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Case Report

One Health Bulletin

# COVID−19 breakthrough infection after four doses of the vaccines: A case report

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## ABSTRACT

The COVID-19 vaccines provide a high degree of protection against severe disease, hospitalisation, and death. However, no vaccine claimed 100% effectiveness and it is expected that a small proportion of vaccinated individuals may develop a breakthrough infection due to individual differences, virus variants and other factors. We conducted an epidemiological investigation and analysis of an imported case who had finished four doses of vaccination, and in order to provide a relevant reference for regular epidemic prevention and control in the post-pandemic era.

**KEYWORDS:** Breakthrough infection; COVID-19; Vaccination

## 1. Introduction

Since the outbreak of Coronavirus Disease 2019 (COVID-19), countries around the world have adopted different ways to contain the spread of the coronavirus. Vaccination is the most cost-efficient and effective strategy for preventing infectious diseases[1–2]. In response to the COVID-19 pandemic, many countries have accelerated vaccination efforts and rapidly built up immunity barrier for the entire population during the COVID-19 pandemic. However, vaccines are not 100% effective[3], meaning COVID-19 breakthrough infection after vaccination are possible. As the epidemic spread, breakthrough infections related to a series of factors including virus variation, transmissibility, pathogenicity immune evasion and health disparities of individual become more frequent. This study introduced a case of COVID-19 infection who had received four doses of the vaccine, which may serve as a benchmark for future studies.

## 2. Case report

A 32-year-old male returning from the Democratic Republic of the Congo (DR Congo) tested positive reverse transcription polymerase chain reaction (RT-PCR) for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) under medical observation at a designated isolation location by Qingpu Center for Disease Control and Prevention (CDC), Shanghai, China, December 31, 2021. Two colleagues who traveled with him tested negative. According to the patient's self-description, he worked as a cost of engineering in a company in Lubumbashi City, DR Congo from March 15 to December 21, 2021 and was in good health without the history of smoking, alcohol consumption, diabetes mellitus, or hypertension.

The case's epidemiological investigation revealed that the patient received two doses of COVID-19 vaccine (Sinovac Research & Development Co. LTD) on February 21 and March 9, 2021 in a hospital in Beijing, China (Beijing time). The case then flew to work in Lubumbashi, DR Congo on March 15, 2021 and received two further doses of the COVID-19 vaccine (Beijing Institute of Biological Products Co. LTD) in a hospital in Lubumbashi, DR Congo on July 30 and August 25, 2021 (Local time). Figure 1

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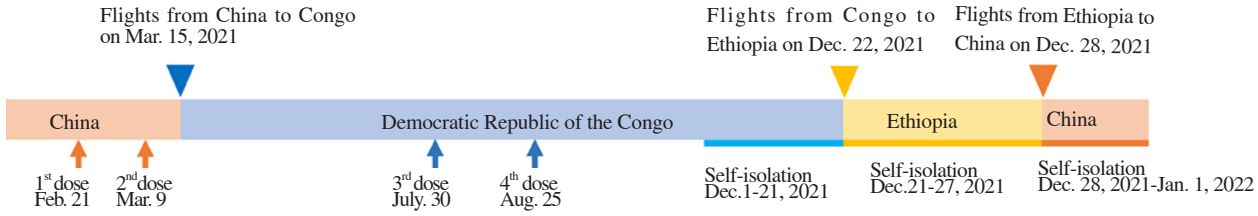


**Figure 1.** The patient's COVID-19 vaccination record and the travel history from February 21 to December 31, 2021.

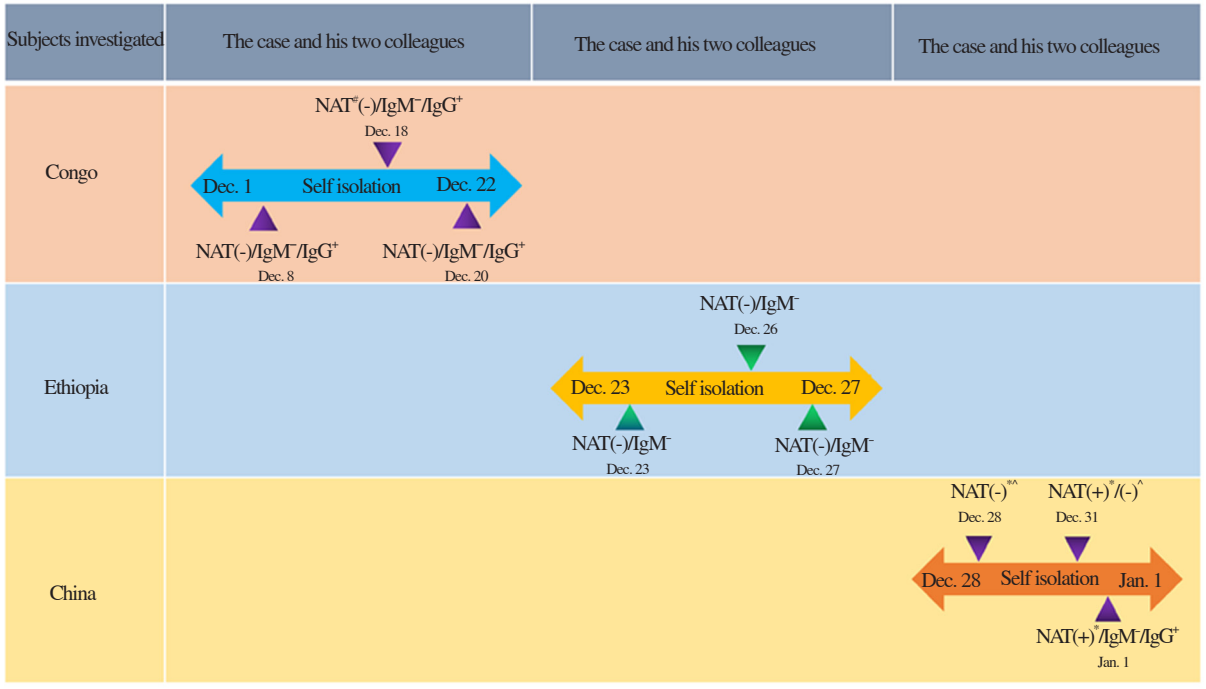


**Figure 2.** The serum antibody test results of the patient and his two colleagues in Congo, Ethiopia and China. *The result of nucleic acid test; *The nucleic acid test results for the case ; ^The nucleic acid test results for the two colleagues.

shows the COVID-19 vaccination and travel history.

