CSP CADERNOS DE SAÚDE PÚBLICA
REPORTS IN PUBLIC HEALTH

PERSPECTIVAS
PERSPECTIVES

The novel coronavirus (SARS-CoV-2) emergency and the role of timely and effective national health surveillance

Emergência do novo coronavírus (SARS-CoV-2) e o papel de uma vigilância nacional em saúde oportuna e efetiva

Surgimiento del nuevo coronavirus (SARS-CoV-2) y el papel de una vigilancia nacional de la salud oportuna y eficaz

Raquel Martins Lana [1]
Flávio Codeço Coelho [2]
Marcelo Ferreira da Costa Gomes [1]
Oswaldo Gonçalves Cruz [1]
Leonardo Soares Bastos [1,3]
Daniel Antunes Maciel Villela [1]
Cláudia Torres Codeço [1]

doi: 10.1590/0102-311X00019620

Coronaviruses are RNA viruses that cause respiratory infections in a variety of animals, including birds and mammals [1]. Seven coronaviruses are known pathogens in humans. Seasonal coronaviruses are generally associated with flu-like illness. In the last 20 years, two coronaviruses have been responsible for virulent epidemics of severe acute respiratory illnesses (SARI), the SARS epidemic that emerged in Hong Kong (China) in 2003, with case-fatality of approximately 10% [2], and the Middle East respiratory syndrome (MERS), which emerged in Saudi Arabia in 2012, with some 30% case-fatality. Both are part of the list of priority diseases for research and development in the emergency setting [3].

The novel coronavirus named SARS-CoV-2, which causes COVID-2019 disease, was first detected on December 31, 2019, in Wuhan, China. On January 9, 2020, the World Health Organization (WHO) confirmed the circulation of the new coronavirus. The first sequencing of SARS-CoV-2 was published by Chinese researchers the following day. The first importated case in Japan was reported on January 16. On January 21, the United States reported its first imported case. On January 30, WHO declared the epidemic a Public Health Emergency of International Concern (PHEIC) [4]. By the end of January, several countries had confirmed cases involving importation, including the United States, Canada, and Australia. In Brazil, as of February 7, there were 9 cases under investigation but no record of confirmed cases [5].

The speed at which a disease spreads is estimated by its basic reproduction number (R_0), defined as the mean number of secondary cases generated per primary case. Initial estimates of R_0 for SARS-CoV-2 vary from 1.6 to 4.1 [6,7,8]. By way of comparison, the influenza A (H1N1) epidemic in 2009 had an R_0 of 1.3 to 1.8 [9], reaching an attack rate of 643 cases per 100,000 in Paraná (the state of Brazil with the most reported cases), while ranging between 50 and 70 per 100,000 in the other states of Southeast Brazil. Since SARS-CoV-2 has higher transmissibility, its introduction in Brazil under similar conditions to those of influenza virus would also result in a higher attack rate. However, the prediction of hospitalization and mortality rates depends on information on the proportion of severe cases and case-fatality, which are still unknown. The first findings suggest lower case-fatality than with influenza A (H1N1) and with other coronaviruses. As of February 9, 2020, of the 37,251 confirmed cases in China, 6,188 (16.6%) had been classified as severe and 812 had resulted in deaths (2.2% overall and 13.2% among severe cases) [10]. For a comparison of magnitude, in the years 2018 and 2019, case-fatality in SARI cases due to influenza notified in Brazil was around 20% [9]. Thus far glob-

[1] Programa de Computação Científica, Fundação Oswaldo Cruz, Rio de Janeiro, Brasil.
[2] Escola de Matemática Aplicada, Fundação Getúlio Vargas, Rio de Janeiro, Brasil.
[3] Department of Infectious Disease Epidemiology, London School of Hygiene and Tropical Medicine, London, U.K.

Correspondence
R. M. Lana
Programa de Computação Científica, Fundação Oswaldo Cruz.
Av. Brasil 4365, Rio de Janeiro, RJ 21040-900, Brasil.
raquelmlana@gmail.com

ally, most fatal cases of SARS-CoV-2 have been associated with elderly patients and/or the presence of comorbidities affecting the immune system [11]. However, the epidemic is still in an initial stage of evolution and case reporting, with relatively few clinical studies and with many cases still hospitalized, so the situation is still preliminary.

In recent years, the emergence and reemergence of infectious diseases like bird flu (influenza A H5N1) in 2003, SARS in 2002/2003, influenza A (H1N1) in 2009, and Zika in 2015 raised numerous questions on the role of epidemiological surveillance. Pandemics have occurred more frequently, and since 2018, the World Health Organization (WHO) has acknowledged the need for preparation in anticipation of the emergence of novel pathogens, including (under the name "disease X") unknown diseases with potential for international emergence on the priority list for research and development in the emergency setting [3,12]. The emergence of novel diseases causes impacts far beyond the cases and deaths they generate. It also creates an ideal context that requires national public health systems to validate their surveillance and healthcare systems for timely detection and response in cascade.

