



**World Health  
Organization**

# **Scientific Advisory Group on the Origins of Novel Pathogens (SAGO)**

**Update to Member States  
17 February 2022**

**Dr Maria Van Kerkhove, Unit Head of Emerging Diseases and  
Zoonoses, COVID-19 Technical Lead  
Professor Marietjie Venter, University of Pretoria, SAGO Chair  
World Health Organization, Health Emergencies Programme**

# Scientific Advisory Group on Novel Origins (SAGO)

**SAGO has been formed in the context of the continued threat of the emergence or re-emergence of pathogens with epidemic and pandemic potential.**

## The Need

- A global framework to study future emerging and re-emerging pathogens, including
  - Comprehensive and coordinated studies
  - A holistic approach to study the emergence of high threat zoonotic pathogens including the animal human interface, environmental safety, biosafety and biosecurity
  - An established framework for studying emerging pathogens where and when they emerge

## Addressing a gap

- A scientific advisory group to advise WHO on technical and scientific considerations regarding origins of emerging and re-emerging pathogens:

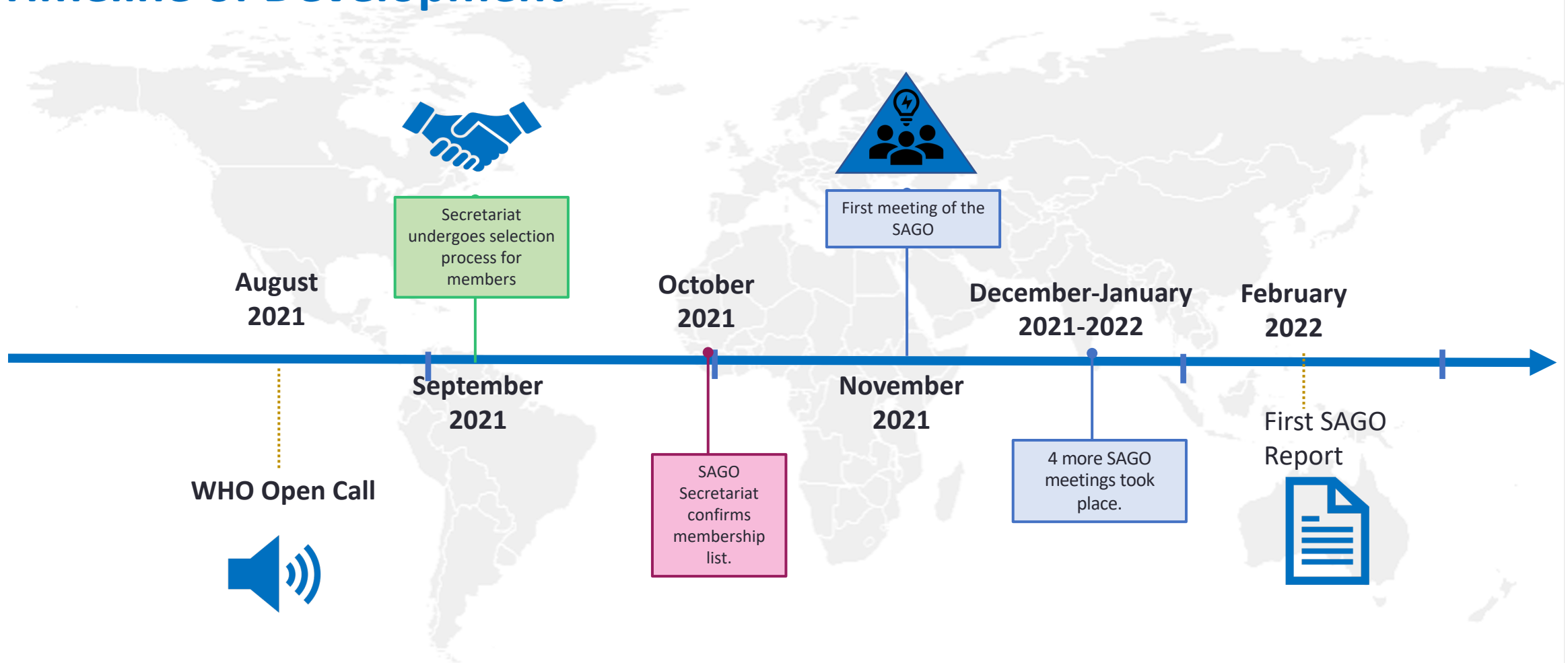
## The Scientific Advisory Group for the Origins of Novel Pathogens (SAGO)

