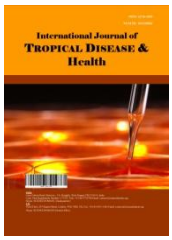

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Strengthening Prevention and Management of Omicron Infection in Children

Mateusz Iwański [a], Jacek Tabarkiewicz [b,c*], Fuyong Jiao [d*] and Chen Wang [d]

[a] Students' Scientific Association for Immunology, Department of Human Immunology, Institute of Medical Sciences, Medical College of Rzeszow University, University of Rzeszow, Poland.
[b] Laboratory for Translational Research in Medicine, Centre for Innovative Research in Medical and Natural Sciences Medical College of Rzeszow University, University of Rzeszow, Poland.
[c] Department of Human Immunology, Institute of Medical Sciences, Medical College of Rzeszow University, University of Rzeszow, Poland.
[d] Children's Hospital of Shaanxi Provincial People's Hospital, Xi 'an, China.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Omicron is a newly discovered new variant virus, which spreads rapidly around the world and has a great impact. It is designated as a variant of concern (VOC) by the World Health Organization. Its characteristic of epidemiology, distribution, pathogenic and clinical diagnosis, treatment and prevention are still being observed and summarized, especially there are few reports on the diagnosis and treatment of children with infected. This article introduces its influence on prevention, diagnosis and treatment of children, in order to improve the understanding and attention to the disease.

Keywords: SARS-Cov2; omicron; children; prevention; treatment.

1. INTRODUCTION

Since November 2021 [1], "the Omicron variant has been reported in South Africa, Botswana and many countries, and its prevalence rate has increased significantly. As of 22 December 2021, Omicron variants have been identified in 110 countries in all six World Health Organization

**Corresponding author: Email: 3105089948@qq.com, jtabarkiewicz@ur.edu.pl;*

(WHO) regions. The WHO said on 29 November that the overall global risk associated with the Omicron variant was assessed to be very high". Depending on the transmissibility of the variant and whether it can escape immunity, there could be a surge of COVID-19 outbreaks in the future, which could have serious consequences, the WHO said in a briefing [2,3].

Over time and with more research, evidence of omicron prevalence, speed of transmission, severity and impact on diagnosis, treatment and vaccine interventions will be confirmed.

“On the recommendation of the WHO Technical Advisory Group on Virus Evolution, THE B.1.1.529 variant was designated as a variant of concern (VOC) by WHO on 26 November 2021. This variant has been named Omicron. Omicron is a highly differentiated variant with a large number of mutations, including 26-32 mutations in spike proteins, some of which may be associated with humoral immune escape potential and higher transmission rates” [4].

The overall threat of omicron depends largely on four key questions: (1) the transmissibility of the mutant; (2) How effective vaccines and previous infections are in preventing infection, transmission, clinical illness and death; (3) The toxicity of this variant compared with other variants; (4) How the population understands these dynamics, perceives risks and takes control measures, including public health and social measures (PHSM). Public health recommendations are based on available information and are dynamically adjusted.

S gene target failure (SGTF) is a marker to identify Omicron variant. Children, as a special group, have not yet developed their cellular and humoral immune functions and are vulnerable to viral infection. With the continuous discovery of novel coronavirus variant strains, it is particularly important to strengthen the prevention and treatment of omicron infection in children.

2. OMICRON FEATURES

2.1 Structure

Omicron variants of spike proteins are characterized by at least 30 amino acid substitutions, three small deletions, and one small insertion. Notably, 15 of the 30 amino acid substituents are in the receptor binding domain (RBD). There are also changes and deletions in other genomic regions. Omicron varieties include the Pango lineage B.1.1.529, ba.1, ba.2, and Ba.3. As of December 23, BA.1 accounted for 99% of the sequence, ba.3 was missing 69-70 in spike protein, while BA.2 was not. Understanding of B.1.1.529 is still developing, but the lineage is more diverse, with 69-70 deletions in about half of all current sequences.

2.2 Contagious

“Available evidence consistently suggests that the Omicron strain has a significant transmission advantage over the Delta strain. In countries and regions where community transmission of the Omicron strain has occurred, it has spread significantly faster than that of the Delta strain, doubling in 2 to 3 days. As described in a WHO technical brief published on 17 December 2021” [4], immune escape following prior infection or vaccination has played an important role in the rapid increase in Omicron cases.

