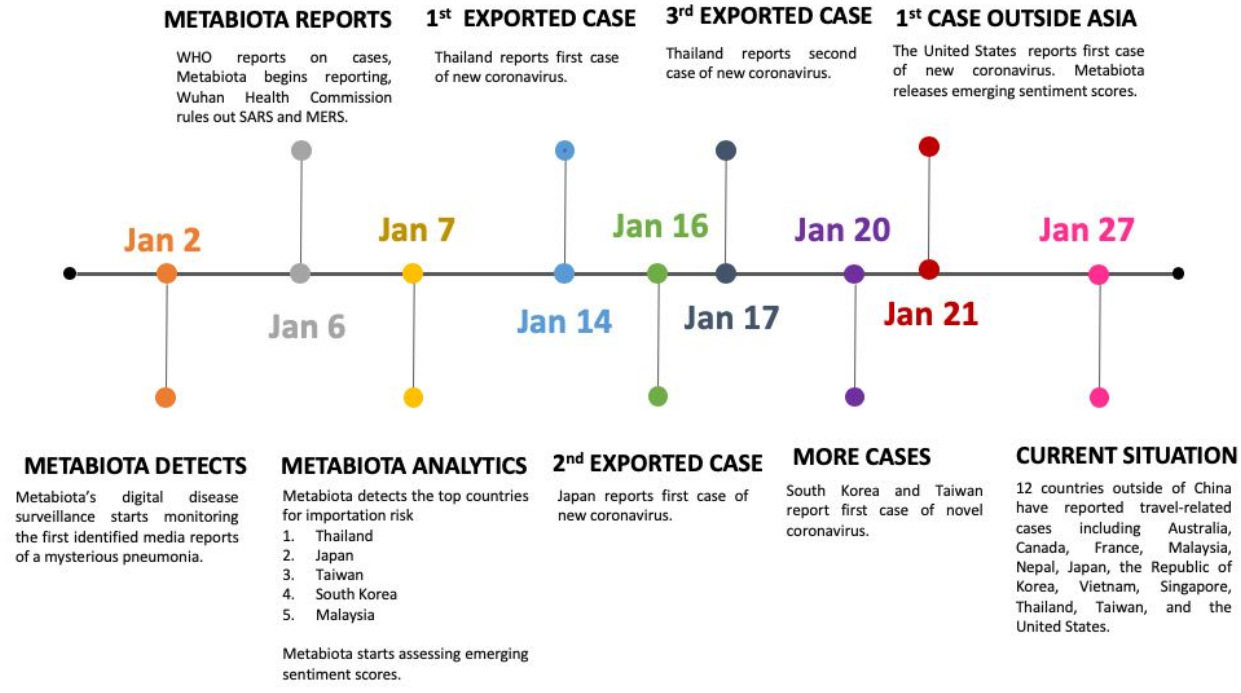
Metabiota Risk Report No. 1: January 27, 2020

Monitoring and risk analytics for the 2019 novel coronavirus (2019-nCoV) epidemic

Executive Summary

Metabiota has been closely monitoring the novel coronavirus (2019-nCoV) event since January 2, 2020. While the novel coronavirus currently appears to cause fewer cases of severe illness than related viruses (i.e., MERS-CoV and SARS-CoV), the number of new cases is continuing to increase, which indicates that the current outbreak has not yet been contained. On January 7, Metabiota's Transit Hub module flagged Thailand, Japan, Taiwan, South Korea, and Malaysia as the countries at highest risk for 2019-nCoV case importation. These countries were some of the first to report imported cases, and our current estimates suggest that they remain at high risk for additional cases. Metabiota has also estimated a high Pathogen Sentiment Score for 2019-nCoV. This indicates that the attributes of this virus are likely to generate public alarm, which can lead to significant economic damage, especially in industries that rely on the public's perception of safety.

Figure 1: Timeline of Metabiota's Analysis of the 2019-nCoV Epidemic



Introduction

Since January 2, 2020, Metabiota has been closely tracking the novel coronavirus (2019-nCoV) epidemic, which began in Wuhan, China.

We have applied a number of technologies to provide situational awareness and risk analytics to our partner organizations, to shed light on the epidemiology of the outbreak, as well as its potential trajectory and impact. These tools and analytics are available on Metabiota's cloud-based software platform and include:

- **Digital surveillance**: near real-time monitoring using curated and validated data sources. We produce structured data on cases and deaths, to provide a precise, rigorous view of the outbreak's development over time.
- **Transit hub risk module**: daily risk scores for thousands of airports around the world, estimating the relative risk of imported and exported cases.
- **Pathogen sentiment score**: dynamic estimates of potential public fear and behavioral reaction to the outbreak.

