

Agility Program Biweekly Progress

Agility Program: To enable the rapid assessment of the biological impacts of new variants of SARS-CoV-2

Partners:

UK Health Security Agency (UKHSA – formerly Public Health England)

National Institute for Biological Standards and Control (NIBSC)



*Slideset provided on a biweekly basis to update latest
in vitro neutralization activity and in vivo
pathogenesis and cross protection data against
SARS-CoV-2 virus variants*

Find this slide set posted at:

https://epi.tghn.org/covax-overview/enabling-sciences/agility_epi/#ref1

WHO Variants of Concern and Interest Monitored by the Agility Project

WHO Variants of Interest	Status*	WHO Variants of Concern	Status*
†Epsilon - B.1.427/B.1.429	Deselected	Alpha - B.1.1.7	Assessed ²
†Zeta – P.2	Assessed ¹	Beta - B.1.351	Assessed ²
Eta – B.1.525	Seeking	Gamma - P.1	Assessed ²
†Theta – P.3	Deselected	Delta - B.1.617.2 (Including AY.1)	Assessed ²
Iota – B.1.526+E484K or S477N	Seeking	Omicron – B.1.1.529 (BA.1 and BA.1.1 ¹)	Assessed ²
Kappa – B.1.617.1	Assessed ²		
Lambda – C.37	Seeking		
Mu - B.1.621	Assessed ²		
additionally sourcing AY sublineages based on geographical prevalence...			
AY.4, AY.23, AY.25, AY.30, AY.32 AY.4.2, AY.43	Seeking Sourced	AY.4.2	Assessed ²

Link to the WHO weekly Epi report website:

<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>

*From; Not selected/Seeking/Sourced/Assessed

†No longer a WHO VUI, may prompt deselection

Superscripts denote assessed at 1 or 2 sites in vitro

Agility Project: Variant Growth/Testing for Neutralization Phenotype

	Variant	Sourcing or Propagation <small>Seeking/In progress/Complete</small>	Characterisation <small>In progress/Complete/No longer required</small>	In vitro (neutralisation) <small>In progress/Complete/No longer required</small>	In vivo <small>Not selected/Planning/In progress/In-life complete</small>
WHO VOCs	Alpha (B.1.1.7)	Complete	Complete	Complete	In-life complete
	Beta (B.1.351)	Complete	Complete	Complete	
	Gamma (P.1)	Complete	Complete	Complete	
	Delta (B.1.617.2)	Complete	Complete	Complete	In-life complete –reporting underway
	Omicron (B.1.1.529) as BA.1 and BA.1.1	Complete	In progress	Complete	In-life complete –manuscript link ^c
	BA.2 and BA.3	Sourced	In progress		
WHO VOIs	†Eta (B.1.525)	Seeking			
	†Epsilon (B.1.427/B.1.429)	Sourced	No longer required		
	†Zeta (P.2)	Complete	Complete	Complete (1 of 2 labs)	In-life complete
	†Theta (P.3)	Deselected	No longer required		
	†Iota (B.1.526+E484K)	Seeking			
	†Kappa (B.1.617.1)	Complete	Complete	Complete	
	Lambda (C.37)	Seeking			
	Mu (B.1.621)	Complete	Complete	Complete	In-life complete
UK	Alpha + E484K	Complete	In progress	Complete	
n/a	*C.1.2 ^a	Complete	In progress	In progress	
n/a	*Isolate D190 ^b	Complete	In progress	In progress	

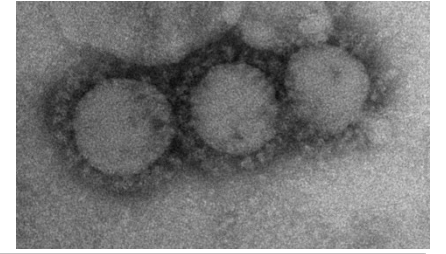
†No longer a WHO VUI, *Isolates provided by Alex Sigal, African Health Research Institute, pursued for reasons of interesting Spike mutations.

