

SARS-CoV-2 Research Summary

Omicron (BA.1) Neutralization Studies

Prepared by:
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Introduction

The rapid evolution of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) has led to the emergence of multiple variants of concern (VOCs). The emergence of [Omicron](#), the latest [VOC designated by the World Health Organization](#) (WHO), has led to a large number of studies detailing this variant's ability to escape neutralization by antibodies generated either by vaccines or previous infections. Below we have compiled a list of such studies and have attempted to provide a brief summary of the main themes each presents.

Major Conclusions

- Omicron appears to have significant immune escape from neutralizing antibodies elicited both by previous infection as well as multiple vaccine types.
- A third booster dose, particularly of an mRNA vaccine significantly boosts neutralizing antibody levels, likely increasing protection against Omicron.
- Omicron appears to have significant immune escape from most therapeutic monoclonal antibodies (mAbs). Exceptions: Sotrovimab, S2K146, S2X2593, S2H974.
- The R346K mutation found in a small percentage of Omicron genomes confers additional Ab escape.
- Omicron retains susceptibility to antivirals (remdesivir, molnupiravir, and PF-07321332).
- This [manuscript](#) has compiled and normalized data from multiple studies.
- This site summarizes [Variant Therapeutic Information](#)

Title	Brief Summary
SARS-CoV-2 Omicron has extensive but incomplete escape of Pfizer BNT162b2 elicited neutralization and requires ACE2 for infection	This publication examined sera from “infected and vaccinated” as well as “vaccinated only” patients, and reported a 22-fold escape from vaccine elicited neutralization for Omicron in both groups. Previously infected and vaccinated individuals appeared to have higher protection from symptomatic Omicron infection, versus vaccinated only.
Quantification of the neutralization resistance of the Omicron Variant of Concern.	This publication used pseudotyped viruses in neutralization assays with sera from 2 groups: random blood donors and previously-infected hospital workers. Results found Omicron neutralization levels to be highly variable, with fold reductions ranging from 1 to 23.
Pfizer and BioNTech Provide Update on Omicron Variant	This press release from the Pfizer company stated that 2 doses of the BNT162b2 had significantly reduced neutralization titers against Omicron, but that a 3rd booster dose increased the neutralizing antibody titers by 25-fold
Reduced Neutralization of SARS-CoV-2 Omicron Variant by Vaccine Sera and monoclonal antibodies	This study used patient derived Omicron isolates to show a large reduction in neutralization efficacy of vaccine-elicited sera, as well as the two mAbs: <i>casirivimab</i> & <i>imdevimab</i> .
SARS-CoV-2 B.1.1.529 variant (Omicron) evades neutralization by sera from vaccinated and convalescent individuals	This study used patient isolated virus to compare neutralization efficacy of convalescent or vaccine-elicited sera, against the following VOCs: BA.1 (B.1.1.529 or Omicron), B.1.1.7 (Alpha), B.1.351 (Beta), and B.1617.2 (Delta). Results indicated highly reduced neutralization of Omicron compared to other variants.