Brazil has made important strides in epidemiological surveillance in the last 20 years. In 2003, the influenza A (H5N1) virus motivated the elaboration of the first Influenza Pandemic Contingency Plan [13]. The plan established the guidelines for bolstering Brazil's epidemiological surveillance, organizing laboratory networks and sentinel units for severe acute respiratory syndromes, a national health alert and emergency response network, the Health Surveillance Strategic Information and Response Center (CIEVS), and investments in the domestic production of influenza vaccine [14]. Six years later, in 2009, the arrival of the influenza A (H1N1) virus met with a more structured network that succeeded in responding with efficient surveillance, at least in some states of Brazil [15]. The state of São Paulo already had outstanding laboratory capacity, while in Paraná the network showed high sensitivity. This experience allowed improvement in the laboratories for typing the viral subtypes and expanding both the testing and the SARI surveillance network in the country. In 2015, Brazil occupied an outstanding position on the global science map by spearheading knowledge on the Zika virus [16].

Prior to SARS-CoV-2, the surveillance protocol for SARI in Brazil had not included coronaviruses as part of the laboratory test panel in routine surveillance, and these viruses were only investigated by the National Influenza Centers (NICs) in cases of deaths and outbreaks. The exception is the state of Paraná, whose Central Public Health Laboratory (LACEN) includes seasonal types in its RT-PCR panel. In 2019, of the more than 5,000 SARI cases reported in the state, only 160 tested positive for coronaviruses (data from Sivep-gripe, Brazilian Ministry of Health, accessed on 14/Jan/2000).

With the situation created by SARS-CoV-2, on January 31, 2020, the Brazilian Ministry of Health launched the Joint Ministerial Working Group on a Public Health Emergency of National and International Concern to monitor the situation and establish protocols [17,18] for SARS-CoV-2 surveillance in the country. The protocol determined the collection of two samples from all patients treated in the public healthcare network that met the case definition, taking into account not only the characteristic symptoms but also a history of recent travel to regions with direct transmission and/or history of contact with suspected or confirmed cases [5]. The collected samples were to be processed by the Central Public Health Laboratories (LACENs), testing for respiratory viruses that are part of the SARI surveillance panel, leaving it up to the states to determine local testing for COVID-19. Negative or inconclusive cases are to be processed by the NICs for specific COVID-19 testing, with a metagenomic analysis performed in parallel. In addition, in order to minimize the impact of notification and digitization delay, fast-track reporting channels were also created, without the need for hierarchical (local-state-federal) notification, along with a platform for rapid visualization of suspected cases [19], the Integrated Health Surveillance Platform (IVIS Platform – http://plataforma.saude.gov.br/novocoronavirus/).

Challenges for improving the effectiveness of the COVID-19 response

The potential arrival of the novel coronavirus is currently testing Brazil's surveillance structure, especially at a time in which cutbacks in funding for the Brazilian Unified National Health System (SUS) and research are undermining the country's capacity for early detection and response. Brazil was a protagonist in the Zika epidemic, and it must keep pace with the knowledge generated abroad and prepare for the specific studies and demands that will emerge in the country, including diagnosis, patient care, prevention, and health promotion. Thus, when the alert of the novel coronavirus was sounded, once again a huge question hovered over the country: are we really prepared?

The global effort to generate information on the novel coronavirus is awe-inspiring. With only one month in existence, the new virus had already been cited 37 times in PubMed, with descriptive analyses of the first cases, genomic sequencing, and clinical characteristics. This movement is the product of a sensitive international surveillance system and a policy of sharing data and findings. Even as some groups organized quickly to monitor cases in real time, others focused on applying mathematical and statistical models to monitor the novel virus and establish action strategies [20,21,22].

Meanwhile, the growing use of social media as information channels posed the challenge of monitoring and responding rapidly to fake contents, while also ensuring that the responses could circulate on these channels. For example, in parallel with the official bulletins and accurate reporting in traditional news outlets, fake audios with erroneous recommendations circulated in the social media, passing themselves off as communiqués from publicly respected sources such as the Brazilian Society of Infectious Diseases (SBI) [23]. There was also an attempt to revive the myth that certain herbal teas have the same antiviral properties as oseltamivir phosphate (the active ingredient in the antiviral drug used to treat SARI due to influenza virus), suggesting the consumption of such teas for cases of both influenza and coronavirus [24]. The claims were publicly refuted by the SBI and the Brazilian Ministry of Health, but the scope of their refutations is unknown. A growing movement to discredit traditional communications channels and foment adherence to alternative sources also poses a risk to public health that has to be confronted. The communications refuting such false claims cannot be limited to the academic community and experts from the field.

