Feedback from operational stakeholders who manage or respond to outbreaks is that they are often too busy to review literature or obtain relevant background information to assist them with acute response. Unlike a traditional analytical outbreak investigation report, ***Watching Briefs*** *are intended as a rapid resource for public health or other first responders in the field on topical, serious or current outbreaks, and provide a digest of relevant information including key features of an outbreak, comparison with past outbreaks and a literature review. They can be completed by responders to an outbreak, or by anyone interested in or following an outbreak using public or open source data, including news reports.*

Watching brief

Title	Is the Delta Plus Variant (B.1.617.2/AY1) more serious than the Delta Variant?
Authors	Mohana Priya Kunasekaran, Danielle Hutchinson, Xin Chen, Haley Stone,
Date of first report of the outbreak	Public Health England (PHE) reported that a new variant, Delta Plus (B.1.617.2/AY1), was present in six genomes sequenced in India, as of 7 June 2021 (1). Retrospective sequencing suggests it was likely circulating earlier in India, as a sample collected on 5 April 2021 tested positive for the Delta Plus variant (1). According to World Health Organization (WHO) variant tracker, the first Delta Plus sequence in Europe was from a sample taken on 31 March 2021 (2), and according to Global initiative on sharing avian influenza data (GSAID), the first Delta Plus sample was collected on 23 February 2021 in North America (3).
Disease or outbreak	The WHO has designated the original Delta (B.1.617.2) strain as a variant of concern (VOC), and sublineages of this variant, which are given the alias AY, are currently being monitored closely. As of 23 September 2021, there have been 33 sub-lineages of Delta identified (AY1 to AY33) (2). The AY.1 sublineage is characterised by the K417N mutation and is known as Delta Plus K417N, or more commonly Delta Plus (4). Indian health authorities designated Delta Plus as a Variant of Concern (VOC) on 22 June 2021, and other countries including the United States followed (4). Assessment by European Centre of Disease Intelligence is ongoing, with only some evidence that the properties of Delta Plus fit the criteria for a VOC (5). Variants of Concern are designated such by the WHO if they have one or more of the following characteristics (6) : • Increase in transmissibility • Increase in virulence or clinical disease presentation • Decrease in effectiveness of public health measures or available diagnostics, therapies or vaccines

Origin (*country, city, region*)	Original strain: Wuhan, Hubei Province, China (7). According to the GSAID database, the first sample collected was on 23 February 2021 from the US. However, further information on this sample is not available (8) (Figure 2). In the United Kingdom, AY.1 was detected in samples dating as early as mid-March 2021, and by April, 41 cases were found in England, prompting the United Kingdom to ban international travel on 16 June 2021. Several patients with no history of travel or contact with travellers had tested positive for the Delta Plus variant, which suggests that the variant had begun to circulate in the community (9). In India, the earliest identification of the Delta Plus strain was on 5 April 2021, and by mid-April 2021 it had been found in the states of Maharashtra, Kerala and Madhya Pradesh (10). One report claimed that it was quite likely that the Delta Plus variant was first identified in Nepal, as the first cases sequenced in the United Kingdom had travelled from that area (11). Nepal has very little sequencing capacity, and the WHO Nepal office did not report any new variants being detected in Nepal during that time (11).
Suspected Source (specify food source, zoonotic or human origin or other)	Similar to many RNA viruses, SARS-CoV-2 has been evolving into new variants as transmission progress. Although transmissibility may differ across variants, the mode of transmission appears to be similar to the Delta variant (12).
Date of outbreak beginning	Likely between February and March 2021, depending on locations (2,3)
Date outbreak declared over	Ongoing, cases of Delta Plus variant detected currently world-wide
Affected countries & regions	Delta Plus variant reporting is not consistent across countries, as several countries include it with reporting of Delta variant cases and all data is subject to the genomic sequencing capacity of respective countries (Table 1). On 22 June 2021, it was reported that the Delta Plus variant has been found in nine countries (13). By 26 September, the AY.1 lineage had been detected in at least 44 countries, including India, the United States, the United Kingdom, Portugal, Switzerland, Japan, Poland, Nepal, China, Russia, South Korea and Peru, as well as 40 US states (14). According to the samples collected in Pangolin database, a large proportion of the samples come from the United States of America 68.0%, Japan 5.0%, Portugal 5.0%, United Kingdom 5.0% and Switzerland 3.0% (14) (Figure 1 & 2). However, the total proportion is relatively small; Delta Plus cases peaked in the US in late June at less than 5% of the nation's sequenced cases.