2.3 Severity of the Disease Caused

It is not clear whether infection with the Omicron variant is associated with disease severity. Preliminary information from South Africa suggests that Omicron variant infection has no abnormal symptoms and some patients are asymptomatic. Data from earlier studies in South Africa, the United Kingdom and Denmark suggest that the omicron strain causes a lower risk of hospitalization than the Delta strain.

2.4 Effects on Vaccine-induced Immunity or Immunity to Previous Infections

Currently, no data are available to assess the ability of serum neutralization of Omicron variants in vaccinated or previous SARS-COV-2 infected individuals.

Spike proteins are the main targets of vaccine-induced immunity. The Omicron variant contains more changes in the spike protein than the other variants. Based on the number of substitutions, the location of these substitutions, and data from other variants with similar spike protein substitutions, a significant reduction in serum neutralization activity is expected in vaccinated or previously infected individuals, which may indicate reduced protection against infection [5-7].

Laboratory and epidemiological studies are therefore needed to assess the impact of Omicron variants on vaccine effectiveness and

breakthrough infections, including in individuals receiving booster doses. However, it is expected that COVID-19 vaccination will continue to provide hospitalization and death protection, with vaccines playing a key role in controlling the COVID-19 pandemic.

2.5 Influence on Monoclonal Antibody Therapy

No virus-specific data are available to assess whether monoclonal antibody therapy will retain efficacy against the Omicron variant. Data on the full spectrum of spike protein changes are needed to understand the impact on therapeutic drugs such as monoclonal antibodies.

3. BACKGROUND AND RECENT GLOBAL DEVELOPMENTS

3.1 Background

On 24 November 2021, a new variant of SARS-COV-2, B.1.1.529, was reported to the World Health Organization (WHO). The new variety was first identified in specimens collected in Botswana on 11 November 2021 and in South Africa on 14 November 2021. On 26 November 2021, WHO named B.1.1.529 Omicron as a "mutant of concern" (VOC). As of 22 December, the novel coronavirus variant omicron strain has been detected in 110 countries and regions. The European Union's health agency, the ECDC, has expressed serious concern that the variant could significantly reduce the effectiveness of coronavirus vaccines and increase the risk of reinfection. However, the exact impact has not been determined.

“The rapid growth rate of Omicron infection is thought to be due to a combination of increased transmissibility and the ability to evade immunity (i.e., immune evasion) conferred by previous infection or vaccination” [8]. “Data from laboratory and epidemiological investigations suggest that the role of immune evasion is greater than that of increased transmissibility; Immunity conferred by previous infection or vaccination may be reduced compared to delta, but cannot be completely overcome” [9,10]. The data also showed that people who received the vaccine or received a booster dose or had a previous infection may have greater protection against Omicron.

The clinical severity of Omicron infection will strongly influence its impact on future hospitalizations and deaths. Early data suggest that Omicron infection may not be as severe as other variants. However, data on clinical severity are still limited. Even if the proportion of infections associated with severe outcomes is lower than in previous variants, the absolute number of severe outcomes is likely to be large, given the likely increase in the number of infections.

3.2 Recent Developments in Global Development

Who pointed out in the briefing that as of December 22, novel coronavirus variant Omicron had been detected in 110 countries and regions, all in five continents, and the cumulative number of global cases had exceeded.

As of 20 December 2021, omicron has been detected in most states and territories in the United States and is rapidly increasing its proportion of novel coronavirus pneumonia cases. Omicron is now the dominant strain circulating in the United States, reaching all 50 states and Washington, D.C. As of Monday, the UK had reported 45,145 cases of the omicron strain. Omicron has been recognised as the dominant mutation in the UK. Omicron accounts for 75% of new cases in the US and 20% in the UK. On 28 December, the Israeli Ministry of Health announced that the number of cases of the Omicron strain had reached 1,741. France now has a total of 347 cases of the omicron strain, although medical researchers say the actual number of cases is much higher. Cases of the omicron mutant strain were found in Russia in December, but all of the cases came on flights outside the country and have been quarantined. According to the European Centre for Disease Control and Prevention, 28 countries in the European Union have reported cases of the omicron strain. Omicron is expected to replace Delta as the main variant in some other countries in the European region in early 2022 [11].