^a<https://www.medrxiv.org/content/10.1101/2021.08.20.21262342v1>

^b<https://www.medrxiv.org/content/10.1101/2021.09.14.21263564v1.full>

^c<https://www.biorxiv.org/content/10.1101/2021.12.24.474081v1>

Wildtype virus Quality Control

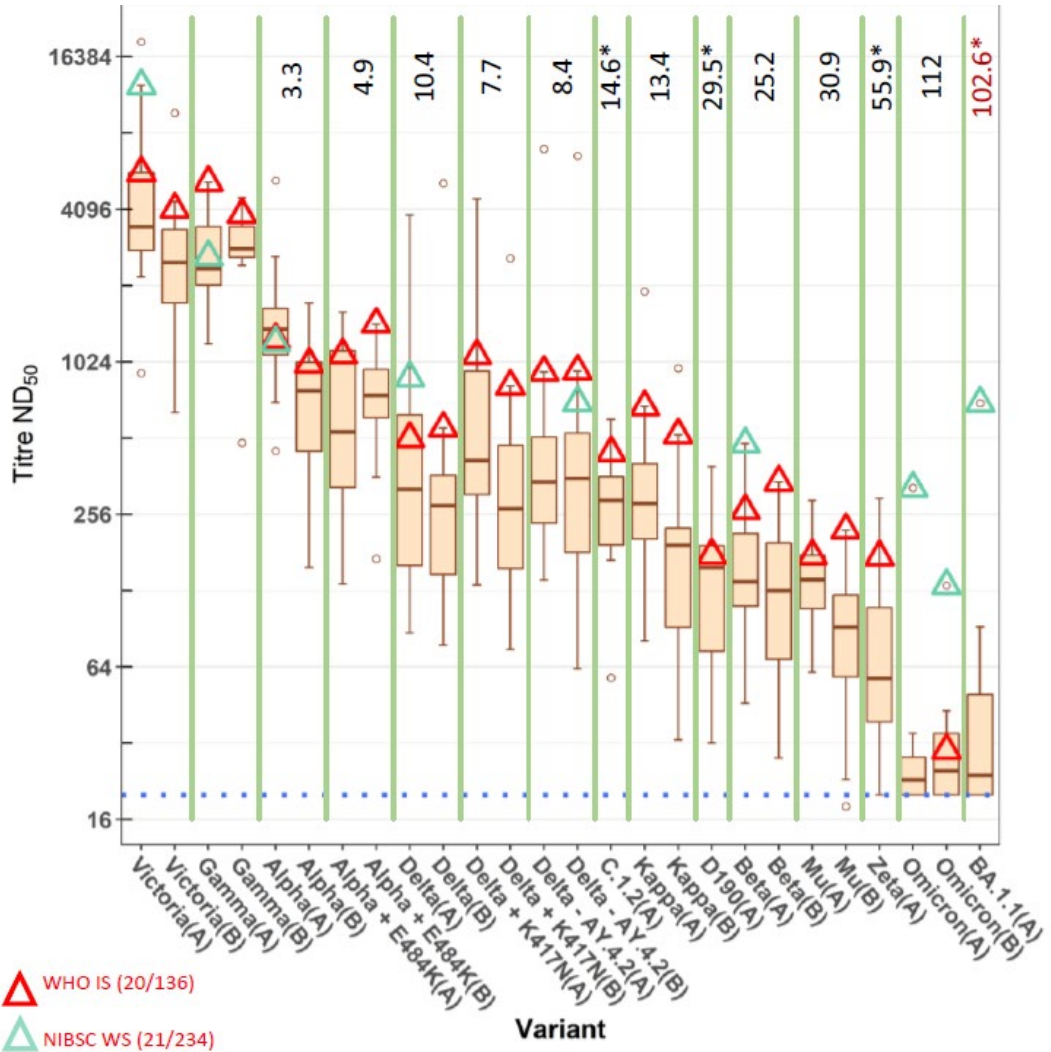


- Most viruses isolated from clinical material through UKHSA's network
- Some have been isolated elsewhere and donated by other institutes
 - G2P consortium
 - Barclay 'flu lab (Imperial College, London)
 - Oxford University, UK
 - Fiocruz, Brazil
 - Sheba Medical Centre, Israel
 - AHRI, South Africa
- All are grown into working banks and quality control assessments are performed
 - CoAs issued
 - Virus stocks available from NIBSC and EVAg

Criteria	Result
Passage history, cell line(s) used, MOI and harvest details	Recorded
Morphology	Transmission electron microscopy
Cytopathic effect	Record appearance
Viable titre	Plaque forming units on Vero E6 (and additionally/alternatively VAT or foci)
Usage dilution in micro-neutralisation assay (MNA)	For ~130 focus forming units/well in non-neutralisation control
Sterility	7 days in TSB & Thioglycollate at 22° and 37°C
Absence of mycoplasma	ECACC validation PCR test
Sequence analysis – Nanopore/Arctic v3	Confirm presence of furin cleavage site, identity, lineage (<i>fast</i>)
Sequence analysis – Illumina NGS/SISPA	Examination of minor variants, absence of contaminants, fill in any 'missed' regions due to Arctic protocol primer mismatches (<i>detailed</i>)