In Australia, Delta Plus was mentioned by the NSW Chief Health Officer on 9 October 2021, although no specific mention was given to case numbers. The first sample of Delta Plus was recorded on GSAID for Australia on 8 July 2021 (15).

Figure 1. Spread of Delta Plus (AY.1) variant samples from GSAID as of 10 August 2021.

Figure 2. Delta Plus samples collected by region as of 10 August 2021 in GSAID(15)

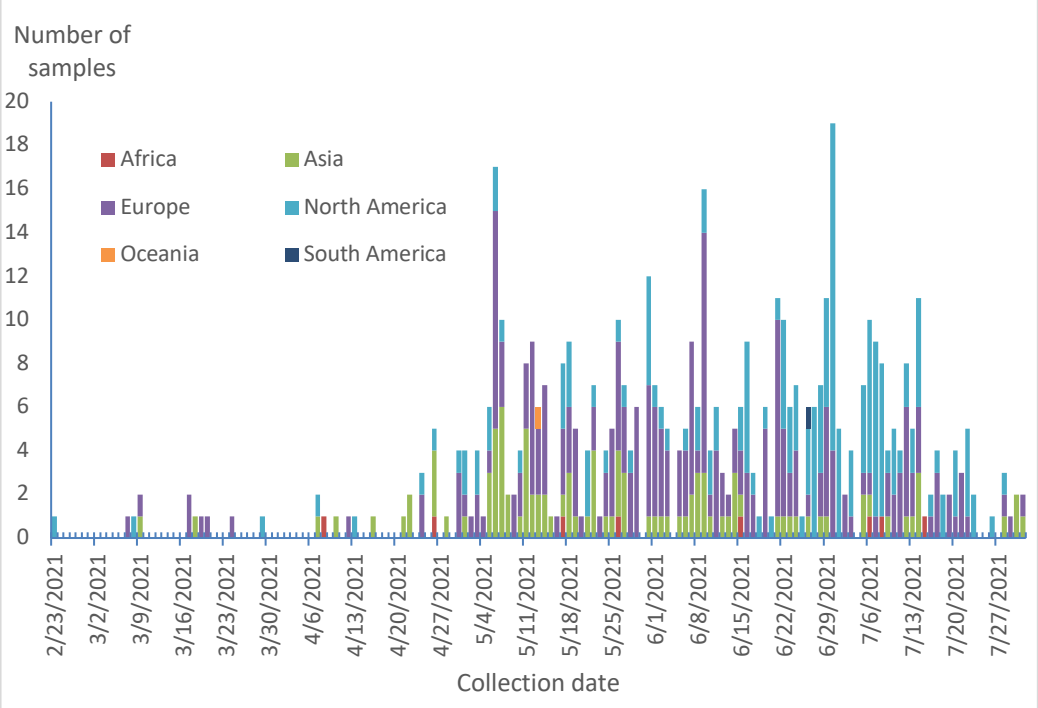

Table 1. Information for first case of Delta Plus by country

Country	Date of detection of first case of Delta Plus/Date of report from online news media	Sample collection date in GSAID	Last reported sample collection date in GSAID	Details
Peru	3 September 2021 (16)	Not uploaded	NA	Three cases were identified, including a healthcare worker who had already been vaccinated and two others who were unvaccinated. All experienced mild symptoms
Georgia	26 July 2021 (17)	5 July 2021	11 July 2021	Two cases identified
Egypt	Mid-July 2021 (18)	Not uploaded	NA	35-year-old female who had shown very mild symptoms and did not require hospitalization
Czech Republic	19 July 2021 (19)	29 June 2021	8 August 2021	30-year-old female patient from Southern Moravia
Israel	7 July 2021 (20)	25 June 2021	10 August 2021	1 vaccinated female entering Israel from abroad
Turkey	6 July 2021 (21)	1 September 2021	1 September 2021	3 unconnected cases in different cities. One of them in Istanbul, no mention of the other two. Those affected are in good condition.
Russia	29 June 2021 (22)	12 April 2021	12 April 2021	1 female who had mild form of disease
Denmark	21 June 2021 (23)	21 June 2021	3 September 2021	Diagnosed in a passenger travelled by plane from Portugal.