# Terms of Reference of the SAGO


In its capacity as an advisory body to WHO, the SAGO will follow the [terms of reference](#) as initially outlined and shall have the following functions:

1. To advise WHO on the development of a WHO global framework
2. To advise WHO on prioritizing studies and field investigations into the origins of emerging and re-emerging pathogens of epidemic and pandemic potential, in accordance with the WHO global framework described in point (1) above; 2
3. In the context of SARS-CoV-2 origins:
  - a. To provide an independent evaluation of all available scientific and technical findings from global studies on the origins of SARS-CoV-2;
  - b. To advise the WHO Secretariat regarding developing, monitoring and supporting the next series of studies into the origins of SARS-CoV-2
4. To provide additional advice and support to WHO, as requested by the WHO Secretariat, which may include participation in future WHO-international missions to study the origins of SARS-CoV-2 or for other emerging pathogens.

# Timeline of Development



# Meetings and Organization of the SAGO

- First meeting November 2021
- 7 Plenary SAGO meetings held to date
- 27 Members with significant and diverse expertise
- Chair and vice-chair  
- 2 Observers  Food and Agriculture Organization of the United Nations  WORLD ORGANISATION FOR ANIMAL HEALTH
- 6 sub-working groups were formed and are meeting regularly;
  - Human, epidemiology
  - Animal/Human Interface,
  - Environment/Ecological,
  - Early Investigation/Anthropology,
  - Biosafety/Biosecurity, and
  - Genomics/Phylogenetics

## Current Main Areas of Focus

- 1 Provide recommendations to establish a **Global Framework** for studying the origins of emerging and re-emerging pathogens
- 2 Review available evidence studying **emergence of SARS-CoV-2** and provide recommendations for studies urgently needed
- 3 Provide preliminary recommendations to study the **emergence of SARS-CoV-2 VOCs**



# Presentations to the SAGO in Plenary and subsequent meetings

- Overview of the work of WHO for high threat zoonotic pathogens, including SARS, MERS, VHF, Arboviruses, COVID-19 (SAGO Secretariat)
- Overview of the work of WHO related to biosafety and biosecurity (SAGO Secretariat)
- Summary of the findings and recommendations from the March 2021 Joint WHO-China mission report (SAGO member)
- Overview of pre-pandemic 2019 studies (WHO Secretariat)
- Overview of the emergence of SARS-CoV-2 variant of concern Omicron (SAGO Member)
- Overview of SARS-CoV-2 and SARS-CoV-like virus circulation in animals (WHO Secretariat)
- Update from Chinese Scientists on the implementation of studies recommended in March 2021 WHO-China Joint report
- Overview of SARS-CoV-2 literature review (WHO Secretariat)

# SAGO discussions of Global Framework for Emerging and Re-emerging Diseases

- **Meeting the need**
  - The rapid emergence and spread of SARS-CoV-2 has highlighted the importance of being prepared for any future event. The need to be able to quickly identify novel pathogens early and to identify the risk factors that contribute to their emergence and spread.
- **Discussions of framework involve**
  - Early investigations following the emergence
  - Human studies: epidemiology
  - Human/Animal Interface studies
  - Retrospective sampling of pre-outbreak samples
  - Environmental/Ecological studies
  - Biosafety/Biosecurity
  - Genomics/Phylogenetics
- **Applying this framework to SARS-CoV-2 variants of concern: e.g., Omicron**