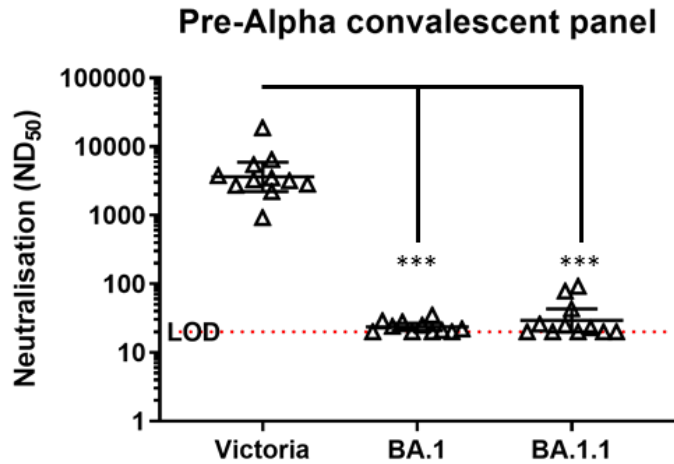
Live-virus *in vitro* antibody neutralization assay progress

Fold changes relative to Victoria (Wuhan-type) measured at each lab

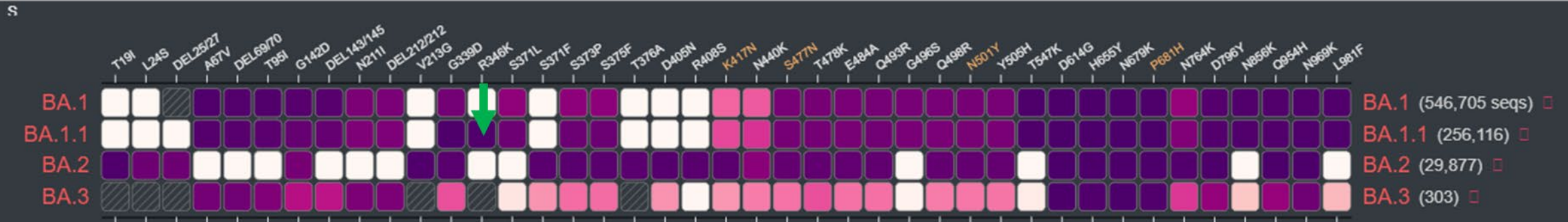


- Fold changes moved slightly due to additional NIBSC WS (21/234) data for VOCs (WHO IS 20/136 no longer available)
- UKHSA and NIBSC neutralisation assays behave comparably across variants
- Variants shows various degree of resistance to the panel - only statistically significant ($p < 0.001$) fold changes relative to lab A or lab B Victoria are shown)
- IS & WS generally show the least neutralisation reduction compared to individual samples – can't be used to correct ND_{50} s across variants
- **Omicron (BA.1)** – 107.5 fold reduction in susceptibility to neutralisation relative to Victoria
- **Omicron BA.1.1** – one measurement to report, no significant difference from BA.1, 103-fold change from Victoria -serum panel IDs that result in <LLOD measurements correspond between variants (~4/5 samples)

Variant Assessment – Convalescent Panel



- Omicron exhibit the largest drops in ND₅₀ seen to date
 - BA.1 = 112 fold-change
 - BA.1.1 = 103 fold-change
 - *** P < 0.001
- BA.1.1 = BA.1 +R346K
- Convalescent panel data is in agreement with neutralisation data for vaccinee serum following 2 doses of approved vaccine



BA alignment generated using webtools at <https://outbreak.info/>

The broader scientific community is currently collecting biological infection data to understand disease severity and immune response to variants of concern in the following ways, plus many others:

- Human clinical studies assessing vaccine effectiveness against variant infections
- Animal studies in various laboratory model species to evaluate effectiveness of original vaccines against variants, and new vaccines, need for boosters, etc.

The Agility Program is leveraging CEPI Preclinical Laboratory Network Partners to perform hamster modeling studies under high ethical standards

- CEPI Network of Partners was established in 2019 via a call for proposals to engage laboratories with high animal ethics standards, biocontainment laboratory capabilities and high-quality research methods that meet regulatory requirements
- All animal studies are performed in accordance with UK NC3Rs guidelines (<https://www.nc3rs.org.uk/the-3rs>)
- All research is done in compliance with CEPI's Animals in Research Policy

CEPI



UK Health
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Primary infection studies confirmed typical coronavirus disease; and Re-Infection Studies showed solid protection from disease in hamsters, even across variants