In addition to Zimbabwe, Omicron cases have been reported in Lesotho, Namibia, Botswana, Kenya, Malawi, democratic Republic of Congo, Rwanda and Mauritius.

The number of Omicron infections reported in India has risen to 578 as of Monday. As infections from the Omicron variant surge, there are growing calls in India to push ahead with booster shots and vaccinate children. Japan, South Korea and Thailand have all seen local transmission cases of Omicron, and the number

of cases is gradually increasing. At present, Cases of omicron infection have been reported in Hong Kong and Taiwan.

In Tianjin and Guangdong province of China, the novel coronavirus strain of omicron variant was detected in recent confirmed COVID-19 cases imported from abroad.

According to data from South Africa and the USA, Omicron infection is leading to higher hospitalization rates than in previous waves [12,13]. However, that does not necessarily mean that children are more at risk for Omicron than they were for Delta or other variants. This is because compared to adults, children have lower rates of previous coronavirus infection and vaccination, which means their levels of preexisting immunity are relatively less. “Due to the fact that children under the age of five in the United States are not eligible for COVID-19 vaccination and children 5 through 11 years of age are not eligible for booster doses, this is particularly concerning” [14,13].

“The retrospective cohort study Wang L. et al., which included 14,054 patients infected with SARS-CoV-2 for the first time (27.7% of patients were patients <18 years of age) when the Omicron variant appeared, showed that the risk of hospitalization of unvaccinated children under 5 years of age (n = 1,361) was one third of the Delta variant period (0.96% vs. 2.65%), while the risk of visiting the Emergency Department was less than one fifth (3.89% vs. 21.01%), both differences were significant. A lower risk was also observed for children aged 5 to 11 years and 12 to 17 years of age. These results suggest that although the number of infections and hospitalizations for SARS-CoV-2 in children is increasing, the results are milder after the appearance of the Omicron variant compared to the predominant Delta period that preceded it by” [14].

“In another retrospective cohort study, Wang L. et al. which involved 79,592 children under 5 years of age infected with SARS-CoV-2 for the first time, including 7,201 patients infected with the Omicron variant and 63,203 patients infected with the predominant Delta variant, it was shown that the risk of severe clinical outcomes after 3 days after diagnosis of SARS-CoV-2 infection in the Omicron cohort (n = 7,198) was significantly lower than in children from the 1: 1 matched Delta cohort, with a 29% reduction in Emergency Department visits, 67% reduction in hospitalization, 68% reduction in admissions in the Intensive Care Unit and a 71% reduction in mechanical ventilation. Although the results of this study indicate that COVID-19 infections caused by the Omicron variant in children younger than 5 years of age are associated with a less severe course compared to the Delta variant, more studies are needed to monitor the long-term effects of Omicron infection. Despite the fact that, according to this analysis, infections with the Omicron variant are milder due to increased viral transmission, the overall number of emergency department visits, hospitalizations, Intensive Care Unit admissions, and mechanical ventilation in children may still be higher with the Omicron variant than with the Delta variant” [15].

The emergence of viral variants of concern (VOC) with increased transmission capacity has led to an increase in the number of infections and diseases among children and, consequently, to an increased number of hospitalizations and deaths. The dose of BNT162b2 vaccine was reduced from the recommended dose for adults due to safety and tolerability concerns in young children. Recently, information about incomplete immunity after vaccination of young children was published, which may be due to lower immunogenicity due to vaccination with a lower dose. “Bartsch YC et al. compared the humoral immune response induced by the vaccine in children 6-11 years of age receiving a pediatric (50 μg) or adult (100 μg) dose of the mRNA-1273 vaccine compared to adults and children with COVID-19 or Multisystem Inflammatory Syndrome in Children (MIS-C). Data from the research carried out suggest that higher pediatric doses can result in more flexible humoral immunity in children against highly divergent VOCs, superior to those induced in adults at a matched dose. What’s more the mRNA-1273 vaccine induced robust binding titers, neutralization, and Fc effector functions in vaccinated children, in a dose-dependent manner, compared to children with COVID-19 or MIS-C therefore vaccination of children of all ages is essential for providing broader, more potent boosting immunity against SARS-CoV-2 and emerging VOCs” [16].