# Critical elements for the Global Framework for Emerging and Re-emerging Diseases



Early investigations following the emergence

Human studies: epidemiology

Human/Animal Interface studies

Retrospective sampling of pre-outbreak samples

Environmental/Ecological studies

Biosafety

Biosecurity

Genomics/Phylogenetics



# Presentations to SAGO: Overview of SARS-CoV-2 Literature Review

- WHO secretariat conducted systematic literature review on available evidence pertaining to the origins of SARS-CoV-2 from 2019 to date using a comprehensive search strategy, assessing grey literature, foreign language, published and pre-print articles
- Using the WHO COVID-19 research literature database which reviews 70 online databases and approximately 500,000 citations
  - Animal susceptibility
  - Molecular epidemiology
  - Review articles
  - Hypothesis
  - Surveillance
  - Early suspect or known cases in China
  - Positive samples from 2019
  - Market tracing and/or animal trade
  - Gain of function experiments
  - Field acquired infection
  - Laboratory acquired infection
  - Biosafety and biosecurity
  - Review studies

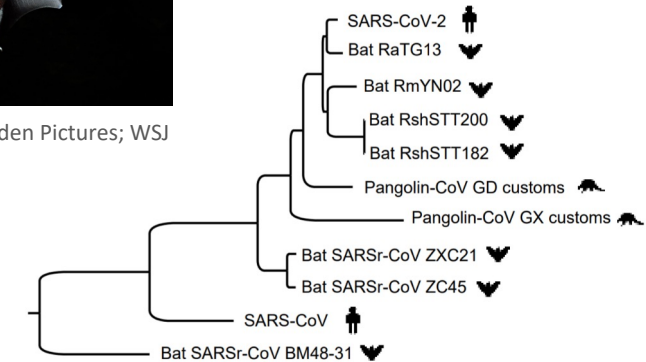


# Presentations to SAGO: SARS-CoV-2 and other SARS- related CoVs

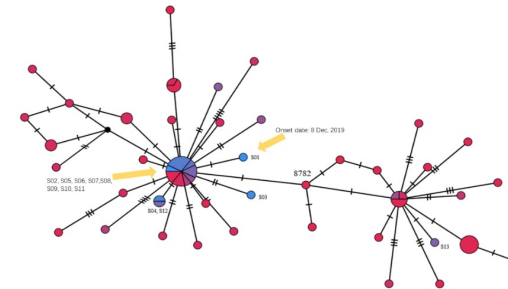
- SARS-CoV-2 is likely to be a coronavirus of bat origin, with the closest viral genome found in *Rhinolophus affinis* bats (RatG13 bat strain in Yunnan, China, 96.1% (2020); BANAL-52, 96.8%, Laos (2021))
- *Rhinolophus* species are abundant and diverse in South China and across Asia, the Middle East, Africa and Europe; Apart from China, SARS-CoV-2 related coronaviruses have also been isolated from bats in Southeast Asia
- Two other closely-related coronaviruses with 85.5% to 92.4% sequence similarity to SARS-CoV-2 were sequenced from custom-seized trafficked Malayan pangolins that were housed in rehabilitation facilities in China
- Earliest market related cases in Wuhan already some diversity suggesting original spill over event to humans may not have happened at the market itself
- Several decades of evolutionary distance between most similar viruses from bats and SARS-CoV-2 suggests the need for search of intermediaries



Photo: Minden Pictures; WSJ



0.07 SubSite  
Phylogenetic tree of SARS-CoV-2 and other coronaviruses in bats and pangolins



Sequences of cases with onset of illness in December

NEWS | 23 November 2020 | Correction 29 November 2020 | Correction 17 December 2020

## Coronaviruses closely related to the pandemic virus discovered in Japan and Cambodia

The viruses, both found in bats stored in laboratory freezers, are relatives to be found outside China.

