Short Communication

In silico analysis of mismatches in RT-qPCR assays of 177 SARS-CoV-2 sequences from Brazil

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Abstract

Introduction: Quantitative reverse transcription polymerase chain reaction (RT-qPCR) can detect the severe acute respiratory syndrome Coronavirus-2 (SARS-CoV-2) in a highly specific manner. However, a decrease in the specificity of PCR assays for their targets may lead to false negative results. **Methods:** Here, 177 high-coverage complete SARS-CoV-2 genome sequences from 13 Brazilian states were aligned with 15 WHO recommended PCR assays. **Results:** Only 3 of the 15 completely aligned to all Brazilian sequences. Ten assays had mismatches in up to 3 sequences and two in many sequences. **Conclusion:** These results should be taken into consideration when using PCR-based diagnostics in Brazil.

Keywords: SARS-CoV-2. COVID-19. Polymerase chain reaction. Diagnosis. Mismatches.

Coronavirus disease 2019 (COVID-19) is a severe acute respiratory syndrome (SARS) caused by the new SARS Coronavirus-2 (SARS-CoV-2, previously known as 2019-nCoV)[1]. COVID-19 exhibits a wide range of symptoms, such as fever, cough, shortness of breath or difficulty breathing, repeated shaking with chills, muscle pain, headache, sore throat, and new loss of taste or smell[2]. While some patients may not develop all of the symptoms, others might experience symptoms not mentioned in the previous list[2]. The outbreak started in Wuhan, China, in December 2019, followed by a rapid and massive worldwide spread, which led to the current pandemic[1]. The pandemic reached Brazil in March 2020; nevertheless, it has caused 2,442,375 confirmed cases and 87,618 confirmed deaths as of July 27, 2020[3].

Several assays can be used to diagnose a patient with COVID-19. The polymerase chain reaction (PCR) technique is a molecular assay capable of detecting SARS-CoV-2 viral RNA with high specificity during the acute phase of infection. A wide variety of primers and probes were developed to detect this virus, mainly targeting the following genomic regions: ORF1ab, envelope genes (E), RNA-dependent RNA polymerase (RdRP), spike protein (S), and nucleocapsid (N)[4]. The high specificity of these molecular assays is directly related to the annealing specificity of the primer/probe to the genomic region. The World Health Organization (WHO) has recommended 26 primers and probes to be used in this type of diagnosis[5].

Recent studies have shown that the rate and pattern of mutations in the SARS-CoV-2 genome differ depending on environmental conditions[6]. The present study investigated the specificity of fifteen primer and probe sets recommended by the WHO in 177 SARS-CoV-2 Brazilian genomes.

The SARS-CoV-2 genome sequences were obtained from the Global Initiative on Sharing Avian Influenza Data-EpiCoV (GISAID-EpiCoV) platform (https://www.gisaid.org/)[7], an initiative for sharing genetic data of the SARS-CoV-2 virus. Only sequences submitted up to July 27, 2020, and complete genomes (above 29,000 bp) were included. A high coverage filter was applied, which means that only entries with less than 1% of undefined bases (stretches of NNNs) were tolerated, and Brazil was used as the location. The selected sequences were downloaded in FASTA format (**Supplementary Data S1**) and aligned using the ClustalW

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Multiple Alignment[8] tool of the BioEdit biological sequence editor 7.2.6[21]. The genome used as reference was the first strain identified in Wuhan (China) (GenBank: NC_045512.2).

Nucleotide sequences with incomplete specificity of bases and constructions for nested PCR were not included, therefore some constructions were not taken into account in the analysis. The fifteen primers and probes constructions used here (sequences depicted at **Figure 1**) are recommended for the diagnosis of COVID-19 through RT-qPCR by the World Health Organization (WHO) and were originally available and published by independent institutions in seven countries[1,5]: China, France, USA, Japan, Germany, Hong Kong, and Thailand. All primers and probes were searched against the aligned genomes.

A total of 177 SARS-CoV-2 complete genome sequences from Brazil, deposited before July 27, 2020, were obtained from GISAID-EpiCoV, and 470 strings were discarded as they did not achieve the requirement for high sequencing coverage. As shown in **Figure 1**, there are primers and probes with 100% hybridization against all sequences. However, many show with matching errors. For the N gene (**Figure 1A**), the Japanese PCR assay, NIID_2019-nCOV_N, showed 100% identity with the aligned sequences. However, most of the diagnostic assays recommended by WHO presented mismatches with the Brazilian SARS-CoV-2 sequences. The German Corman-N, Japanese N_Sarbeco, North American 2019-nCoV_N (N1, N2, and N3), and Thai NIH-TH_N presented 1 to 3 base pairs (bp) mismatches. The Chinese assays CN-CDC-N and HKU-N had a high frequency of mismatched sequences, 151 and 101, respectively, in view of the high prevalence of G28881A, G28882A, G28883C, and T29148C mutations. Unlike the mismatches found for the N gene, the targets against ORF1ab (**Figure 1B**) and E (**Figure 1C**) showed less frequent variability. The French nCoV_IP4 and Chinese CN-CDC-E assays demonstrated total identity to their motives. The other assays, nCoV_IP2, CN-

FIGURE 1: Alignment of PCR assays against the reference genome sequence (Genome Ref) and the mutated motifs. The occurrence of mismatch is indicated for each primer, forward (Fw) and reverse (Rv), and probe (Pr) for targets N (A), ORF1ab (B), and E (C). The frequency of a mutation among the 177 aligned sequences is shown on the side, if present.

CDC-ORF1ab, Charité-E, and E_Sarbeco showed low frequency of errors, such as 1 to 2 bp mismatches.

Thirteen out of the 26 Brazilian states contributed with the deposit of sequences until the collection date. Most of these sequences were from two states, Rio de Janeiro (RJ) 49.71% (88/177) and São Paulo (SP) 27.69% (49/177) (**Figure 2A**). Three of the four most frequent mutations found, G28881A, G28882A, and G28883C, were observed mainly in sequences from RJ (54.30 %) and SP (26.49 %) (**Figure 2B**). However, interestingly, the T29148C mutation was highly common among sequences collected from RJ (74.25 %) and was rarely seen in the sequences collected in SP (3.96 %) (**Figure 2C**). The remaining eleven states had less participation in the number of genomes deposited so far.