In the area of laboratory surveillance, it is crucially important for the LACENs to have resource stockpile to remain constantly capable of processing incoming samples and releasing the tests results in timely fashion. Shortage of viral detection kits (primers, probes, controls, etc.) or trained personnel delays the turnaround of locally produced test results or requires sending the samples to NICs, generating both delays in notification and an overload on reference laboratories. Without these resources, the investment in the installation of high-quality test-processing equipment , although essential, becomes worthless. Timely turnaround of test results is crucially important for surveillance of unusual cases, such as outbreaks involving novel infectious agents and early outbreaks of seasonal endemic diseases like influenza and arbovirus infections.

In the area of data processing, sharing and timely analysis of epidemiological data still face challenges in Brazil, despite strides in transparency policies such as the Citizens' Online Information Service (e-SIC) and investment in recent years in real-time follow-up systems for health alerts, such as the SARI Reporting System (InfoGripe) [9]. The main challenges include the health surveillance system's heterogeneous infrastructure, since the data's quality and timeliness depend primarily on reducing the "attrition" with data entry in the system. Many places in Brazil still use paper forms that need to be collected and digitalized. Lack of data validation when electronic forms are completed leads to the entry of incorrect data that could otherwise be corrected automatically even while they are being keyed in.

Another critical point is the lack of integration between the various existing information systems, making it unfeasible to integrate data from different sources. For example, the Laboratory Infrastructure Management System (GAL) lacks access to the numerical code of the notification made to the Brazilian Information System for Notifiable Diseases (SINAN), making it impossible to monitor test results in real time, delaying early case detection, and contributing to gaps in the completion of notifications, which are often left with no record of the case's closure. From the data analyst's perspective, difficulties with data access lead to frequent data "blackouts", besides the huge effort needed to reconstruct the information, resulting in uncertainties in the data's analysis.

The increasingly frequent emergence of novel diseases requires restructuring the way diseases are reported in the country. It is necessary to invest in a new SINAN, based on more modern technologies both to facilitate notification and to allow speedier data dissemination and analysis, in keeping with the principles of precision epidemiology [25]. It is essential for the Ministry of Health to develop an integrated data infrastructure, consistent with the speed of disease spread in this age of high global mobility. A sufficiently flexible system should allow the inclusion of new diseases, but without losing the existing structure. As for communication of this type of information and data availability, access by APIs to the notification system is essential, since it allows building dashboards and automated reports for temporal and spatial follow-up of notified and confirmed cases with minimal delay. The positive example of rapid notification and visualization channels for the current COVID-19 outbreak, known to be essential for timely action, should be incorporated as the standard for Brazil's national epidemiological surveillance.

Contributors

R. M. Lana, F. C. Coelho, and C. T. Codeço contributed to the article's conception, writing, and revision. M. F. C. Gomes, O. G. Cruz, L. S. Bastos, and D. A. M. Villela contributed to writing and revising the article.

Additional informations

ORCID: Raquel Martins Lana (0000-0002-7573-1364); Flávio Codeço Coelho (0000-0003-3868-4391); Marcelo Ferreira da Costa Gomes (0000-0003-4693-5402); Oswaldo Gonçalves Cruz (0000-0002-3289-3195); Leonardo Soares Bastos (0000-0002-1406-0122); Daniel Antunes Maciel Villela (0000-0001-8371-2959); Cláudia Torres Codeço (0000-0003-1174-178X).

Acknowledgments

The authors wish to thank the Brazilian National Influenza Surveillance Network (LACENs, state and municipal surveillance systems, Influenza Working Group, DEVIT/SVS/MS, and NICs) for their partnership.