<i>Initial Infection</i>	<i>Re-infection</i>	<i>Clinical signs after re-infection?</i>	<i>Weight loss after re-infection?</i>	<i>Protection against re-infection?</i>
Alpha	Delta	No	No	Yes
Victoria	Delta	No	No	Yes
Beta	Gamma	No	No	Yes
Beta	Beta	No	No	Yes
Gamma	Beta	No	No	Yes
Gamma	Gamma	No	No	Yes
Victoria	Mu	No	No	Yes
Victoria	Zeta	No	No	Yes
Victoria	Omicron	No	No	Yes*

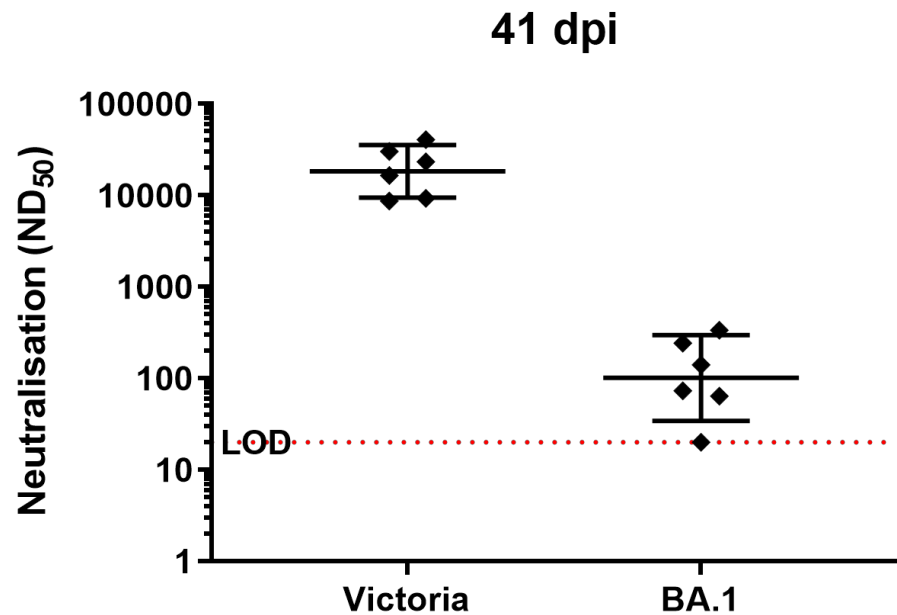
- ✓ For all VOCs tested, prior infection was able to protect against secondary infection 28 days later.
- ✓ None of the combinations of VOCs tested showed escape from immunity.
- ✓ Preliminary pathology data has not identified any difference between VOCs with the exception of Omicron for which similar lesions in the lung and upper respiratory tract were present, but with lower severity.

All studies were conducted in compliance to all UK government regulatory requirements. In-life phase complete: full data analysis is underway, with ELISA, microneutralization and pathology data pending.

*pre-print released Dec 24 <https://www.biorxiv.org/content/10.1101/2021.12.24.474081v1>

Variant assessment – In vivo

Preliminary data



Hamsters infected with Vic and sera taken 41 days pi

Similar fold-change to human convalescent sera with a 150-fold drop

Omicron neutralisation titres above the LOD

Ryan et al 2021, Convalescence from prototype SARS-CoV-2 protects Syrian hamsters from disease caused by the Omicron variant

<https://www.biorxiv.org/content/10.1101/2021.12.24.474081v1>

Important considerations for laboratory methods

- Serial propagation of SARS-CoV-2 variants in Vero E6 or other cell types may lead to furin cleavage site mutations that affect how the virus grows and behaves in vitro or in vivo. Propagation of unwanted mutations can be mitigated by growth in cells such as Vero/hSLAM and by frequent sequence confirmation (deep sequence methods preferred). [link](#)
- NIBSC Working Standard should be used for neutralization assays, but it performs differently for each variant. Any data presented comparing the WHO IS should always identify the variant under test.

Recent relevant publications

- Quantification of SARS-CoV-2 neutralizing antibody by wild-type plaque reduction neutralization, microneutralization and pseudotyped virus neutralization assays Nature Protocols **16**, 3114-3140 (2021)
- A cautionary perspective regarding the isolation and serial propagation of SARS-CoV-2 in Vero cells NPJ Vaccines **6**:83 (2021)

Recent online conference presentations

- 10 November 2021: Training Webinar for the calibration of quantitative serology assays using the WHO International Standard for anti-SARS-CoV-2
- 13 January 2022: WHO Animal Models Working Group meeting
- 22 Feb 2022: Joint ECDC and WHO lab assay working group meeting