Several factors can interfere with the quality of a PCR analysis, and the perfect nucleotide identity match in primers/probes could be a determinant for successful amplification[9]. Our results reveal a total hybridization of PCR assays NIID_2019-nCOV_N, nCoV_IP4, and CN-CDC-E with all aligned sequences. In contrast, the assay devised by the US CDC, 2019-nCoV N3 as well as the German Corman-N and the Japanese N_Sarbeco assays, for N gene hybridization, presented mismatches at a 5 bp distance of their 3' end (**Table 1**). Base pairing errors in this region can be extremely harmful and directly affect amplification by increasing, on average, by 5 the cycle threshold (Ct) of a PCR analysis, which is a risk factor for a false-negative result[10,11] .

The assays 2019-nCoV (N1, N2, and N3), NIH-TH_N, nCoV_IP2, CN-CDC-ORF1ab, Charité-E, and E_Sarbeco, presented mismatches located in the 5' or central portion of their primers when aligned with the Brazilian viral genomes (**Table 1**). Although little information is known regarding the influence that mismatches in these regions of the primers may cause, it is important not to underestimate its potential impact in diagnosis[9]. In addition, mismatches were found for the American and Thai assays for the N gene and the Chinese assay for ORF1ab, in the 5', 3', and central portions and in the 5' portion of the probes, respectively, which might induce a decrease or even an absence of fluorescent signal, promoting unfaithful results[11]. Despite the lack of results on Brazilian sequences, Toms et al.[12] observed the presence of mismatches in the targets of these assays in several other countries.

Our results demonstrated a higher occurrence of four mismatches from the Chinese CN-CDC-N and HKU-N assays in the Brazilian genomes of SARS-CoV-2. The high frequency (**Figure 2A** and **Figure 2B**) of G28881A, G28882A, G28883C (151/177), and T29148C (101/177) mutations inside the target regions of both assays might deeply reduce the accuracy of its use in Brazilian samples. In a previous alignment analysis of 17,175 sequences (including 90 Brazilian sequences), the CN-CDC-N assay presented mismatches in more than 18.8% of the total aligned genomes[1]. In addition, the combination of multiple mismatches, as we found for CN-CDC-N, could directly decrease the amplification performance[9]. A South American study, which included 95 viral sequences deposited by Brazil, also through the GISAID platform, phylogenetically analyzed the genetic diversity of the virus and identified possible mutation hot spots for viral detection within the N gene[13]. This suggests that the use of tests

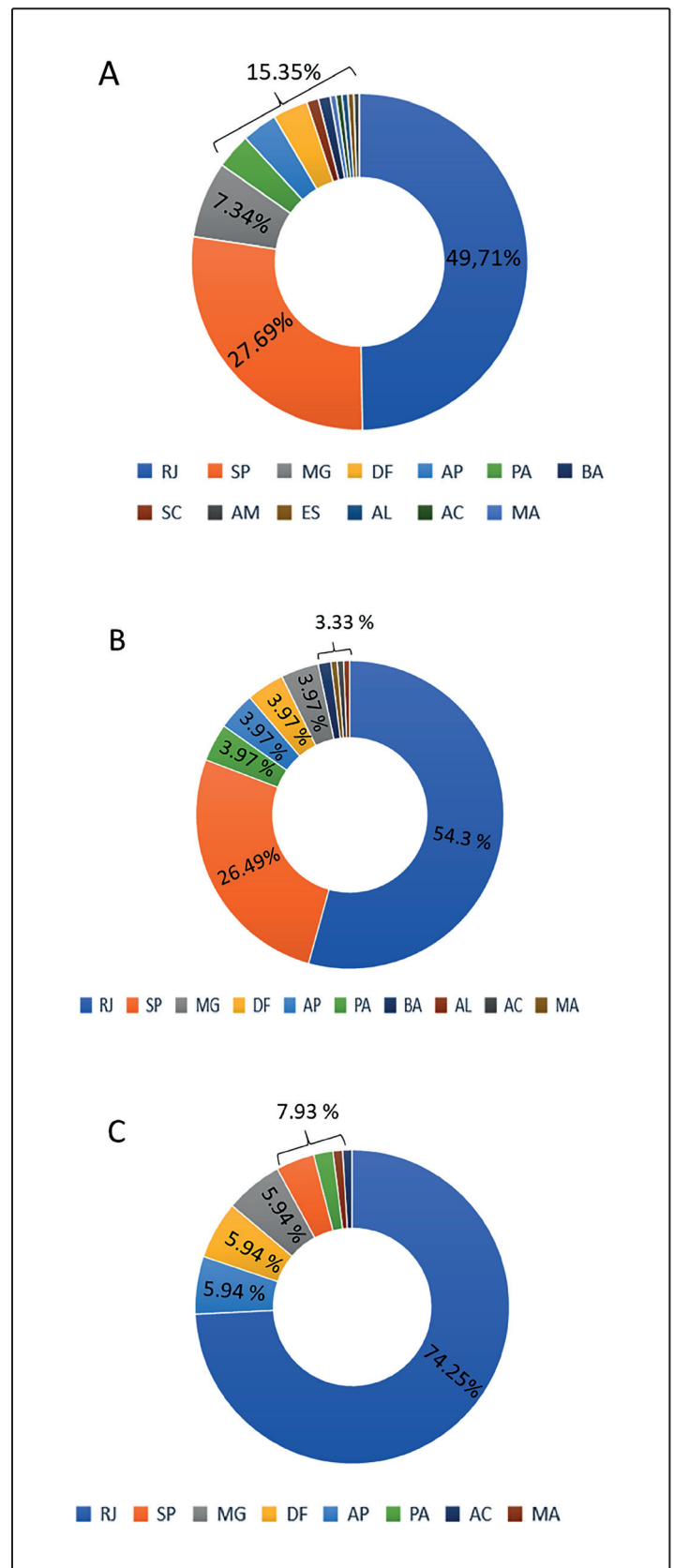**FIGURE 2:** (A) Brazilian SARS-Cov-2 genome sequences deposited in the GISAID-EpiCoV platform, divided by state: Rio de Janeiro (RJ), São Paulo (SP), Minas Gerais (MG), Distrito Federal (DF), Amapá (AP), Pará (PA), Bahia (BA), Santa Catarina (SC), Amazona (AM), Espírito Santo (ES), Alagoas (AL), Acre (AC) and Maranhão (MA). Occurrence of the G28881A, G28882A, G28883C (B), and T29148C (C) mutations in each state.

