: virology, epidemiology and biological diagnosis. Option/Bio 31:15.
2. Andersen KG, Rambaut A, Lipkin WI, Holmes EC, Garry RF (2020) The proximal origin of SARS-CoV-2. Nat Med 26: 450-2.
3. Wu P, Duan F, Luo C, Liu Q, Qu X, et al. (2020) Characteristics of ocular findings of patients with coronavirus disease 2019 (COVID-19) in Hubei Province, China. JAMA ophthalmology 138:575-578.
4. Zhu N, Zhang D, Wang W, Li X, Yang B, et al. (2020) A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med 382:727-33.
5. Wu Z, McGoogan JM (2020) Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. JAMA 323:1239-42.
6. Zhou P, Yang XL, Wang XG, Hu B, Zhang L, et al. (2020) A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature 579: 270-3.
7. Coronaviridae Study Group of the International Committee on Taxonomy of Viruses (2020) The species severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARSCoV-2. Nat Microbiol 5: 536-44.
8. WHO (2020) Novel Coronavirus (2019-nCoV) SITUATION REPORT - 1. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019-ncov.pdf .
9. He X, Lau EH, Wu P, Deng X, Wang J, et al. (2020) temporal dynamics in viral shedding and transmissibility of COVID19. Nat Med 26: 672-5.
10. B Pozzetto, M Delolme, J Rigaill, M Lleres Vadeboin, P Verhoeven, et al. (2021) Virological diagnostic tests for COVID19. Journal of Medical Biology 359:17-28.
11. Serge KOFFI (2020) COVID-19: first confirmed case in the Republic of Congo. Last updated: https://www.afro.who.int/news/first-case-COVID-19-confirmed-democratic-republic-congo .
12. Ryu S, Chun BC, of Epidemiology KS (2020) an interim review of the epidemiological characteristics of 2019 novel coronavirus. Epidemiology and health.
13. Yin Y, Wunderink RG (2018) MERS, SARS and other coronaviruses as causes of pneumonia. Respirology 23:130-137.
14. F Collart, L Mazzoleni, T Baudoux, G Cornet, JM Desmet, et al. (2020) Epidemiology of COVID-19 in French-speaking Belgium, Nephrology & Therapeutics 16: 248.
15. Anaïs Thiébaux Victims of COVID in France: age, men / women, diseases, Le Journal des femmes (2021) HEALTH. 11 :13.
16. Li Y, Yao L, Li J, Chen L, Song Y, et al. (2020) Stability issues of RT-PCR testing of SARS-CoV-2 for hospitalized patients clinically diagnosed with COVID-19. Journal of medical virology 92: 903-908.
17. Brown KA, Gubbay J, Hopkins J, Patel S, Buchan SA, et al. (2021) S-Gene Target Failure as a Marker of Variant B.1.1.7 among SARS-CoV-2 Isolates in the Greater Toronto Area, December 2020 to March 2021. JAMA 325: 2115-2116.
18. Artesi M, Bontems S, Gobbels P, Franckh M, Maes P, et al. (2020) A Recurrent Mutation at Position 26340 of SARS-CoV-2 Is Associated with Failure of the E Gene Quantitative Reverse Transcription-PCR Utilized in a Commercial Dual-Target Diagnostic Assay. J Clin Microbiol 58: e01598-20.
19. Hasan MR, Sundararaju S, Manickam C, Mirza F, Al-Hail H, et al. (2021) A Novel Point Mutation in the N Gene of SARS-CoV-2 May Affect the Detection of the Virus by Reverse Transcription-Quantitative PCR. J Clin Microbiol 59: e03278-20.
20. Afzal A (2020) Molecular diagnostic technologies for COVID-19: Limitations and challenges. J Adv Res 26: 149-59.
21. Wang R, Hozumi Y, Yin C, Wei GW (2020) Mutations on COVID-19 diagnostic targets. Genomics. 112: 5204-13.
22. Pachetti M, Marini B, Benedetti F, Giudici F, Mauro E, et al. (2020) Emerging SARS-CoV-2 mutation hot spots include a novel RNA-dependent-RNA polymerase variant. J Transl Med 18:179.
23. Dhama K, Khan S, Tiwari R, Sircar S, Bhat S, et al. (2020) Coronavirus Disease 2019–COVID-19. Clinical Microbiology Reviews 33: e00028-00020.
24. Sharma P, Tripathi S, Patel SK, Dhama K, Chandra R (2020) SARS-CoV-2/COVID-19 and its Transmission. Prevention, Treatment and Control–An Update, J Pure Appl Microbiol 14: 945-956.