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FACT CHECK

Will we ever know where covid-19 came from?

The pandemic's origins, the lab leak theory, and the blame game have been in the headlines again. Despite another war of words, we aren't any closer to a definitive answer as to where the novel coronavirus came from. Mun-Keat Looi asks why

Mun-Keat Looi *international features editor*

"Simply preposterous," said Anthony Fauci, responding in a US congressional hearing to one more in a long line of allegations that he had caused the covid-19 pandemic by funding research that may have created the SARS-CoV-2 virus.

"Mr Fauci," said Marjorie Taylor Greene, a far right Republican representative from Georgia, at the same hearing, "we should be writing a criminal referral because you should be prosecuted for crimes against humanity . . . You belong in prison." She emphasised her refusal to address Fauci, the former director of the US National Institute of Allergy and Infectious Diseases, as "Dr" because, in her opinion, he did not deserve the title.

This was the latest in a long line of questioning at the Republican controlled Congress investigating the US government's response to covid-19 and where SARS-CoV-2 came from.[1] The session in June, the 27th in a 15 month period, restoked flames of contention over the virus's origins.

For the past four years experts and politicians have been, at times very publicly, in a war of words over the origins of SARS-CoV-2 (box 1). The arguments have left the public—eager to forget the limits put on personal freedoms at the outset of the pandemic but still searching for a scapegoat—confused. Years after lockdowns, masking, social distancing, and vaccination became polarising issues for Republicans and Democrats, the response to the pandemic remains a political issue in the US—not least in a presidential election year.

Box 1: Two theories of covid-19's origins

Natural evolution

In this theory SARS-CoV-2 evolved naturally as a spillover from animals, as happened with SARS-CoV-1 in the 2002 SARS (severe acute respiratory syndrome) epidemic. This could have started in bats, which often carry coronaviruses, and then jumped to another species such as raccoon dogs, which were then sold as bushmeat at a wet market in Wuhan.[2]

Lab leak

This posits that the virus was engineered—perhaps with good intentions to understand viruses better—to make it more infective (in what is dubbed "gain-of-function" research), thus enabling the jump to humans. The virus would then somehow have escaped from the laboratory before spreading in the human population.

These two theories are not mutually exclusive, and other theories have also been put forward. But the politicisation of the pandemic discourse has meant that, as with lockdowns, masking, social distancing, and vaccines, the debate over the origins of covid has become highly polarised into camps advocating for one theory being "right" over the other.

Everyone wants someone to blame, but we still can't say for sure where the virus came from. And experts say we may never know for certain. Why?

Lawrence Gostin, faculty director of the O'Neill Institute for National and Global Health Law at Georgetown University, Washington, DC, says, "After all the deaths and suffering from the pandemic, the world deserves to know the origins of covid-19 with a greater sense of certainty. But that will never happen."

Why might we never definitively know the origin of covid-19?

In a nutshell, the trail for definitive, scientific evidence is cold. The decisions that Chinese officials made during the early stages of the Wuhan outbreak in the winter of 2019 meant that very little information was communicated—possibly not even collected—when the virus emerged in the first patients. Also, the Chinese government has been reluctant to share data and cooperate with international investigations, including those led by the World Health Organization (WHO) since the pandemic began.

Gostin says that a rigorous scientific examination of the origins questions would require cooperation by China, including access to the Wuhan Institute of Virology. "It is quite clear that China will not allow an objective and independent scientific investigation led by WHO. In addition, much of the evidence from the lab as well as the Wuhan market has now vanished. All in all, there is little chance that the world will ever know for sure. And that is a global tragedy."

"We're too late in the game to obtain new scientific information," says Richard Ebright, director of the Waksman Institute of Microbiology at Rutgers University, New Jersey. "It continues to be the case that there is no secure scientific evidence that has emerged since the first weeks of the pandemic . . . Without a time machine we're unlikely to get access to any kind of new, direct scientific evidence that's relevant to the question.

"The word 'prove' is problematic," Ebright adds. "To reach an absolute certainty it's scientific or mathematical proof that will never be reached . . .

But we don't require mathematical certainty to make decisions about political conduct or about judicial conduct."

The consensus among scientists is that, although a lab leak origin is possible, the scientific evidence points to a natural, zoonotic origin from wild animals.

At the June congressional hearing Fauci said that he had always been open to both origin hypotheses, pointing to a February 2020 email he sent to a prominent scientist who was alarmed that SARS-CoV-2 could have leaked from a laboratory. "It is inconceivable that anyone who reads this email could conclude that I was trying to cover up the possibility of a laboratory leak," he told the hearing.

Why has the Chinese government obstructed the process?

Put simply, China has been trying to avoid political blame and embarrassment over its handling of the situation, even if its subsequent actions have shone an even harsher spotlight on the country.

In 2020 the then US president, Donald Trump, led the call to blame China for the pandemic, infamously nicknaming it the "Wuhan flu." China, in turn, accused the US of politicising the issue. When Australia called for an independent probe into the virus's origins, China imposed trade sanctions on the country.