This summary briefly presents the current situation of the outbreak.

Digital Surveillance

Metabiota has been structuring true-to-source case data from a wide variety of reporting sources having the finest geographic and temporal resolution available. Data source quality assessments are performed by subject matter experts, who cross-check multiple sources, including official reports and media sources, to capture the most accurate and up-to-date data available on suspected, probable and confirmed cases.

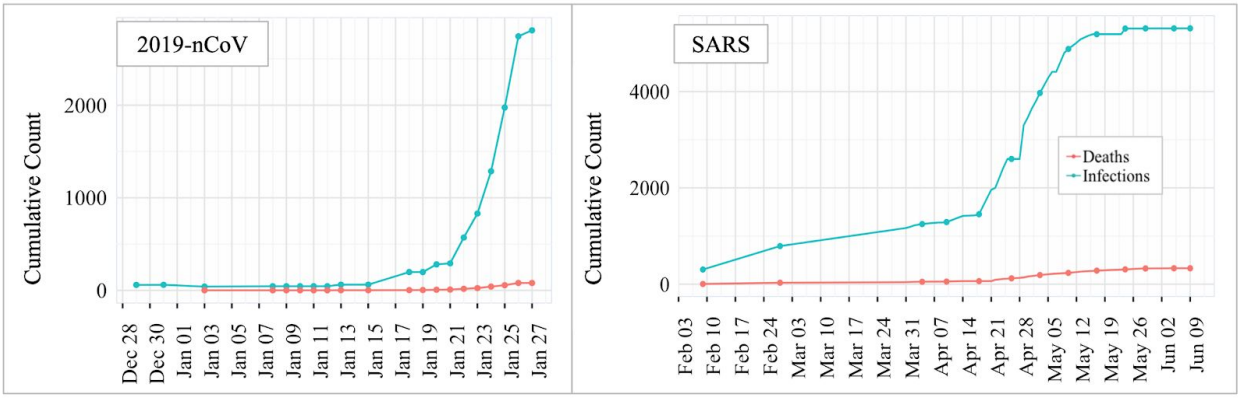
This approach allows us to provide updates in near-real-time, while ensuring the data are robust, reliable, interoperable, and suitable for analysis and decision making.

Box 1: Situation Report as of Monday, January 27

- There are currently 2,836 confirmed cases with 80 deaths
- Cases have been confirmed in 31 territories[1] in China
- Cases have been confirmed in 12 countries including Australia, Canada, France, Malaysia, Nepal, Japan, the Republic of Korea, Viet Nam, the Republic of Singapore, Thailand, Taiwan, and the United States
- There have been 5 confirmed cases in the US, one in Washington state, one in Illinois, two in California, and one in Arizona. All cases are travel related.

[1] Including provinces, special administrative regions, and municipalities

Figure 2: Number of cumulative reported cases in China[2] for 2019-nCoV[3] (left panel). The timeline for the 2002 SARS outbreak[4] is also shown for comparison (right panel)



Box 2: 2019-nCov: Current epidemiologic assessment

What we currently know

- The virus is a novel coronavirus and belongs in the same family as respiratory viruses that cause SARS (severe acute respiratory syndrome) and MERS (Middle East respiratory syndrome).
- Symptoms include fever, cough, shortness of breath, and difficulties breathing. Approximately 25% of cases will have more severe symptoms that can include pneumonia, severe acute respiratory syndrome, organ failure, and death.
- Person-to-person transmission of the virus has been confirmed.
- The current observed case fatality ratio is 0.03, which is lower than MERS and SARS. However, the current observed mortality data are incomplete due to the time delay between illness onset and death and potential undercounting of less severe cases.

What is uncertain

- The novel coronavirus is very likely zoonotic in origin (i.e., from an animal host), though the original source is still unknown. It is believed that the first cases became infected at a seafood and animal market in Wuhan, China.
- It is likely that the virus can be spread through respiratory droplets like other coronaviruses, but the mode of transmission has not yet been confirmed. A preliminary estimate of the basic reproductive number (R_0), the average number of cases infected by a single case in a completely susceptible population, is 1.4 - 2.5

[2] Including Hong Kong and Macao
[3] The National Health Commission of the People's Republic of China (http://en.nhc.gov.cn/); Wuhan Municipal Health Commission (http://wjw.wuhan.gov.cn)
[4] WHO Disease Outbreak News (https://www.who.int/csr/don/en/)

- The incubation period of the disease is still unknown. Health authorities are monitoring contacts with exposure to known cases for development of symptoms for more than two weeks.
- Both MERS and SARS had the potential to cause large case clusters, also known as “super-spreading events”, particularly in health care settings. A cluster of 2019-CoV infections that may have been the result of a super-spreading event has been identified among healthcare workers in a hospital in China.