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Plasma neutralization properties of the SARS-CoV-2 Omicron variant	<p>This study used pseudotyped virus to compare neutralization efficacy of convalescent or vaccine-elicited sera against Omicron spike protein and PS20, a laboratory-designed neutralization-resistant SARS-CoV-2 spike. Omicron and PS20 spike proteins were both highly resistant to neutralization compared to the reference strain, Wuhan-hu-1.</p>
The significant immune escape of pseudotyped SARS-CoV-2 variant Omicron	<p>This study used pseudotyped virus to compare neutralization efficacy of convalescent sera ("original strain") against multiple variants: Alpha, Beta, Gamma, Delta, Lambda, and Mu. Results indicated that Omicron was highly resistant to neutralization compared to other variants.</p>
HKUMed-CU Medicine joint study finds COVID-19 variant Omicron significantly reduces virus neutralisation ability of BioNTech vaccine	<p>This press release reported that Omicron neutralization by the Pfizer BioNTech (BNT162b2) vaccine elicited sera was significantly reduced.</p>
mRNA-based COVID-19 vaccine boosters induce neutralizing immunity against SARS-CoV-2 Omicron variant	<p>This study used pseudotyped virus to compare neutralization efficacy of vaccine-elicited sera, against the following VOCs: wild type, Delta, and Omicron. Vaccines studied included mRNA-1273, BNT162b, and Ad26.COVS. Results indicated almost no neutralization of Omicron. Individuals who had received 3rd mRNA booster were able to neutralize Omicron with less significant reductions in neutralizing activity compared to wild-type.</p>
mRNA booster immunization elicits potent neutralizing serum activity against the SARS-CoV-2 Omicron variant	<p>This study used pseudotyped virus to compare neutralization efficacy of convalescent or vaccine-elicited sera, and mAbs against Omicron. Results indicated almost no neutralization of Omicron either by sera or most mAbs. Individuals who had received 3rd mRNA booster were able to neutralize Omicron with less significant reductions in neutralizing activity compared to wild-type.</p>
Broadly neutralizing antibodies overcome SARS-CoV-2 Omicron antigenic shift	<p>This study used pseudotyped virus to compare neutralization efficacy of convalescent or vaccine-elicited sera, and mAbs against Omicron. Results indicated highly reduced neutralization of Omicron by both sera and mAbs. Three mAbs retained neutralizing potency.</p>
The Omicron variant is highly resistant against antibody-mediated neutralization – implications for control of the COVID-19 pandemic	<p>This study used pseudotyped virus to compare neutralization efficacy of convalescent or vaccine-elicited sera, and mAbs against Omicron. Results indicated highly reduced neutralization of Omicron by both sera and mAbs. Heterologous vaccination or third vaccines doses boosted neutralization.</p>
Booster of mRNA-1273 Strengthens SARS-CoV-2 Omicron Neutralization	<p>Used live and pseudotyped virus to compare neutralization of mRNA-1273 vaccine-elicited sera, against D614G, Beta and Omicron variants. Results showed Omicron had highly reduced neutralization compared to other variants. A 50 µg boost increased Omicron neutralization titers.</p>

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Striking Antibody Evasion Manifested by the Omicron Variant of SARS-CoV-2	Used live and pseudotyped virus to compare neutralization of convalescent or vaccine-elicited sera, and mAbs against Omicron. Results indicated highly reduced neutralization of Omicron by both sera and mAbs.
Considerable escape of SARS-CoV-2 variant Omicron to antibody neutralization	Used live and pseudotyped virus to compare neutralization of convalescent or vaccine-elicited sera, and mAbs against Omicron. Results indicated highly reduced neutralization of Omicron by sera and mAbs. Boosters and hybrid convalescent/vaccine immunity improved neutralization.
SARS-CoV-2 Omicron spike mediated immune escape, infectivity and cell-cell fusion	Used pseudotyped virus to compare neutralization of vaccine-elicited sera and mAbs against Omicron. Results indicated highly reduced neutralization of Omicron by both sera and mAbs. A third dose rescued and broadened neutralization. Antivirals retained efficacy against Omicron.
Reduced neutralisation of SARS-CoV-2 omicron B.1.1.529 variant by post-immunisation serum	Used live virus to compare neutralization of vaccine-elicited sera against Omicron, Victoria (early strain), Beta and Delta variants. Results indicated highly reduced or no neutralization of Omicron.
Neutralization and Stability of SARS-CoV-2 Omicron Variant	Used pseudotyped virus to compare neutralization of convalescent or vaccine-elicited sera. Results indicated highly reduced neutralization of Omicron. A third dose improved neutralization.
Activity of convalescent and vaccine serum against a B.1.1.529 variant SARS-CoV-2 isolate	Used live virus to compare neutralization of convalescent or vaccine-elicited sera, against the following VOCs: wild type, Beta, and Omicron. Results indicated little to no neutralization with sera from convalescent and double vaccinated patients. Neutralization was improved in individuals who had either received a booster or had hybrid convalescent/vaccine immunity.
Reduced sensitivity of SARS-CoV-2 Omicron variant to booster-enhanced neutralization	Used pseudotyped virus to compare neutralization of vaccine-elicited sera (Sinopharm BBIBP-CorV with homologous booster) against Omicron. Results indicated highly reduced neutralization of Omicron (2 doses). A third dose improved neutralization.
Reduced sera neutralization to Omicron SARS-CoV-2 by both inactivated and protein subunit vaccines and the convalescents	Used pseudotyped virus to compare neutralization of convalescent or vaccine-elicited sera (CoronaVac, BBIBP-CoV, or ZF2001) against Omicron. Results indicated highly reduced neutralization of Omicron (2 doses)). A third dose improved neutralization.
SARS-CoV-2 spike conformation determines plasma neutralizing activity	Used pseudotyped virus to compare neutralization of convalescent or vaccine-elicited sera (mRNA-1273, BNT162b2, AZD1222, Sputnik V, or BBIBP-CorV, Ad26.COVS) against Omicron. Results showed highly reduced neutralization of Omicron. Also showed a reduction of S1-directed Abs relative to postfusion S2-targeting Abs.