TABLE 1: List of analyzed assays by targets, frequency and location of mismatches. Each assay below includes three components, 2 primers and 1 probe. Both can be susceptible to matching errors.

Assays/Origen	Target	Total frequency of mismatches	Mismatches at 3' or 5' portion
US-CDC-N1/US-CDC	N	3/177	5' and 3'
US-CDC-N2/US-CDC	N	2/177	5'
US-CDC-N3/US-CDC	N	3/177	5' and 3'
NIID_2019-nCOV_N/Japan	N	0/177	-
N_Sarbeco/Japan	N	1/177	3'
CN-CDC-N/China	N	151/177	5'
HKU-N/Hong Kong	N	103/177	5' and 3'
NIH-TH_N/Thailand	N	2/177	5'
Corman-N/Germany	N	1/177	3'
nCoV_IP2/France	ORF1ab	1/177	5'
nCoV_IP4/France	ORF1ab	0/177	-
CN-CDC-ORF1ab/China	ORF1ab	2/177	5'
Charité-E/Germany	E	2/177	5'
CN-CDC-E/Germany	E	0/177	-
E_Sarbeco/France	E	2/177	5'

Note that the Chinese and Hong Kong assays for the N gene have many mismatches compared to the others. ORF1ab and E targets are less frequent in 3 'mismatches.

designed by the Chinese CDC and the University of Hong Kong needs to be carefully evaluated, in view of the existence of mutated strains in the targets of these assays in the Brazilian territory. This conclusion was also pointed out by Candido et al.[14] However, our results include additional data for May, June, and July and take into account only high-coverage sequences. The sequencing quality depends directly on a robust coverage[15], which is a key factor to be considered, especially in the evaluation of how mismatches could impact diagnosis.

Interestingly, molecular diagnoses by RT-PCR have shown a conflict with the hospital scenario and clinical parameters. Di Paolo et al.[16] reported what happened in an intensive care unit in Rome. At the admission of 69 patients on May 19, 13 of them (23.2%) had a high suspicion of presenting the disease based on clinical parameters and chest high-resolution computed tomography (HRCT). However, these patients obtained negative results for diagnostic RT-PCR in three independent analyses. In Beijing, cases of false-negatives by molecular results were identified in two out of ten cases (20%) at the beginning of the pandemic. Considering this issue, the National Health Commission of China established the concept of "Clinical diagnosis" for cases like these, using RT-PCR data for patient isolation matters[17].

Out of the 177 selected SARS-CoV-2 genome sequences, 77.4% (137/177) were from only two states (**Figure 2A**), SP and RJ, both located in the southeast region of the country. The 40 remaining sequences were divided among the states of Minas Gerais, Amapá, Pará, Bahia, Alagoas, Acre, Maranhão, Santa Catarina, Amazonas, Espírito Santo and Distrito Federal. SP and RJ were indeed very affected by the pandemic. However, other states, such as Ceará, Bahia, and Pará, were also deeply affected[3]. Nevertheless, the number of complete high-coverage sequences deposited for those states are not representative, or in some cases nonexistent. This vast distinction regarding the number of available sequences between SP and RJ and the other states may be due to their higher Human Development Index (HDI) associated with being the two largest economic centers in Brazil[18].

Other studies have evaluated the specificity of several PCR assays to sequences from different countries or continents[1,12]. They also found that the assays targeting N exhibited more mismatches than the others, which could be due to the existence of more published assays targeting this region. Additionally, the Chinese PCR assays exhibited a higher mismatch than any other assay when aligned to sequences from several countries. Although the mutation rate of SARS-CoV-2 is apparently lower than that of the first SARS-CoV, which has two mutations per human passage[19], periodic monitoring of the PCR assay protocols is necessary nonetheless.

From the 15 primers and probes analyzed in this study, our results suggest the PCR assays NIID_2019-nCOV_N, nCoV_IP4, and CN-CDC-E are ideal for SARS-CoV-2 diagnosis in Brazil. The selection of assays used in Brazil must be done with caution, considering that the use of primers and probes containing mismatches may lead to false negative results. Certainly, the imprecision of a final result may result from several factors such as incorrect sample handling, transport, storage, insufficient viral material, and contamination[20], but also from non-functional or poorly validated RT-PCR assays[13,16].

Until now, Brazil has not presented studies reporting the rate of false-negative cases of RT-PCR results, but these possible diagnostic failures may lead to incorrect conduct, contribute to breaks in social isolation, and impact on epidemiological surveillance, increasing the risk of infection.

As the number of high-coverage genomes deposited from states other than SP and RJ was low, our results have a regional bias. It is also important to highlight that we did not perform *in vitro* comparisons between the assays, and our conclusions are based solely on *in silico* analysis.

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AUTHOR'S CONTRIBUTIONS

RSS, RSCB, DML and KCST: designed the study; RSS and RSCB researched the data and performed the experiments; RSS, RSCB, DML, ACOMM, ARCB, ARAS and KCST: analyzed data and wrote the manuscript. All authors read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interests.

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SUPPLEMENTARY DATA S1: Sequences used for alignment, downloaded from the GISAID-EpiCoV platform.

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Identification of 177 deposited sequences using Virus name and Accession
ID provided by the GISAID-EpiCoV platform.