## Identification of a novel lineage bat SARS-related coronavirus receptor

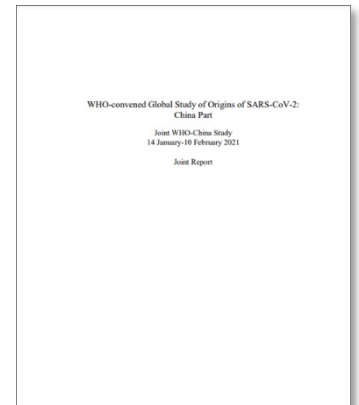
Hua Guo, Ben Hu, Hao-rui Si, Yan Zhu, Wei Zhang, Bei Li, Ang Li, Rong Geng, H. Peng Zhou, Zheng-Li Shi  
doi: <https://doi.org/10.1101/2021.05.21.445091>

Article | Open Access | Published: 09 February 2021

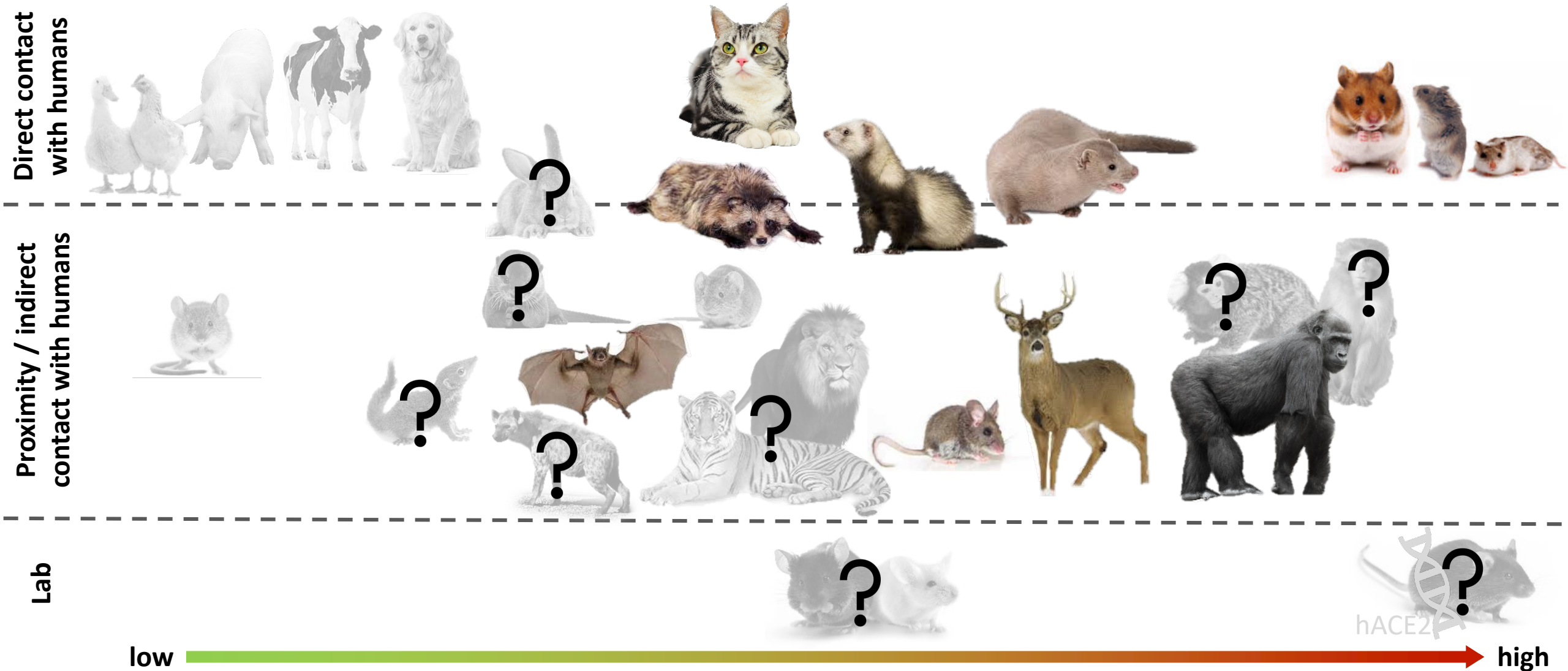
## Evidence for SARS-CoV-2 related coronaviruses circulating in bats and pangolins in Southeast Asia