Interpretation

- The novel coronavirus currently appears to cause less severe clinical illness than the related viruses which cause MERS or SARS.
- Currently, the number of new cases is continuing to increase which indicates that the current outbreak has not yet been contained.

Transit Hub Risk Module

The Transit Hub Risk module combines Metabiota’s digital surveillance data with information on global air travel networks. It provides a probabilistic risk estimate of an emerging infectious disease moving through thousands of airports worldwide, and is updated daily. The Transit Hub Risk estimates provide situational awareness, and can help decision-makers to identify potential regions at risk for disease importation, focus strategic attention, and allocate preparedness, surveillance and response assets to specific airports or geographies.

The Transit Hub Risk module is accessible through the Metabiota software platform, and provides airport-level relative and absolute risk scores. These scores allow users to:

- Visualize and evaluate an individual airport’s origin risk (i.e., risk of export of cases from the selected airport) and destination risk (i.e., risk of importation of cases to the airport).
- Download the latest daily, and previous 14 days, conditional risk assessments by airport, pathogen, and risk type (i.e., origin or destination).

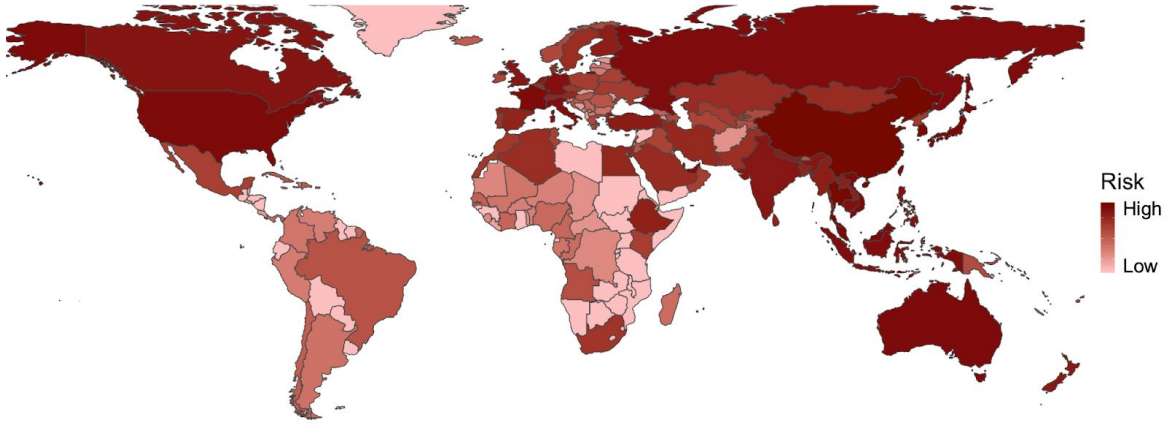
On January 7th, the Module estimated that Thailand, Japan, Taiwan and South Korea had the highest aggregated country risk of 2019-nCoV importation. This estimate was made more than a week before 2019-nCoV cases were detected and reported in these countries (see below).

Table 1. Aggregated Country-level Destination Risk Scores, Metabiota Transit Hub Risk Score as Calculated on January 7, 2020

Country	Rank (1 = highest risk of importation)	Date of First Case Reported in Country	Number of confirmed cases[5]
Thailand	1	1/14/2020	5
Japan	2	1/16/2020	4
Taiwan	3	1/20/2020	5
South Korea	4	1/20/2020	2
Malaysia	5	1/25/2020	3
Singapore	6	1/23/2020	4
France	7	1/25/2020	3
United States	8	1/21/2020	5

Although the 2019-nCoV situation is constantly evolving, our latest destination risk estimates indicate the following countries to be at the highest risk for new imported infections: China, Thailand, South Korea, Japan, Taiwan, Malaysia, Singapore, and the United States (Figure 3).

Figure 3: Metabiota Transit Hub, Rank of Aggregated Importation Risk by Country, January 27, 2020.