Virus name                   Accession ID
hCoV-19/Brazil/SP-01/2020     EPI_ISL_412964
hCoV-19/Brazil/SP-02/2020     EPI_ISL_413016
hCoV-19/Brazil/SP-03/2020     EPI_ISL_414014
hCoV-19/Brazil/SP-06/2020     EPI_ISL_414015
hCoV-19/Brazil/SP-05/2020     EPI_ISL_414016
hCoV-19/Brazil/SP-04/2020     EPI_ISL_414017
hCoV-19/Brazil/RJ-314/2020    EPI_ISL_414045
hCoV-19/Brazil/BA-312/2020    EPI_ISL_415105
hCoV-19/Brazil/ES-225/2020    EPI_ISL_415128
hCoV-19/Brazil/SP-07/2020     EPI_ISL_416028
hCoV-19/Brazil/SP-08/2020     EPI_ISL_416029
hCoV-19/Brazil/SP-09/2020     EPI_ISL_416031
hCoV-19/Brazil/SP-10/2020     EPI_ISL_416032
hCoV-19/Brazil/SP-11/2020     EPI_ISL_416033
hCoV-19/Brazil/SP-12/2020     EPI_ISL_416034
hCoV-19/Brazil/SP-13/2020     EPI_ISL_416035
hCoV-19/Brazil/SP-14/2020     EPI_ISL_416036
hCoV-19/Brazil/AMBR-02/2020   EPI_ISL_417034
hCoV-19/Brazil/DFBR-0001/2020 EPI_ISL_426580
hCoV-19/Brazil/AL-837/2020    EPI_ISL_427292
hCoV-19/Brazil/BA-510/2020    EPI_ISL_427293
hCoV-19/Brazil/DF-615i/2020   EPI_ISL_427294
hCoV-19/Brazil/DF-619i/2020   EPI_ISL_427295
hCoV-19/Brazil/DF-861/2020    EPI_ISL_427296
hCoV-19/Brazil/DF-862/2020    EPI_ISL_427297
hCoV-19/Brazil/DF-891/2020    EPI_ISL_427298
hCoV-19/Brazil/RJ-352/2020    EPI_ISL_427299
hCoV-19/Brazil/RJ-477/2020    EPI_ISL_427300
hCoV-19/Brazil/RJ-477i/2020   EPI_ISL_427301
hCoV-19/Brazil/RJ-763/2020    EPI_ISL_427302
hCoV-19/Brazil/RJ-818/2020    EPI_ISL_427303
hCoV-19/Brazil/RJ-872/2020    EPI_ISL_427304
hCoV-19/Brazil/SC-766/2020    EPI_ISL_427305
hCoV-19/Brazil/SC-769/2020    EPI_ISL_427306
hCoV-19/Brazil/CV4/2020       EPI_ISL_429667
hCoV-19/Brazil/CV6/2020       EPI_ISL_429669
hCoV-19/Brazil/CV8/2020       EPI_ISL_429671
hCoV-19/Brazil/CV12/2020      EPI_ISL_429674
hCoV-19/Brazil/CV16/2020      EPI_ISL_429676
hCoV-19/Brazil/CV19/2020      EPI_ISL_429679
hCoV-19/Brazil/CV21/2020      EPI_ISL_429681
hCoV-19/Brazil/CV26/2020      EPI_ISL_429684
hCoV-19/Brazil/CV31/2020      EPI_ISL_429687
hCoV-19/Brazil/CV32/2020      EPI_ISL_429688
hCoV-19/Brazil/CV33/2020      EPI_ISL_429689
hCoV-19/Brazil/CV42/2020      EPI_ISL_429695
hCoV-19/Brazil/CV49/2020      EPI_ISL_429702
hCoV-19/Brazil/SP02cc/2020    EPI_ISL_450506
hCoV-19/Brazil/AP161167-IEC/2020  EPI_ISL_450873
hCoV-19/Brazil/PA161548-IEC/2020  EPI_ISL_450874
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hCoV-19/Brazil/RJ-899/2020    EPI_ISL_456071
hCoV-19/Brazil/RJ-1056/2020   EPI_ISL_456072
hCoV-19/Brazil/RJ-1058/2020   EPI_ISL_456073
hCoV-19/Brazil/RJ-1065/2020   EPI_ISL_456074
hCoV-19/Brazil/RJ-1100/2020   EPI_ISL_456075
hCoV-19/Brazil/RJ-1111/2020   EPI_ISL_456076
hCoV-19/Brazil/RJ-1119/2020   EPI_ISL_456077