4. CHILDREN'S CONDITION AND CLINICAL FEATURES

The Omicron variant probably originated in South Africa and was already dominant there. Children with a previously low prevalence of novel coronavirus pneumonia suddenly become

seriously ill and have to be hospitalized. In South Africa, the emergence of the Omicron variant led to a significant increase in the number of young children hospitalized. Scientists and public health officials say it is unclear whether young children are vulnerable to the new variant. The number of novel coronavirus positive tests in children aged 10 to 14 is also increasing. Twelve children were admitted to a hospital in Soweto, three of them requiring oxygen. At another hospital, 10 children have also been admitted to the Pediatric novel coronavirus isolation unit, one of whom required oxygen after being confirmed. However, in South Africa, the tendency for children to become ill after exposure to the presence of Omicron variants is not widespread, and it is unclear whether children are more likely to undergo more severe Omicron treatment. German virologists predict a "euromicron wall" of infections will emerge in the coming weeks without knowing how badly children and adults will be affected.

“Omicron is a novel coronavirus variant. After infection, the typical clinical symptoms are fever, dry cough and fatigue. Some people may suffer from decreased or loss of smell and taste function, and a small number of people may also suffer from nasal congestion, runny nose, sore throat, vomiting and diarrhea. However, clinical observations have found that patients infected with the Omicron strain usually have mild or no symptoms, with no severe or fatal cases. Researchers at the University of Hong Kong found that the Omicron variant replicates more rapidly (70 times faster) in the human bronchi than the Delta virus variant and the original SARS-COV-2 virus” [5]. In contrast, Omicron variants replicate relatively slowly in the lungs. This replication pattern is thought to explain the milder clinical manifestations in patients infected with the Omicron variant.

But the nature of the strain remains to be seen. The clinical manifestations of children are not typical, including vomiting, diarrhea and other gastrointestinal symptoms or only poor response, tachypnea, etc.

5. THE DIAGNOSIS

“According to the epidemiological and clinical manifestations, the diagnosis of suspected novel coronavirus pneumonia is consistent with that of novel coronavirus pneumonia. Meanwhile, the novel coronavirus nucleic acid is positive detected by real-time fluorescence RT-PCR, and the virus gene sequencing is highly homologous with the Omicron variant strain. Refer to this guideline for novel coronavirus diagnostic tests and the use of antigen tests” [6].

The diagnostic accuracy of conventional PCR and antigen-based rapid diagnostic tests (AG-RDT) did not appear to be affected by Omicron; the relative sensitivity of AG-RDT is being studied. Most Omicron variants have been reported to include deletion of the S gene, which may result in S target gene failure (SGTF) in some PCR assays. Therefore, this S gene target deletion (SGTF) can be a marker of Omicron. However, at least one subset of the sample needs to be sequenced for confirmation, as this deletion is present in other variants (such as subsets of Alpha and Gamma and Delta).

6. PREVENTION, TREATMENT AND TREATMENT: TRILOGY

Depending on the genetic changes in Omicron, some treatments may still be effective, while others may have poor results. But the vaccine, mask, and test trilogy remain our three weapons against Omicron.

6.1 The Prevention

The use of appropriate masks, social distancing, indoor ventilation, avoidance of clusters and hand hygiene remain key to reducing the transmission of the novel coronavirus, even in cases of mutation.

6.1.1 Vaccine

Vaccines remain the best public health measure to protect populations from Corona Virus Disease 2019 (COVID-19), slow transmission and reduce the likelihood of new mutations.

COVID-19 vaccines are highly effective in preventing serious illness, hospitalizations and reducing mortality; The United States Centers for Disease Control and Prevention.

“The CDC recommends that everyone age 5 and older protect themselves against COVID-19 by getting a full vaccination. So far, Delta remains the main vaccine variant that is very effective, and the vaccine may have some efficacy against Omicron” [4], especially in preventing serious complications and reducing mortality.

6.1.2 Masks

Masks protect against all novel coronavirus variants. CDC recommends that masks continue to be worn in public indoor Settings in areas of high or high community transmission, regardless of vaccination status; The CDC advises people on things like mask types.

6.1.3 Test

Tests can confirm COVID-19. Two types of tests can be used to test for present infections: nucleic acid amplification test (NAAT) and antigen test; Individuals can use COVID-19 virus testing tools to determine specific types of testing, such as additional tests to determine if the infection was caused by Omicron; Self-testing can be done at home or anywhere, is easy to use and produces results quickly.