Over the past few years tensions have heightened as US agencies, including the FBI, CIA, and even the Department of Energy, all issued their own investigations into the pandemic's origins. In June 2024 a Reuters investigation revealed how US intelligence agencies had, in the early years of the pandemic, launched a social media campaign to discredit Sinovac, the covid vaccine developed in China, and protective equipment such as masks made in the country.[3] These clashes have meant that China has also been reluctant to release data that might shed light on the issue and could have aided the pandemic response.

US officials say there is good evidence that local and national authorities in China disposed of virus samples and used up others in research. The same US officials have, however, "cautioned against overstating the importance of the destroyed samples."[4]

It took three years for data from the Chinese Centre for Disease Control to be released, despite the researchers themselves having released the data to an international database, GISAID, only to have them taken down shortly after. Eddie Holmes, a virologist at the University of Sydney, said it was an "absolute scandal that it's taken this long for [the data] to see the light of day."

The Chinese government was also criticised for its delay in declaring the virus contagious through human-to-human transmission.

Is there a "smoking gun" proof of a lab leak?

There is no agreed, exact definition of what such a proof would be or would look like. Some people have pointed to a "defining feature" that a virus of this kind, arising from a lab leak, might possess. This usually refers to the furin cleavage site, a genetic sequence that enhances infectivity. SARS-CoV-2's famous "spike protein"—specifically, its angiotensin converting enzyme 2 (ACE2) receptor that helps it bind to human cells—features one such sequence. This initially worried experts such as Jeremy Farrar, now chief scientist at WHO, when he first saw it. At the time, he thought that if someone had set out to adapt an animal coronavirus to humans by inserting a specific bit of genetic material, this is what it might look like. He has since been convinced otherwise by the weight of evidence for a natural origin.

However, some experts think there is enough correlative evidence to show that a lab leak is highly likely. Ebright, for instance, says that there are now more than half a dozen estimates of what the most recent common ancestor might have looked like, in terms of its genetic sequence. This is the original virus from which all variants, including the "wildtype" strain first detected in 2020, would have evolved. These estimates "become refined and better as numbers of isolates over time become larger," says Ebright. "So each year, as the number of sequenced isolates [increases], and the time window of those isolates expands from just 2019 to 2019-2024, the calibration of the molecular clock becomes stronger.

"The majority place the date [at which the common ancestor emerged] in September or October 2019. All of them place the date between July and November 2019. That's an example of scientific evidence that becomes stronger with the passage of time and requires no direct access to Wuhan, [though] that's probably not going to get much firmer with additional time."

Yet there are things that other experts say do not make sense if it was an engineered virus. Notably, SARS-CoV-2 attaches to cells differently from SARS-CoV-1 and is unlike any other known viruses used in laboratory gain-of-function research.

As Kristian Andersen, professor in the department of immunology and microbiology at the Scripps Research Institute in California, puts it: "Scientists are lazy. If we want to make viruses in the lab, we follow recipes we've used for decades, because we know they work." In other words, there would be some more recognisable sign in the genetic code of Sars-CoV-2, and the wildtype virus had no such laboratory "signature."

Did the US fund research that created covid-19?

It is true that researchers at the Wuhan Institute of Virology, at the heart of the leak allegations, had funding from the US in the past. It is also true that the EcoHealth Alliance, the US research group that received US grants and helped to fund research at the institute from those grants, had its funding suspended by the US Department of Health and Human Services in May 2024.[5]

A July 2023 memo sent to the US House of Representatives oversight select subcommittee, which had been investigating US grants to the Wuhan institute,[6] detailed a lengthy record of failed communications between US agencies and the institute. The memo said that the institute repeatedly refused to provide requested laboratory notebooks, data records, and other information about safety and security.

The memo said, "NIH [the US National Institutes of Health] stated that it had received reports that WIV [Wuhan Institute of Virology] had been conducting research at its facilities in China that posed serious biosafety concerns and, as a result, created health and welfare threats to the public in China and other countries, including the US." Given the institute's failure to respond to requests for records, the committee concluded that "WIV research likely violated NIH protocols regarding biosafety. There is a risk that WIV not only previously violated, but is currently violating, and will continue to violate, NIH protocols on biosafety."

The EcoHealth Alliance submitted a proposal in 2018 for a project to the US Defense Advanced Research Projects Agency (DARPA) for funding, but the application was rejected.[7] In the same statement EcoHealth said that it "did not support 'gain-of-function' research at WIV."

In the statement EcoHealth said that the SARS related research it conducted with the Wuhan institute involved bat coronaviruses

that had never been shown to infect people, let alone cause significant morbidity or mortality in humans. Because of this it was, "by definition, not gain-of-function research," EcoHealth argued. It said, "This was confirmed by NIH on July 7, 2016, in a letter to the EcoHealth Alliance made public via Freedom of Information Act requests stating, 'NIAID [National Institute of Allergy and Infectious Diseases] is in agreement that the work proposed . . . is not subject to the [gain-of-function] research funding pause.'" EcoHealth added that an NIH spokesperson, Elizabeth Deatrick, had also said this in comments to the press.