hCoV-19/Brazil/RJ-1402/2020   EPI_ISL_456079
hCoV-19/Brazil/RJ-1464/2020   EPI_ISL_456080
hCoV-19/Brazil/RJ-1466/2020   EPI_ISL_456081
hCoV-19/Brazil/RJ-1600/2020   EPI_ISL_456082
hCoV-19/Brazil/RJ-1627/2020   EPI_ISL_456083
hCoV-19/Brazil/RJ-1690/2020   EPI_ISL_456084
hCoV-19/Brazil/RJ-1691/2020   EPI_ISL_456085
hCoV-19/Brazil/RJ-1701/2020   EPI_ISL_456086
hCoV-19/Brazil/RJ-1702/2020   EPI_ISL_456087
hCoV-19/Brazil/RJ-1719/2020   EPI_ISL_456088
hCoV-19/Brazil/RJ-1901/2020   EPI_ISL_456089
hCoV-19/Brazil/RJ-1902/2020   EPI_ISL_456090
hCoV-19/Brazil/RJ-1921/2020   EPI_ISL_456091
hCoV-19/Brazil/RJ-1923/2020   EPI_ISL_456092
hCoV-19/Brazil/RJ-1927/2020   EPI_ISL_456093
hCoV-19/Brazil/RJ-1943/2020   EPI_ISL_456094
hCoV-19/Brazil/RJ-1948/2020   EPI_ISL_456095
hCoV-19/Brazil/RJ-1952/2020   EPI_ISL_456096
hCoV-19/Brazil/RJ-1966/2020   EPI_ISL_456097
hCoV-19/Brazil/RJ-2000/2020   EPI_ISL_456098
hCoV-19/Brazil/RJ-2007/2020   EPI_ISL_456099
hCoV-19/Brazil/RJ-2033/2020   EPI_ISL_456100
hCoV-19/Brazil/RJ-2044/2020   EPI_ISL_456101
hCoV-19/Brazil/RJ-2057/2020   EPI_ISL_456102
hCoV-19/Brazil/RJ-2062/2020   EPI_ISL_456103
hCoV-19/Brazil/RJ-2072/2020   EPI_ISL_456104
hCoV-19/Brazil/RJ-2077/2020   EPI_ISL_456105
hCoV-19/Brazil/RJ-2078/2020   EPI_ISL_456106
hCoV-19/Brazil/AP162741-IEC/2020    EPI_ISL_458138
hCoV-19/Brazil/AC162535-IEC/2020    EPI_ISL_458139
hCoV-19/Brazil/PA162802-IEC/2020    EPI_ISL_458140
hCoV-19/Brazil/PA164239-IEC/2020    EPI_ISL_458141
hCoV-19/Brazil/AP162966-IEC/2020    EPI_ISL_458142
hCoV-19/Brazil/AP164082-IEC/2020    EPI_ISL_458143
hCoV-19/Brazil/AP163972-IEC/2020    EPI_ISL_458144
hCoV-19/Brazil/AP164346-IEC/2020    EPI_ISL_458145
hCoV-19/Brazil/PA164173-IEC/2020    EPI_ISL_458146
hCoV-19/Brazil/PA164218-IEC/2020    EPI_ISL_458147
hCoV-19/Brazil/PA164684-IEC/2020    EPI_ISL_458148
hCoV-19/Brazil/MA163069-IEC/2020    EPI_ISL_458149
hCoV-19/Brazil/RJ-1555/2020   EPI_ISL_467344
hCoV-19/Brazil/RJ-1574/2020   EPI_ISL_467345
hCoV-19/Brazil/RJ-1595/2020   EPI_ISL_467346
hCoV-19/Brazil/RJ-2091/2020   EPI_ISL_467347
hCoV-19/Brazil/RJ-2195/2020   EPI_ISL_467348
hCoV-19/Brazil/RJ-2197/2020   EPI_ISL_467349
hCoV-19/Brazil/RJ-2208/2020   EPI_ISL_467350
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hCoV-19/Brazil/RJ-2233/2020    EPI_ISL_467351
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hCoV-19/Brazil/UFRJ-IBEX_32317/2020     EPI_ISL_492040
hCoV-19/Brazil/UFRJ-IBEX_32321/2020     EPI_ISL_492041
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hCoV-19/Brazil/UFRJ-IBEX_58271/2020     EPI_ISL_492048
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SUPPLEMENTARY DATA S2: List of laboratories involved in the deposition of viral sequences.