The case began self-isolation at home in Lubumbashi City, DR Congo from December 1 to 21, 2021, before returning to China. He and his two coworkers visited the nearby hospital for nucleic acid testing three times on December 8, 18 and 20, 2021, respectively. On December 22, 2021, they flew to Addis Ababa, Ethiopia from Lubumbashi City, DR Congo, and the case spent 1.5 h to pick up the checked baggage. The three were subsequently quarantined for seven days at a hotel close to the airport, where they stayed there the entire time. And the medical staff took nucleic acid test samples in the hotel room on December 23, 26, and 27, 2021, respectively. On December 28, 2021, the case returned from Addis Abeba, Ethiopia, to Shanghai Pudong, China, where he spent 0.5 h retrieving the checked baggage. He was subsequently transported by airport bus to a Shanghai quarantine point in Qingpu District, where he was placed under medical observation there for 14 days.

During the case's self isolation at home in Lubumbashi City, DR Congo, and the seven-day quarantine at the hotel in Addis Ababa, Ethiopia, as well as at the airport of Shanghai Pudong, a series of antibody and nucleic acid tests were performed. However, on December 31, 2021, the fourth day of quarantine in Qingpu District, Shanghai, the case got a positive PCR result for coronavirus. On the same day, the patient presented with mild cold and sputum in the throat. The results of related laboratory tests in the assigned hospital showed that the white blood cell count was $7.35\times10^9$/L, the lymphocyte was $0.94\times10^9$/L, and the lung CT showed a little chronic inflammation in the left lower lobe. On January 1, 2022, freshly obtained samples from the case were retested by the Shanghai Municipal Center for Disease Control and Prevention. With the exception of Immunoglobulin M (IgM), all other tests were positive, including nasal swabs, throat swabs, sputum and anal swabs for COVID-19 nucleic acid detection and the serum Immunoglobulin G (IgG). The specific antibody and nucleic acid test results are shown in Figure 2.

As soon as the information confirmed, the case was reported to the Shanghai CDC immediately and the appropriate treatment measures were also actively performed. According to the guidelines and procedures for identifying and monitoring the close contacts developed by the China CDC, the patient's close contacts were screened quickly by the Shanghai CDC and the corresponding medical isolation and control measures were taken.

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## 3. Discussion

The current evidence indicates that in fully vaccinated people the risk of SARS-CoV-2 infection hospitalization, severe illness, and death from COVID-19 is relatively less. However, the risk of breakthrough infection in fully vaccinated people can't be eliminated due to the individual differences, COVID-19 variant strains and other factors[4–7].

The case in this study have received the fourth dose of COVID-19 vaccination and had protective antibodies (such as IgG) in his body, but he was still infected. Until the patient recovered and discharged from the hospital and completed another 14 days of isolation, no one at the company where the case worked tested positive and the two colleagues on the same trip were also not infected. The case spent the entire time in the company and home except for nucleic acid testing during the home isolation period in DR Congo. The itineraries of the case, coworkers A and B were basically the same, and the seats on the two flights were adjacent (except for drinking and eating, the three wore the same N95 masks throughout the whole trips). The case did not stayed with coworkers A and B during the baggage claim at the Addis Ababa Bole International Airport (Ethiopia) and Pudong International Airport (China), as well as during the isolation period in the Ethiopia hotel. Combining the case' itinerary and the IgM test results of the case and two colleagues in each period, it is inferred that the case was probably to be infected with COVID-19 during the travel (especially at the baggage claim area), and the possibility of cross-infection due to nucleic acid sampling during the three isolation periods in Congo, Ethiopia (it is uncertain whether the hotel had confirmed cases of COVID-19 when the case was quarantined) and Shanghai (even though there were no additional positive cases in the hotel when the patient was quarantined) cannot be ruled out.

Currently, certain nations and areas have begun administering the fourth dose of COVID-19 vaccine[8,9]. However, a study by Israel's Sheba Medical Center has discovered that while the fourth dose of the COVID-19 vaccine increases antibodies to levels even higher than the third shot, it is insufficient to prevent Omicron infections[10]. It is advised that even after the initial immunization and booster shot, fully vaccinated people must remain vigilant in adhering to the non pharmaceutical interventions, such as wearing a mask in public and indoor settings to prevent and control SARS-CoV-2 transmission in the community.

## Conflict of interest statement

The authors declare that there is no conflict of interest.

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## Authors' contributions

Zhou HR and Zhong WJ designed the study. Zhou HR, Zhou Z, Kong W and Hu JF conducted the epidemiological investigation and collected the materials. Zhou HR and Wang XL analyzed the data and drafted the initial manuscript. Li GF, Wang XM, and Ye KY contributed to the critical revision of the article. Zhou HR, Zhong WJ, Wang XL and Xiao N reviewed and edited the content of the whole paper. All authors reviewed subsequent drafts of the manuscript and approved the final version.

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