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mRNA-1273 and BNT162b2 mRNA vaccines have reduced neutralizing activity against the SARS-CoV-2 Omicron variant	Used live virus to compare neutralization of mRNA-1273 and BNT162b) sera against Omicron. Results indicated highly reduced neutralization of Omicron by sera from vaccines with 2 doses. Boosters and hybrid convalescent/vaccine immunity improved neutralization.
SARS-CoV-2 Omicron Spike recognition by plasma from individuals receiving BNT162b2 mRNA vaccination with a 16-weeks interval between doses	Used pseudovirus to test neutralization of naive, convalescent or vaccine-elicited (2 doses of BNT162b2 mRNA 3 or 16-weeks apart) sera against Omicron. Plasma from individuals with longer vaccine intervals neutralized omicron more effectively than from those with short intervals.
Homologous or Heterologous Booster of Inactivated Vaccine Reduces SARS-CoV-2 Omicron Variant Escape from Neutralizing Antibodies	Used pseudovirus to test neutralization of convalescent or vaccine-elicited sera (BBIBP-CorV) against Omicron. Results indicated low or no neutralization of Omicron with sera from convalescent or double vaccinated individuals. A third booster dose improved neutralization. Homologous or heterologous vaccine boosters significantly increased neutralization titers.
SARS-CoV-2 Omicron neutralization by therapeutic antibodies, convalescent sera, and post-mRNA vaccine booster	Used pseudovirus to test neutralization of convalescent or vaccine-elicited sera, and mAbs against Omicron. Results indicated low or no neutralization of Omicron with sera from convalescent or double vaccinated individuals. A third booster dose improved neutralization. Only 3/24 mAbs tested retained significant potency against Omicron.
Increased resistance of SARS-CoV-2 Omicron Variant to Neutralization by Vaccine-Elicited and Therapeutic Antibodies	Used pseudovirus to test neutralization of vaccine-elicited (mRNA-1273 and BNT162b) sera and mAbs against Omicron. Results indicated highly reduced neutralization of Omicron compared to D614G. A booster immunization improved neutralizing titers against Omicron. mAbs had reduced or no effectiveness against Omicron..
Functional properties of the spike glycoprotein of the emerging SARS-CoV-2 variant B.1.1.529	Used pseudotyped virus to compare neutralization of convalescent or vaccine-elicited sera against WT, Delta and Omicron. Results indicated highly reduced neutralization of Omicron.
Comprehensive antibody profiling of mRNA vaccination in children	Used pseudovirus to compare neutralization of convalescent or vaccine-elicited (mRNA-1273) sera from adults and children against the several variants: D614G, Alpha, Beta, Delta and Omicron. Results indicated highly reduced neutralization of Omicron compared to other variants. In children, 100ug of mRNA resulted in "highly preserved omicron-specific functional humoral immunity".
Differential neutralization and inhibition of SARS-CoV-2 variants by antibodies elicited by COVID-19 mRNA vaccines	Used live virus to compare neutralization of convalescent or vaccine-elicited sera against Omicron. Results indicated highly reduced neutralization of Omicron by sera. A third booster dose improved neutralization.
Analysis of SARS-CoV-2 Omicron Neutralization Data up to 2021-12-22	This paper normalizes and compares results from multiple publications on Omicron neutralization data.

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Antibodies elicited by SARS-CoV-2 infection or mRNA vaccines have reduced neutralizing activity against Beta and Omicron pseudoviruses	Used pseudovirus to compare neutralization of convalescent or vaccine-elicited (mRNA-1273 and BNT162b) sera from individuals vaccinated during pregnancy against several variants: Beta, Delta and Omicron. Results indicated highly reduced neutralization of Omicron compared to other variants. Furthermore vaccinated healthy adults had higher and broader antibody responses than vaccinated pregnant women.