...lly acknowledge the following Authors from the Originating laboratories responsible for obtaining the specimens, as well as the ...laboratories where the genome data were generated and shared via GISAID, on which this research is based.

...ers of data may be contacted directly via www.gisaid.org

Accession ID	Originating Laboratory	Submitting Laboratory	Authors
EPI_ISL_412964	Hospital Israelita Albert Einstein	Instituto Adolfo Lutz Interdisciplinary Procedures Center Strategic Laboratory	Jaqueline Goes de Jesus, Claudio Tavares Sacchi, Daniela Bernardes Borges da Silva, Ingra Morales Claro, Flávia Cristina da Silva Sales, Claudia Regina Gonçalves, Joshua Quick, Maria do Car... Tavares Timenetsky, Nicholas James Loman, Andrew Rambaut, Ester Cerdeira Sabino, Nuno Rodrigues Faria
EPI_ISL_413016	Hospital Israelita Albert Einstein	Instituto Adolfo Lutz, Interdisciplinary Procedures Center, Strategic Laboratory	Jaqueline Goes de Jesus, Claudio Tavares Sacchi, Daniela Bernardes Borges da Silva, Ingra Morales Claro, Flávia Cristina da Silva Sales, Claudia Regina Gonçalves, Joshua Quick, Maria do Car... Tavares Timenetsky, Nicholas James Loman, Andrew Rambaut, Ester Cerdeira Sabino, Nuno Rodrigues Faria
EPI_ISL_414014	Hospital Israelita Albert Einstein	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Carlos Henrique Camargo, Maria do Carmo Sampaito Tavares Timenetsky, Terezinha Maria de Paiva, Ester Cerd...
EPI_ISL_414015	Hospital São Joaquim Beneficencia Portuguesa	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, SimoneGuadagnucci Morillo, Carlos Henrique Camargo, Maria do Carmo Sampaito Tavares Timenetsky, Fabiana Cristina Pereira dos Sant... Maria de Paiva, Ester Cerdeira Sabino
EPI_ISL_414016	Hospital São Joaquim Beneficencia Portuguesa	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Audrey Cilli, Carlos Henrique Camargo, Maria do Carmo Sampaito Tavares Timenetsky, Daniela Bernardes Borges da Silva, Terezinha Mar...
EPI_ISL_414017	Hospital São Joaquim Beneficencia Portuguesa	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Fabiana Cristina Pereira dos Santos, Carlos Henrique Camargo, Maria do Carmo Sampaito Tavares Timenetsky, Daniela Bernardes Borge... Terezinha Maria de Paiva, Ester Cerdeira Sabino
EPI_ISL_414045	LACEN RJ - Laboratório Central de Saúde Pública Noel Nutels	Instituto Oswaldo Cruz FIOCRUZ - Laboratory of Respiratory Viruses and Measles (LVRS)	Paola Resende, Alisson Fabri, Joilson Xavier, Sunando Roy, Fernando Motta, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Jonathan Lopes, Luciana Appo... Nóbrega, Marilda Siqueira
EPI_ISL_415105	Laboratório Central de Saúde Pública Professor Gonçalo Moniz – LACEN/BA	Instituto Oswaldo Cruz FIOCRUZ - Laboratory of Respiratory Viruses and Measles (LVRS)	Paola Resende, Allison Fabri, Joilson Xavier, Sunando Roy, Fernando Motta, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Jonathan Lopes, Luciana Appo... Nóbrega, Marilda Siqueira
EPI_ISL_415128	LACEN/ES - Laboratório Central de Saúde Pública do Espírito Santo	Instituto Oswaldo Cruz FIOCRUZ - Laboratory of Respiratory Viruses and Measles (LVRS)	Paola Resende, Allison Fabri, Joilson Xavier, Sunando Roy, Fernando Motta, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Jonathan Lopes, Luciana Appo... Nóbrega, Marilda Siqueira
EPI_ISL_416028	National Influenza Center - Instituto Adolfo Lutz	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Carlos Henrique Camargo, Fabiana Cristina Pereira dos Santos, Daniela Bernardes Borges da Silva, Simone Guadagnucci Morillo, Adriano Al... Bugno, Maria do Carmo Sampaio Tavares Timenetsky, Terezinha Maria de Paiva
EPI_ISL_416029	Laboiratório Fleury	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Carlos Henrique Camargo, Fabiana Cristina Pereira dos Santos, Daniela Bernardes Borges da Silva, Simone Guadagnucci Morillo, Adriano Al... Bugno, Maria do Carmo Sampaio Tavares Timenetsky, Terezinha Maria de Paiva
...ISL_416031, EPI_ISL_416032	National Influenza Center - Instituto Adolfo Lutz	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Carlos Henrique Camargo, Fabiana Cristina Pereira dos Santos, Daniela Bernardes Borges da Silva, Simone Guadagnucci Morillo, Adriano Al... Bugno, Maria do Carmo Sampaio Tavares Timenetsky, Terezinha Maria de Paiva
...ISL_416033, EPI_ISL_416034	Hospital Israelita Albert Einstein	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Carlos Henrique Camargo, Erica Valessa Ramos Gomes, Fabiana Cristina Pereira dos Santos, Daniela Bernardes Borges da Silva, Simone G... Morillo, Adriano Abbud, Adriana Bugno, Maria do Carmo Sampaio Tavares Timenetsky, Terezinha Maria de Paiva
...ISL_416035, EPI_ISL_416036	National Influenza Center - Instituto Adolfo Lutz	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Carlos Henrique Camargo, Erica Valessa Ramos Gomes, Fabiana Cristina Pereira dos Santos, Daniela Bernardes Borges da Silva, Simone G... Morillo, Adriano Abbud, Adriana Bugno, Maria do Carmo Sampaio Tavares Timenetsky, Terezinha Maria de Paiva
EPI_ISL_417034	Laboratorio de Ecologia de Doencas Transmissiveis na Amazonia, Instituto Leonidas e Maria Deane - Fiocruz Amazonia	Laboratorio de Ecologia de Doencas Transmissiveis na Amazonia, Instituto Leonidas e Maria Deane - Fiocruz Amazonia	Valdinete Nascimento, André Corado, Fernanda Nascimento, Ágatha Costa, Debora Duarte, Luciana Gonçalves, Michele Jesus, Sérgio Luz, Felipe Naveca
EPI_ISL_426580	Instituto Sabin	Laboratory of Virology	Fernando L Melo,Gustavo Barra, Ticiane H Santa-Rita, Pedro G Mesquita, Ikaro A Andrade, Tatsuya Nagata, Bergmann M Ribeiro
EPI_ISL_427292	LACEN-AL - Laboratorio Central de Alagoas	Instituto Oswaldo Cruz FIOCRUZ - Laboratory of Respiratory Viruses and Measles (LVRS)	Paola Resende, Fernando Motta, Luciana Appolinario, Sunando Roy, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Priscila Born, Jonathan Lopes, Maril...