References

1. Fehr AR, Perlman S. Coronaviruses: an overview of their replication and pathogenesis. Methods Mol Biol 2015; 1282:1-23.
2. World Health Organization. Severe acute respiratory syndrome (SARS). https://www.who.int/csr/sars/en/ (accessed on 03/Feb/2020).
3. World Health Organization. Prioritizing diseases for research and development in emergency contexts. https://www.who.int/activities/prioritizing-diseases-for-research-and-development-in-emergency-contexts (accessed on 29/Jan/2020).
4. World Health Organization. IHR procedures concerning public health emergencies of international concern (PHEIC). http://www.who.int/ihr/procedures/pheic/en/ (accessed on 29/Jan/2020).
5. Secretaria de Vigilância em Saúde, Ministério da Saúde. Infecção humana pelo novo coronavírus (2019-nCoV). Boletim Epidemiológico 2020; (02). https://portalarquivos2.saude.gov.br/images/pdf/2020/fevereiro/07/BE-COE-Coronavirus-n020702.pdf.
6. Read JM, Bridgen JRE, Cummings DAT, Ho A, Jewell CP. Novel coronavirus 2019-nCoV: early estimation of epidemiological parameters and epidemic predictions. medRxiv 2020; 28 jan. https://www.medrxiv.org/content/10.1101/2020.01.23.20018549v2.
7. Liu T, Hu J, Kang M, Lin L, Zhong H, Xiao J, et al. Transmission dynamics of 2019 novel coronavirus (2019-nCoV). BioRxiv 2020; 26 jan. https://www.biorxiv.org/content/10.1101/2020.01.25.919787v1.
8. Cao Z, Zhang Q, Lu X, Pfeiffer D, Jia Z, Song H, et al. Estimating the effective reproduction number of the 2019-nCoV in China. medRxiv 2020; 29 jan. https://www.medrxiv.org/content/10.1101/2020.01.27.20018952v1.
9. InfoGripe. Situação da gripe. http://info.gripe.fiocruz.br/ (accessed on 03/Feb/2020).
10. World Health Organization. Novel coronavirus (2019-nCoV): situation reports – 20. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200209-sitrep-20-ncov.pdf?sfvrsn=6f80d1b9_4 (accessed on 10/Feb/2020).
11. World Health Organization. Q&A on coronaviruses. https://www.who.int/news-room/q-a-detail/q-a-coronaviruses (accessed on 10/Feb/2020).

12. Cousins S. WHO hedges its bets: the next global pandemic could be disease X. BMJ 2018; 361:k2015.
13. Secretaria de Vigilância em Saúde, Ministério da Saúde. Plano brasileiro de preparação para enfrentamento de uma pandemia de influenza. http://bvsms.saude.gov.br/bvs/publicacoes/plano_brasileiro_pandemia_influenza_IV.pdf (accessed on 31/Jan/2020).
14. Costa LMC, Merchan-Hamann E. Influenza pandemics and the structure of Brazilian health care system: brief history and characterization of the scenarios. Rev Pan-Amazônica Saúde 2016; 7:11-25.
15. Codeço CT, Cordeiro JS, Lima AWS, Colpo RA, Cruz OG, Coelho FC, et al. The epidemic wave of influenza A (H1N1) in Brazil, 2009. Cad Saúde Pública 2012; 28:1325-36.
16. Brasil P, Pereira Jr. JP, Moreira ME, Nogueira RMR, Damasceno L, Wakimoto M, et al. Zika virus infection in pregnant women in Rio de Janeiro. N Engl J Med 2016; 375:2321-34.
17. Ministério da Saúde. Coronavírus e novo coronavírus: o que é, causas, sintomas, tratamento e prevenção. https://www.saude.gov.br/saude-de-a-z/coronavirus (accessed on 03/Feb/2020).
18. Ministério da Saúde. Grupo Interministerial vai atuar no enfrentamento ao novo coronavírus. http://saude.gov.br/noticias/agencia-saude/46266-grupo-interministerial-vai-atuar-no-enfrentamento-ao-novo-coronavirus (accessed on 04/Feb/2020).
19. Plataforma Integrada de Vigilância em Saúde, Ministério da Saúde. Notificação de casos pelo novo coronavírus (COVID-2019). http://plataforma.saude.gov.br/novocoronavirus/ (accessed on 04/Feb/2020).
20. Johns Hopkins University. Coronavirus COVID-19 global cases by Johns Hopkins CSSE. https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6 (accessed on 04/Feb/2020).
21. MOBS Lab. Preliminary analysis of the 2019 nCOV outbreak in Wuhan city. https://www.mobs-lab.org/2019ncov.html (accessed on 04/Feb/2020).
22. Bedford T, Neher R, Hadfield J, Hodcroft E, Ilcisin M, Müller N. Genomic analysis of nCoV spread. Situation report 2020-01-23. https://nextstrain.org/narratives/ncov/sit-rep/2020-01-23 (accessed on 04/Feb/2020).
23. Sociedade Brasileira de Infectologia. Nota de repúdio (fake news). https://ammg.org.br/wp-content/uploads/NotaRepu%CC%81dio_Sociedade-Brasileira-de-Infectologia.pdf (accessed on 10/Feb/2020).
24. Ministério da Saúde. Chá de erva doce e o tratamento do novo coronavírus – É FAKE NEWS! https://www.saude.gov.br/fakenews/46239-cha-e-o-tratamento-do-novo-coronavirus-e-fake-news (accessed on 10/Feb/2020).
25. Coelho FC, Codeço CT. Precision epidemiology of arboviral diseases. J Public Health Emerg 2019; 3:1.

Submitted on 04/Feb/2020
Final version resubmitted on 12/Feb/2020
Approved on 13/Feb/2020