Supaporn Wacharapluesadee, Chee Wah Tan, Patarapol Maneerom, Prateep Duengkae, Feng Zhu, Yuthana Joyjinda, Thongchai Kaewpom, Wan Ni Chia, Weenassarin Ampoot, Beng Lee Lim, Kanthita Worachotsueptrakun, Vivian Chih-Wei Chen, Nutthinee Sirichan, Chanida Ruchisrisarod, Apaporn Rodpan, Kirana Noradechanon, Thanawadee Phaichana, Niran Jantararat, Boonchu Thongnumchaima, Changchun Tu, Gary Cramer, Martha M. Stokes, Thiravat Hemachudha & Lin-Fa Wang

*Nature Communications* 12, Article number: 972 (2021) | Cite this article



# Presentations to SAGO: SARS-CoV-2 Animal Susceptibility Studies



Susceptibility of animal species

Adapted from Michelitsch et al.; Adv Virus Res. 2021

# Presentations to SAGO: Update on status of global studies on pre-pandemic samples in 2019

- WHO review of pre-pandemic testing of samples or referral of samples for confirmatory testing to external laboratories for validation
- Systematically reached out to authors of published/pre-print studies with positive test results in pre-pandemic biological samples (2019 and early January 2020):
  - Examples: Germany, US, Scotland, Italy, Canada, Netherlands, and Japan have tested biobanked samples from respiratory samples, wastewater – all negative
  - Spain, Italy, France, US, Brazil tested respiratory pathogens, serum from blood donations, measles samples, skin samples, wastewater etc – some positive results
    - Requested and arranged referral testing for confirmation
    - Requested information on follow up or investigations planned or underway
    - Requested respiratory materials for virus sequence processing
- Further testing/verification of biological samples is ongoing in Italy.

Countries	Study period	Sample type	Population	Results for samples
Germany <sup>1</sup>	December 2019 – April 2020	Respiratory specimens	Patients with pneumonia	No positive results before March 2020 N=195
UK <sup>2</sup>	January 2020	Respiratory specimens	Patients with pneumonia	No positive results before February 2020. N=1,378
Scotland <sup>1</sup>	December 2019 – February 2020	Respiratory specimens	ICU admitted patients	No positive results before March 2020. N=148
US <sup>4</sup>	December 2019 – June 2020	Respiratory specimens	Patients, BAL samples, dept. defense	No positive samples found before January 2020. N=7,000
Italy <sup>5</sup>	November 2019 – March 2020	Respiratory specimens	Patients, SARI	No positive results. N=166
Italy <sup>6</sup>	December 2019 – March 2020	Respiratory	Patients with	No positive results. N=906

Countries	Study Period	Sample type	Population	Results	Dates of positive samples
Canada <sup>7</sup>	Aug				
Netherlands <sup>4</sup>	France <sup>8</sup> Dec 2019 – Jan 2020	Respiratory sample	ICU admitted patients	1/714 tested positive (PCR)	December 2019
US <sup>9</sup>	Nov 2019 – Jan 2020	Serum	Blood donations	10/9144 tested positive (neutralization)	November – December 2019
	Dec 2019 – Jan 2020	Serum	Blood donations	84/7389 tested positive (neutralization)	December 2019 – January 2020
Italy <sup>4,11,12</sup>	Sept 2019 – Feb 2020	Oropharyngeal	Measles-suspected patients	1/39 tested positive (in house PCR)	December 2019
	Aug 2019 – Feb 2020	Oropharyngeal	Measles-suspected patients	11/44 tested positive (in house PCR) *	September-December 2019
	Nov 2019	Dermatosis sample	Patients with skin manifestations	1 tested positive (in house assay)	November 2019
	Dec 2019	Wastewater	-	Tested positive (PCR)	December 2019
Brazil <sup>10</sup>	Oct 2019 – March 2020	Wastewater	NA	Tested positive (PCR)	November, December 2019
Spain <sup>9</sup>	2019	Wastewater	NA	Tested positive but cannot be verified	March 2019
Italy <sup>9</sup>	Sept 2019 – March 2020	Serum	Cancer screening trials	Initially positive, negative upon re-testing 6/959 (neutralization)	October – December 2019