Still, scientists don't all agree on definitions of gain-of-function research. And some see the very presence of proposals such as that of the EcoHealth Alliance to DARPA as evidence of intent. "That proposal set forth in detail the steps of what they propose to do in 2019 and 2020, and they propose to construct more such viruses," says Ebright, "They propose to aim for viruses . . . that would confer higher affinity for human binding receptors. They propose to incorporate a furin cleavage site into those spikes, and they told us exactly where they propose to incorporate the furin cleavage site, and how they propose to construct the virus."

What about the Wuhan Institute of Virology?

We know the virus was first detected in the city of Wuhan. And we know that there was a laboratory, at the institute, where the scientist Shi Zhengli, who has had funding from the NIH among others, was looking at SARS related coronaviruses. This included gain-of-function research, aiming to find out which mutations it would take to make a virus stronger.

"Zhengli's lab does great work on SARSr-CoVs [SARS related coronaviruses], but they aren't the only lab in the world doing so. They aren't even the only lab in China doing this work," wrote Angela Rasmussen, a virologist at the University of Saskatchewan, on X. "People all over the world have been studying these viruses—including those isolated from bats—since SARS1 emerged in 2002. In the US, Australia, Hong Kong, Singapore, the UK, the Netherlands, Japan, France, Canada, and so on."

In 2020 Rasmussen joined a WHO expert group on experimentally modelling SARS-CoV-2. "Multiple folks from China were there, none of whom were from WIV or Wuhan. SARS-CoV-1 emerged in China, so many labs there study these viruses. Wuhan isn't special, and WIV is one of many," she said. "There is zero evidence that WIV had SARS-CoV-2 or a progenitor in their collection. No SARS2 at WIV, no lab leak."

She also said, "The viruses that WIV was known to have are more closely related to SARS-CoV-1," adding that the most closely related SARS related coronavirus in WIV's collection is different by more than 1100 mutations across its entire genome.

"No amount of insertions, mutagenesis, or passaging in cells, transgenic mice, bats, or whatever else, can make it SARS-CoV-2," she said, "I'm closely related to my sibling and my parents. If I got cancer or HIV (which would cause mutations/insertions/recombination of my genome), it would not turn me into my brother or my parents. Similarly, the WIV's SARSr-CoVs can't turn into SARS-CoV-2 at any containment level."

Is there strong evidence for a natural origin for covid-19?

Geographically, the earliest cases centre on Wuhan's wet market. Zoonotically, animals that could be infected with SARS-CoV-2 were present at the wet market, as confirmed by swabs collected there before the outbreak.

In addition, genetic evidence following the mutations that occur in a virus's genome as it replicates point to two spillover events from animals to humans tied to the wet market.[8]

In March 2023 a team of scientists claimed to have the "best evidence" we are ever likely to find of how the virus that causes covid-19 was first transmitted to a human. The crux of this analysis is that DNA from raccoon dogs, wild mammals that were being sold live in the market for meat, was found in the same locations as swabs from the market that tested positive for SARS-CoV-2.

Florence Debarre, a senior researcher at the Institute of Ecology and Environmental Sciences in Paris, reviewed the data and told BBC World Service, "We saw the results appear on our screens, and it was: raccoon dog, raccoon dog, raccoon dog, raccoon dog. We found animals and virus [together]. That does not prove that the animals were infected, but that is the most plausible interpretation of what we've seen."

Gostin says that there is considerable evidence that covid-19 originated in Wuhan from a naturally occurring spillover from an animal to humans. "Most scientists feel that a naturally occurring event was most likely the cause of the SARS-CoV-2 outbreak and subsequent pandemic spread," he says. "The evidence is strong but is still circumstantial, and we need to keep an open mind about the origins of covid-19."

Rasmussen wrote that the role of the market in the pandemic's emergence was covered up in ways that didn't apply to SARS1 or Middle East respiratory syndrome (MERS). "The market was closed. Live animals were removed. Clearly evidence was suppressed, not collected, or not made accessible," she said, "That doesn't mean the evidence we do have doesn't support a market origin. Existing affirmative evidence isn't invalidated by a lack of other types of evidence."

She added, "I have yet to see an alternative explanation for the multiple threads of evidence supporting zoonosis. No infected animals at the market (because samples weren't taken to look for said infected animals) doesn't disprove all the other evidence that very clearly points to the market.

"Evidence isn't a carton of milk. It doesn't expire if you don't find it. Intermediate hosts of SARS-CoV-1 and MERS were not found in days, as claimed, and sometimes they are never found. It took years to find the reservoir for Marburg virus. Nobody debates that it is zoonotic."

Editor's note: On 13 September 2024 we amended the paragraph relating to the research that the EcoHealth Alliance conducted with the Wuhan Institute to make it clearer which statements came from EcoHealth.

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Competing interests: ML was science editor and fact checker on Jeremy Farrar's book *Spiked: The Virus v The People*. He has previously been employed at the Wellcome Trust, where Jeremy Farrar was director at the time.

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