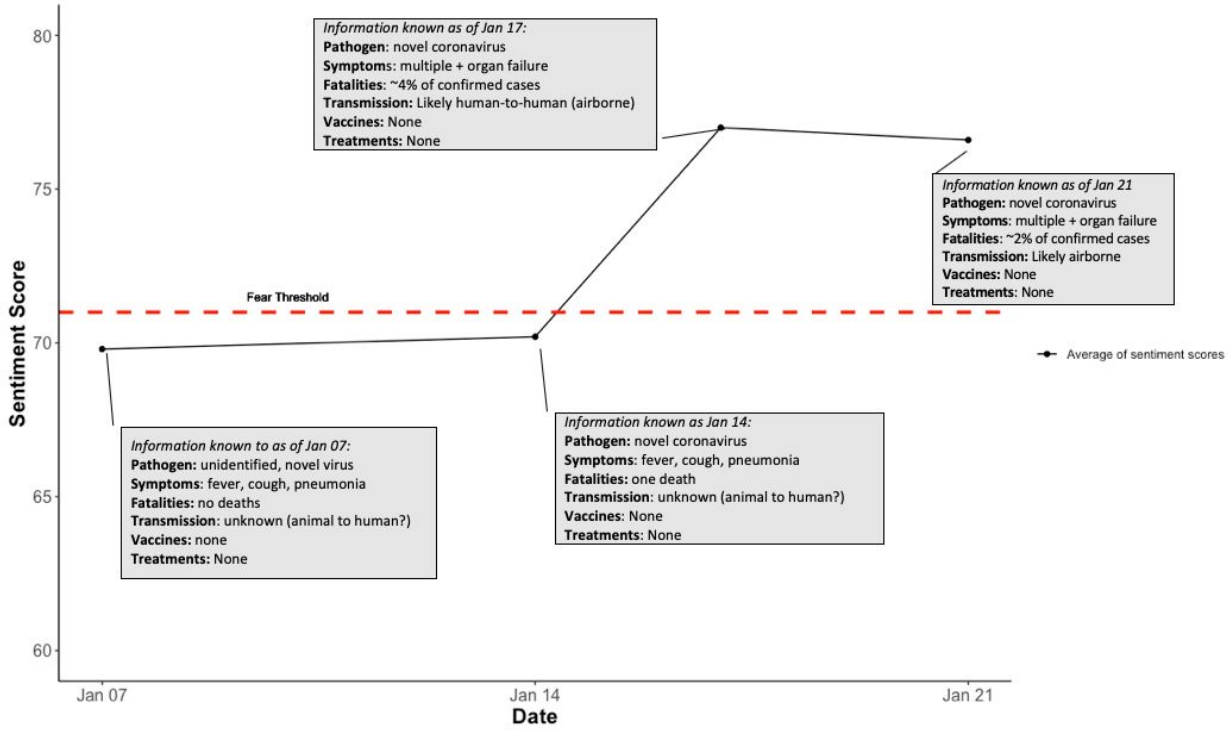


[5] Current as of 1/27/2020

Pathogen Sentiment Score

The Pathogen Sentiment Score provides a quantitative estimate of public fear and anxiety caused by an emerging infectious disease. The score integrates data on multiple features of each pathogen – including morbidities and symptoms, mortality risk, the availability of prophylactic and therapeutic options, disease transmission mechanisms, and novelty – in order to estimate public emotional and behavioral reaction to a potential outbreak. Not all countries react similarly to disease outbreaks, due to culture, familiarity with specific pathogens, and other spatially variable factors. The Score takes this variation into account, providing specific scores for multiple countries (currently: the United States, China, Japan, Mexico, and Germany).[6]

Figure 4. Changes in Pathogen Sentiment Score for 2019-nCoV, January 7-21, 2020



Metabiota began scoring the 2019-nCoV event on January 7th. The Score has increased over time (Figure 4), due mainly to confirmation of more severe symptoms and human-to-human respiratory transmission. The score is now above 71, a key threshold for economic risk that

[6] The Score is available on Metabiota's software platform, which has a specific module that tracks and displays estimates for an emerging pathogen. These estimates are updated as more is known and reported about an emerging pathogen's symptoms, case fatality ratio, transmission mechanism, and other features. Scores are updated at least biweekly and if there are significant developments in the course of an outbreak, Metabiota will revise scores as necessary.

Metabiota scientists have identified via historical backtesting. The high score suggests that this virus is likely to generate public alarm, which can lead to significant economic damage, especially in industries that rely on the public's perception of safety.

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