National Cancer Institute, Milan, Italy



Erasmus Medical Center, Rotterdam, The Netherlands



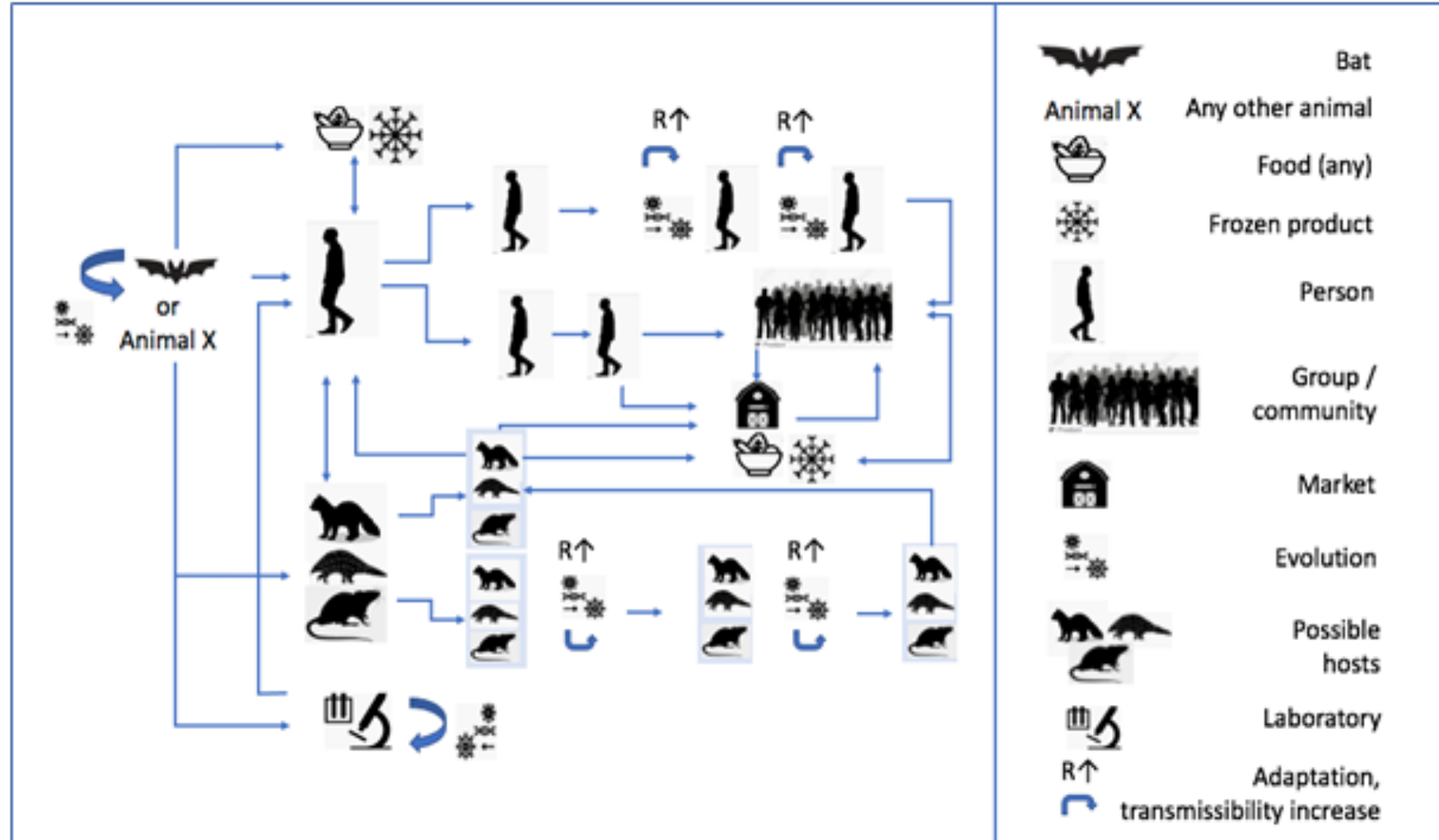
# Presentations to SAGO: Overview of findings of the WHO-China Joint Mission Report 2021