EPI_ISL_427293	LACEN-BA - Laboratório Central de Saúde Pública Professor Gonçalo Moniz	Instituto Oswaldo Cruz FIOCRUZ - Laboratory of Respiratory Viruses and Measles (LVRS)	Paola Resende, Fernando Motta, Luciana Appolinario, Sunando Roy, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Priscila Born, Jonathan Lopes, Maril...
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see above	Instituto Oswaldo Cruz FIOCRUZ - Laboratory of Respiratory Viruses and Measles (LVRS)	Instituto Oswaldo Cruz FIOCRUZ - Laboratory of Respiratory Viruses and Measles (LVRS)	Paola Resende, Fernando Motta, Luciana Appolinario, Sunando Roy, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Priscila Born, Jonathan Lopes, Maril...
...ISL_427305, EPI_ISL_427306	LACEN-SC - Laboratorio Central de Santa Catarina	Instituto Oswaldo Cruz FIOCRUZ - Laboratory of Respiratory Viruses and Measles (LVRS)	Paola Resende, Fernando Motta, Luciana Appolinario, Sunando Roy, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Priscila Born, Jonathan Lopes, Maril...
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see above	Central Public Health Laboratory/Octávio Magalhães Institute (IOM) from the Ezequiel Dias Foundation (FUNED)	Instituto Octávio Magalhães / Fundação Ezequiel Dias (IOM/Funed)	Talita Adelino, Joilson Xavier, Marta Giovanetti, Vagner Fonseca, Marcos Vinícius Silva, Luiz Carlos Junior Alcantara, Marluce Aparecida Assunção Oliveira
EPI_ISL_450873	Evandro Chagas Institute	Evandro Chagas Institute	Santos, M.C.; Silva, A.M.; Junior, W.D.C.; Barbagelata, L.S.; Ferreira, J.A.; Sousa, E.M.A.; da Silva, P.S.; Martins, L.C.; Sousa Junior, E.C.; Viana, G.M.R
EPI_ISL_450874	Evandro Chagas Institute	Evandro Chagas Institute	Santos, M.C.; Silva, A.M.; Junior, W.D.C.; Barbagelata, L.S.; Ferreira, J.A.; Sousa, E.M.A.; da Silva, P.S.; Martins, L.C.;Sousa Junior, E.C.;Viana, G.M.R
...71, EPI_ISL_456072, EPI_ISL_456073, ISL_456074, EPI_ISL_456075	Laboratory of Respiratory Viruses and Measles, Oswaldo Cruz Institute, FIOCRUZ	Laboratory of Respiratory Viruses and Measles, Oswaldo Cruz Institute, FIOCRUZ	Paola Resende, Luciana Appolinario, Fernando Motta, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Jonathan Lopes, Marilda Siqueira
ISL_456076, EPI_ISL_456077	LACEN RJ - Laboratório Central de Saúde Pública Noel Nutels	Laboratory of Respiratory Viruses and Measles, Oswaldo Cruz Institute, FIOCRUZ	Paola Resende, Luciana Appolinario, Fernando Motta, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Jonathan Lopes, Marilda Siqueira
...079, EPI_ISL_456080, EPI_ISL_456081	Laboratory of Respiratory Viruses and Measles, Oswaldo Cruz Institute, FIOCRUZ	Laboratory of Respiratory Viruses and Measles, Oswaldo Cruz Institute, FIOCRUZ	Paola Resende, Luciana Appolinario, Fernando Motta, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Jonathan Lopes, Marilda Siqueira
ISL_456082, EPI_ISL_456083	LACEN RJ - Laboratório Central de Saúde Pública Noel Nutels	Laboratory of Respiratory Viruses and Measles, Oswaldo Cruz Institute, FIOCRUZ	Paola Resende, Luciana Appolinario, Fernando Motta, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Jonathan Lopes, Marilda Siqueira
...84, EPI_ISL_456085, EPI_ISL_456086, EPI_ISL_456087	Laboratory of Respiratory Viruses and Measles, Oswaldo Cruz Institute, FIOCRUZ	Laboratory of Respiratory Viruses and Measles, Oswaldo Cruz Institute, FIOCRUZ	Paola Resende, Luciana Appolinario, Fernando Motta, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Jonathan Lopes, Marilda Siqueira
EPI_ISL_456088	LACEN RJ - Laboratório Central de Saúde Pública Noel Nutels	Laboratory of Respiratory Viruses and Measles, Oswaldo Cruz Institute, FIOCRUZ	Paola Resende, Luciana Appolinario, Fernando Motta, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Jonathan Lopes, Marilda Siqueira
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see above	Laboratory of Respiratory Viruses and Measles, Oswaldo Cruz Institute, FIOCRUZ	Laboratory of Respiratory Viruses and Measles, Oswaldo Cruz Institute, FIOCRUZ	Paola Resende, Luciana Appolinario, Fernando Motta, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Jonathan Lopes, Marilda Siqueira
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see above	Evandro Chagas Institute	Evandro Chagas Institute	Santos, M.C.; Silva, A.M.; Junior, W.D.C.; Barbagelata, L.S.; Ferreira, J.A.; Sousa, E.M.A.; da Silva, P.S.; Resque, H.R; Martins, L.C.; Sousa Junior, E.C.;Viana, G.M.R
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see above	Laboratory of Respiratory Viruses and Measles, Oswaldo Cruz Institute, FIOCRUZ	Laboratory of Respiratory Viruses and Measles, Oswaldo Cruz Institute, FIOCRUZ	Paola Resende, Luciana Appolinario, Fernando Motta, Anna Carolina Paixão, Ana Carolina Mendonça, Aline Mattos, Milene Miranda, Cristiana Garcia, Braulia Caetano, Maria Ogrzewalska, Jona... Marilda Siqueira
ISL_468305, EPI_ISL_468307	Centro de Vigilancia a Saude de Diadema	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_468308	Hospital Municipal do Tatuape Carmino Caricchio	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_468310	Hospital Sao Paulo de Ensino da UNIFESP	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
ISL_468311, EPI_ISL_468312	Hospital Municipal Dr Ignacio Proenca de Gouvea	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_468313	Vigilancia Epidemiologica de São Bernardo do Campo	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_468314	CTA Centro de Testagem e Aconselhamento	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_468315	Hospital Municipal do Tatuape Carmino Caricchio	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_468316	UPA Vila Assis	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_468318	Hospital Universitario da USP	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes

ID	Location	Submitting Lab	Authors
EPI_ISL_468321	Hospital Universitario da USP	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471539	Hospital Universitario da USP Sao Paulo	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471541	Hospital Geral Santa Marcelina	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471542	Secretaria de Saude de Mogi das Cruzes	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471543	Centro de Saude I Tacito Leite de Carvalho e Silva	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471545	Hospital Sao Paulo de Ensino da Unifesp	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471546	AMA DR Jose Soares Hungria	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471548	Hospital do Servidor Público Estadual Francisco Morato de Oliveira	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471549	Hospital Municipal Carmen Prudente	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471551	Hospital Sao Paulo de Ensino da Unifesp	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471552	Hospital Sancta Maggiore	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471554	Hospital Bosque da Saúde	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471556	Pronto Socorro Jose Ibrahin	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
562, EPI_ISL_471581, EPI_ISL_471582	Hosp. Municipal Prof. Dr. Alípio Corrêa Netto	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471647	Hospital Municipal de Barueri Dr. Francisco Moran	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_471648	UBS e Pronto Socorro Jd. Jacira	Instituto Adolfo Lutz, Interdiciplinary Procedures Center, Strategic Laboratory	Claudio Tavares Sacchi, Claudia Regina Gonçalves, Erica Valessa Ramos Gomes
EPI_ISL_476221	Laboratory Fleury	Instituto de Medicina Tropical da Univesdade de São Paulo	Samples: Celso Granato; Sequencing: Ingra Morales Claro, Jaqueline Goes de Jesus, Erika Regina Manuli, Flavia Cristina da Silva Sales, Thais de Moura Coletti, Camila Alves Maia da Silva, Mar Ramundo, Giula Magalhaes Ferreira, Darlan da Silva Candido, Julien Theze, Nuno Faria, Ester Sabino
82, EPI_ISL_476288, EPI_ISL_476289, EPI_ISL_476297	DB Diagnósticos do Brasil	Instituto de Medicina Tropical da Univesdade de São Paulo	Samples: Nelson Gaburo Jr; Sequencing: Ingra Morales Claro, Jaqueline Goes de Jesus, Erika Regina Manuli, Flavia Cristina da Silva Sales, Thais de Moura Coletti, Camila Alves Maia da Silva, Mar Ramundo, Giula Magalhaes Ferreira, Darlan da Silva Candido, Julien Theze, Nuno Faria, Ester Sabino
EPI_ISL_476341	Laboratório de Patologia Clínica - UNICAMP	Laboratório de Estudos de Vírus Emergentes - UNICAMP	José Luiz Proença-Modena, Magnun Nueldo Nunes dos Santos, Angelica Schreiber, Julia Forato,Camila Simeoni, Marcilio Jorge Fumagalli, Mariene Ribeiro Amorim, Darlan da Silva Candido, Nu Faria, Julien Theze, Luiz Gonzaga,Jaqueline Goes Jesus e William Marciel de Souza
EPI_ISL_476373	Hospital da Clínicas da Faculdade de Medicina da Universidade de São Paulo	Instituto de Medicina Tropical da Univesdade de São Paulo	Samples: Ingra Morales Claro, Erika Regina Manuli, Cecilia Salete Alencar, Carolina S. Lazar, Silvia F. Costa; Sequencing: Ingra Morales Claro, Jaqueline Goes de Jesus, Erika Regina Manuli, Flav Silva Sales, Thais de Moura Coletti, Camila Alves Maia da Silva, Mariana Severo Ramundo, Giula Magalhaes Ferreira, Darlan da Silva Candido, Julien Theze, Nuno Faria, Ester Sabin
ISL_476395, EPI_ISL_476398	Laboratório de Patologia Clínica - UNICAMP	Laboratório de Estudos de Vírus Emergentes - UNICAMP	José Luiz Proença-Modena, Magnun Nueldo Nunes dos Santos, Angelica Schreiber, Julia Forato,Camila Simeoni, Marcilio Jorge Fumagalli, Mariene Ribeiro Amorim, Darlan da Silva Candido, Nu Faria, Julien Theze, Luiz Gonzaga,Jaqueline Goes Jesus e William Marciel de Souza
35, EPI_ISL_476439, EPI_ISL_476445, 146, EPI_ISL_476469, EPI_ISL_476490	Hospital da Clínicas da Faculdade de Medicina da Universidade de São Paulo	Instituto de Medicina Tropical da Univesdade de São Paulo	Samples: Ingra Morales Claro, Erika Regina Manuli, Cecilia Salete Alencar, Carolina S. Lazar, Silvia F. Costa; Sequencing: Ingra Morales Claro, Jaqueline Goes de Jesus, Erika Regina Manuli, Flav Silva Sales, Thais de Moura Coletti, Camila Alves Maia da Silva, Mariana Severo Ramundo, Giula Magalhaes Ferreira, Darlan da Silva Candido, Julien Theze, Nuno Faria, Ester Sabin
EPI_ISL_483065	Centro de Desenvolvimento Tecnologico em Saude, Fundacao Oswaldo Cruz	Centro de Desenvolvimento Tecnologico em Saude, Fundacao Oswaldo Cruz	Souza,T.M., Fintelman-Rodrigues,N., De Paula,A.D., Tschoeke,D., Barroso,S.P., Gregorio,M.L., Oliveira,J.S., Saraiva,F.B., Ferreira,M.A., Sacramento,C.Q.
EPI_ISL_492032	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza , Marcos Dornelas-Ribeiro, Tatiana LS Nogueira, Nádia Vaez Gonçalves da Cruz, Caleb GM Santos, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492033	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza, Caleb GM Santos, Marcos Dornelas-Ribeiro, Tatiana LS Nogueira, Nádia Vaez Gonçalves da Cruz, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492034	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza, Nádia Vaez Gonçalves da Cruz, Caleb GM Santos, Marcos Dornelas-Ribeiro, Tatiana LS Nogueira, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492035	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza, Tatiana LS Nogueira, Nádia Vaez Gonçalves da Cruz, Caleb GM Santos, Marcos Dornelas-Ribeiro, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492036	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza , Marcos Dornelas-Ribeiro, Tatiana LS Nogueira, Nádia Vaez Gonçalves da Cruz, Caleb GM Santos, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492037	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza, Caleb GM Santos, Marcos Dornelas-Ribeiro, Tatiana LS Nogueira, Nádia Vaez Gonçalves da Cruz, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492038	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza, Nádia Vaez Gonçalves da Cruz, Caleb GM Santos, Marcos Dornelas-Ribeiro, Tatiana LS Nogueira, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492039	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza, Tatiana LS Nogueira, Nádia Vaez Gonçalves da Cruz, Caleb GM Santos, Marcos Dornelas-Ribeiro, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492040	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza , Marcos Dornelas-Ribeiro, Tatiana LS Nogueira, Nádia Vaez Gonçalves da Cruz, Caleb GM Santos, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492041	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza, Caleb GM Santos, Marcos Dornelas-Ribeiro, Tatiana LS Nogueira, Nádia Vaez Gonçalves da Cruz, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492042	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza, Nádia Vaez Gonçalves da Cruz, Caleb GM Santos, Marcos Dornelas-Ribeiro, Tatiana LS Nogueira, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492043	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza, Tatiana LS Nogueira, Nádia Vaez Gonçalves da Cruz, Caleb GM Santos, Marcos Dornelas-Ribeiro, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492044	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza , Marcos Dornelas-Ribeiro, Tatiana LS Nogueira, Nádia Vaez Gonçalves da Cruz, Caleb GM Santos, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492045	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza, Caleb GM Santos, Marcos Dornelas-Ribeiro, Tatiana LS Nogueira, Nádia Vaez Gonçalves da Cruz, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492046	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza, Nádia Vaez Gonçalves da Cruz, Caleb GM Santos, Marcos Dornelas-Ribeiro, Tatiana LS Nogueira, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492047	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza, Tatiana LS Nogueira, Nádia Vaez Gonçalves da Cruz, Caleb GM Santos, Marcos Dornelas-Ribeiro, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva
EPI_ISL_492048	Instituto de Biologia do Exército	Laboratório Metabolismo Macromolecular FirminoTorres de Castro, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro	Bianca Catarina Azevedo Cabral, Aline Rosa Vianna de Souza , Marcos Dornelas-Ribeiro, Tatiana LS Nogueira, Nádia Vaez Gonçalves da Cruz, Caleb GM Santos, Elizabeth Valentin, Marcio da C Virginia Sara Grancieri do Amaral, Rodrigo Soares de Moura Neto, Clarissa Damaso, Rosane Silva