The Institute of Virology, China CDC has established a specific nucleic acid test for the Omicron variant strain, and continues to conduct genome surveillance for possible imported cases. Effective measures that individuals are advised to take to prevent infection include staying at least 1 meter away in public places, wearing a mask, opening Windows for ventilation, keeping hands clean, coughing or sneezing into elbows or tissues, getting vaccinated, and avoiding poorly ventilated or crowded places.

6.2 Treatment

6.2.1 General treatment

Rest in bed, strengthen supportive treatment, ensure adequate calories. To maintain the stability of the internal environment, that is, to maintain the balance of water and electrolyte, to maintain the balance of intestinal microbiota. Intensive psychotherapy for older children.

6.2.2 Antiviral therapy

There are currently no effective antiviral drugs for children. Aerosol inhalation of recombinant human interferon α -2B can be tried. The efficacy and safety of oral lopinavir, ritonavir tablets or intravenous infusion of ribavirin are unknown, and should be used with caution according to the condition and the balance of advantages and disadvantages.

6.2.3 Use of antibiotics

If there is evidence of secondary bacterial infection, antibiotics should be used in time.

6.2.4 Treatment of severe and critical cases

Domestic guidelines recommend oxygen inhalation, mechanical ventilation and other respiratory support and circulation support, anticoagulant therapy, blood purification, ECMO, and the use of glucocorticoid or gamma globulin when necessary. Children's cardiopulmonary compensation ability is weaker than adults, more sensitive to hypoxia, oxygen therapy and mechanical ventilation indications should be appropriately relaxed; Routine use of lung extension is not recommended for children with severe and critical cases.

Data on the severity of the condition, including hospitalization, the need for oxygen, mechanical ventilation or death, remain limited. Interleukin-6 blockers and corticosteroids are expected to remain effective in the management of severe and critically ill patients because they reduce the host's inflammatory response to the virus. Preliminary in vitro data from abroad suggest that some monoclonal antibodies developed for novel coronavirus may reduce the neutralization of Omicron.

6.2.5 TCM treatment

Tianjin released the TCM Prevention and Treatment Plan for COVID-19 (Trial Version 5), which provides TCM prevention and treatment plans for close contacts, treatment of asymptomatic infected persons, treatment of confirmed cases, and rehabilitation of confirmed cases during recovery for clinical reference.

Close contact prevention program

Children's prescription: Qingqing children's drink.

How to take: Add 100ml boiled water to 1 bag each time, soak for 10 minutes, take it warm, swallow it slowly, soak for several times for each bag.

Treatment plan for asymptomatic infected persons

(1) Soup:

"Qingqing drink" series of preparations: spring drink, summer drink, autumn drink, winter drink.

Taking method: Add 300ml boiled water to 2 ~ 3 bags each time, soak for 10 minutes, take it warm, swallow it slowly, soak for several times for each bag. Suitable for ages 14 and up, or as directed by a doctor.

Qingqing children drink.

How to take: Add 150ml boiled water to two bags each time, soak for 10 minutes, take it warm, swallow it slowly, soak for several times for each bag.

(2) Chinese patent medicine:

Xuanfei Baidu granule, Lianhua Qingwen capsule (granule), etc.

7. CONCLUSION

The overall risk associated with the new Omicron variant therefore remains very high for a number of reasons. First, the global risk of COVID-19 remains high, and second, Omicron is spreading faster in communities than Delta, which could lead to a further surge of cases with serious consequences. Our understanding of Omicron is still evolving.