Zoonotic

Zoonotic +  
intermediate host

(Cold) food chain  
related

Laboratory related

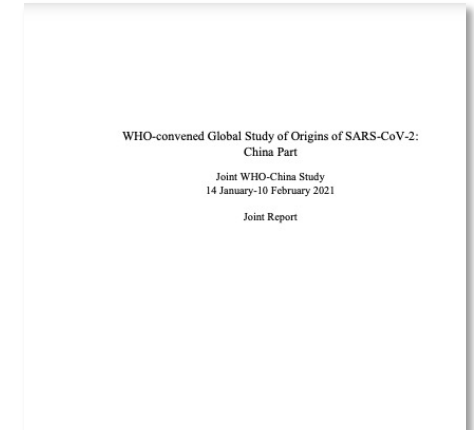


# Presentations to SAGO: Update on implementation of recommended studies from March 2021 Report & publications since March 2021

The SAGO secretariat has requested further information from Chinese scientists on the status of the implementation of studies recommended in the March 2021 report

SAGO received two presentations from invited Chinese scientists

- Overview of the findings of the recommended studies outlined in the March 2021 Joint China-WHO March mission report
- Update on the implementation of studies recommended in March 2021 WHO-China Joint report
- Information gathering is ongoing.



scientific reports

OPEN **Animal sales from Wuhan wet markets immediately prior to the COVID-19 pandemic**

Xiao Xiao<sup>1,2</sup>, Chris Newman<sup>3,4</sup>, Christina D. Buesching<sup>5,6</sup>, David W. Macdonald<sup>7</sup> & Zhao-Min Zhou<sup>1,4,6</sup>

Here we document 47,381 individuals from 38 species, including 31 protected species sold between May 2017 and November 2019 in Wuhan's markets. We note that no pangolins (or bats) were traded, supporting reform opinion that pangolins were not likely the spillover host at the source of the current coronavirus (COVID-19) pandemic. While we caution against the misattribution of COVID-19's origin, the wild animals on sale in Wuhan suffered poor welfare and hygiene conditions and we detail a range of other zoonotic infections they can potentially vector. Nevertheless, in a precautionary response to COVID-19, China's Ministries temporarily banned all wildlife trade on 26th Jan 2020 until the COVID-19 pandemic concludes, and permanently banned eating and trading terrestrial wild (non-livestock) animals for food on 24th Feb 2020. These interventions, intended to protect human health, redress previous trading and enforcement inconsistencies, and will have collateral benefits for global biodiversity conservation and animal welfare.



# Next steps

- **Continue to meet in plenary and as working groups to meet objectives set out in TORs**
- **Finalize SAGO First Report to WHO** (*anticipated in the coming weeks*)
  - Establishment of SAGO, aims and objectives, organization, meetings
  - Preliminary recommendations by the SAGO
    1. General considerations for the scope of the global framework
    2. Preliminary recommendations on studies needed to better understand the origins of SARS-CoV-2
      - Epidemiology and molecular epidemiology recommendations
      - Animal and environmental studies
      - Introduction of SARS-CoV-2 to the human population through a laboratory accident or incident
    3. Initial recommendations for studies on the source of the Omicron variant
  - Outline Next steps of SAGO to meet TORs