At present, novel coronavirus pneumonia has become a major new infectious disease in the world. Novel coronavirus continues to mutate, and the newly discovered Omicron strain poses a great challenge to the public health system in all countries. Due to the unique physiological characteristics of children, the whole body system is in dynamic change, the development of cellular immunity and humoral immunity is not perfect, vulnerable to pathogen infection, more attention should be paid to strengthen the prevention and treatment of children omicron infection. Therefore, families, schools and society must work together to cope with the unknown challenges and jointly meet the beautiful future of mankind [11]. Prevention of novel coronavirus variants remains a long and arduous task.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Distributed via the CDC Health Alert Network. New SARS-CoV-2 Variant of Concern Identified: Omicron(B.1.1.529)Variant. Available: https://emergency.cdc.gov/han/2021/han00459.asp,2021-12-01
2. Distributed via the CDC Health Alert Network Omicron Variant: What You Need To Know. Available:https://www.cdc.Gov/coronavirus/2019-ncov/ variants/omicron-variant.html,2021-12-01
3. Kupferschmidt K, Vogel G. How bad is Omicron? Some clues are emerging[J]. Science (New York, NY). 2021;374 (6573):1304-1305.
4. World Health Organization. Enhancing Readiness for Omicron (B.1.1.529): Technical Brief and Priority Actions for Member States. Available:https://www.who.int/publications/m/item/enhancing-readiness-for-omicron-(b.1.1.529)-technical-brief-and-priority-actions-for-member-states,2021-12.
5. HKU Med. HKUMed finds Omicron SARS-CoV-2 can infect faster and better than Delta in human bronchus but with less severe infection in lung [Internet]. The University of Hong Kong. Available:https://www.med.hku.hk/en/news/press/20211215-omicron-sars-cov-2-infection,2021-12-22.
6. World Health Organization. Antigen-detection in the diagnosis of SARS-CoV-2 infection: Interim Guidance. Available:https://www.who.int/publications/i/item/antigen-detection-in-the-diagnosis-of-sars-cov-2infection-using-rapid-immunoassays, 2021-12.
7. Queen D. Another year another variant: COVID 3.0-Omicron. Int Wound J. 2022;19(1):5. DOI: 10.1111/iwj.13739. PMID: 34927365.
8. Pulliam JRC, van Schalkwyk C, Govender N, et al. Increased risk of SARS-CoV-2 reinfection associated with emergence of the Omicron variant in South Africa [J]. Med Rxiv. 2021;6.

9. Khoury DS, Steain M, Triccas J A, et al. A meta-analysis of Early Results to predict Vaccine efficacy against Omicron [J]; 2021.
10. Doria-Rose N A, Shen X, Schmidt S D, et al. Booster of mRNA-1273 Strengthens SARS-CoV-2 Omicron Neutralization [J]; 2021.
11. European Centre for Disease Prevention and Control. Assessment of the further emergence of the SARS-CoV-2 Omicron VOC in the context of the ongoing Delta VOC transmission in the EU/EEA. Available: https://www.ecdc.europa.eu/en/publications-data/covid-19-assessment-further-emergence-omicron-18th-risk-assessment, 2021-12.
12. Cloete J, Kruger A, Masha M, Plessis NM du, Mawela D, Tshukudu M, Manyane T, Komane L, Venter, M., Jassat, W., Goga, A., & Feucht, U. (2021). Rapid rise in paediatric COVID-19 hospitalisations during the early stages of the Omicron wave, Tshwane District, South Africa. Bio Rxiv. DOI:10.1101/2021.12.21.21268108
13. Ledford H. How severe are Omicron infections? Nature. 2021;600(7890):577-578. DOI: 10.1038/d41586-021-03794-8
14. Wang L, Berger NA, Kaelber DC, Davis PB, Volkow ND, Xu R. (2022). Comparison of outcomes from COVID infection in pediatric and adult patients before and after the emergence of Omicron. Med Rxiv: the Preprint Server for Health Sciences. 2021;12.30.21268495. Available:https://doi.org/10.1101/2021.12.30.21268495
15. Wang L, Berger NA, Kaelber DC, Davis PB, Volkow ND, Xu R. COVID infection severity in children under 5 years old before and after Omicron emergence in the US. Med Rxiv : the Preprint Server for Health Sciences, 2022.01.12.22269179. Available:https://doi.org/10.1101/2022.01.12.22269179
16. Bartsch YC, St Denis KJ, Kaplonek P, Kang J, Lam EC, Burns MD, Farkas EJ, Davis JP, Boribong BP, Edlow AG, Fasano A, Shreffler W, Zavadska D, Johnson M, Goldblatt D, Balazs AB, Yonker LM, Alter G. Comprehensive antibody profiling of mRNA vaccination in children. Bio Rxiv: the Preprint Server for Biology. 2021; 10(07):463592. Available:https://doi.org/10.1101/2021.10.07.463592

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