1. This list includes countries where information on first case of Delta Plus was available on google news since Delta Plus was identified.
2. The search was limited to 31 March 2021 onwards, with the search terms First case, Delta Plus, B.1.617.2, [country: one by one through WHO member countries list]

Number of cases (specify at what date if ongoing)	As of 26 September 2021, 1454 sequences of the AY.1 lineage have been detected globally (14). However, as reporting of Delta Plus (AY.1) in many

	countries is combined with Delta, the exact number of cases of AY.1 and other sublineages is difficult to obtain. The India SARS-COV-2 Genomics Consortium (INSACOG), as of 1 September 2021, reported the total number of Delta Plus cases in India was 856 after analysing 51,561 samples (24).
Clinical features	Some studies suggest that Delta Plus symptoms may manifest over a longer period (25, 26). At present there is no evidence to suggest that the symptoms of infection with Delta Plus are different to the Delta strain (12, 27, 28) and may include dry cough, tiredness or fever, and if exacerbated shortness of breath and abdominal pain (29).
Mode of transmission (dominant mode and other documented modes)	Studies show that the mode of transmission for Delta Plus variant is similar to that of the Delta strain (12). A low proportion of global sequences suggest that Delta Plus has reduced transmissibility compared to the globally dominant Delta strain (30). Further study needs to be done to elicit if there are any differences in mode of transmission between Delta Plus strain and the other variants.
Demographics of cases	It has been noted that Delta Plus cases have primarily been in younger people, however, this sample was quite small, and more information needs to be gathered on susceptible population (31). Data collected in Maharashtra in July 2021 showed no difference between sexes and the majority of cases were in the 19-49 year age group (32). Although studies have showed that children and adults under 50 were 2.5 times likely to become infected with Delta, no such data has been available for delta plus in children (33). Likelihood of travel and therefore increased risk of exposure to Delta Plus variant, as well as lower vaccination rates compared to the elderly population, may contribute to higher case numbers in the younger age groups (34).
Case fatality rate	Since April 2021, 0.5% of 11 968 samples in the state of Maharashtra (66 cases) were identified as Delta Plus and there were five deaths among these cases, giving a rough case fatality rate estimate of 7.6% (35). This data is based on rough estimates in a single state of India and not verified by any other sources. It is likely that the CFR reported here may be biased as the proportion of delta plus cases may be underreported (based on sample tested). Hence, the actual CFR may be lower than expected.
Complications	The K417 position within the region of the spike protein interacts with the ACE2 receptor protein and enables the virus to infect the cells of the lung, heart, kidney

	and even the intestine (28). Information to date suggests that the Delta Plus variant is likely to result in less severe disease than the Delta strain (34).
Available prevention	Preliminary data shows that existing vaccines are still effective against Delta Plus variant. Half of the cases in the UK occurred among people who were not vaccinated and as of 5 July 2021, there were no deaths in those infected with Delta Plus (36). A sero-prevalence study, although with a relatively small sample size, showed that Delta Plus displayed a degree of resistance to mRNA vaccine-elicited antibodies similar to that of the Beta and Delta variant (37, 38). While it is too early to conclude whether vaccines will be affected by Delta Plus, initial studies suggest K417N mutation is unlikely to have a significant impact (38, 39). In a pre-print vaccine study, the Pfizer vaccine was tested against Delta Plus using a computational tool PROVEAN that carried out a 2D interaction diagram analysis to find amino acid residue's interaction against antibodies (39). The authors suggested that the mutation appeared to have not led to virus escape from vaccine-elicited neutralising antibodies (39). Therefore, the preventive measures recommended against the Delta Plus strain are similar to that of the Delta strain (38) However, there has not been any published information on the effectiveness of control measures such as mask use, social distancing specific to Delta Plus strain.
Available treatment	Similar treatment modalities as for Delta strain are recommended (27, 38). In a preprint study that assessed the sensitivity of Delta Plus variant to various monoclonal antibodies (mAb) targeting various targets of spike protein, some therapeutic mAb, including Bamlavinimab, lost binding to the variant Spike and no longer neutralized Delta Plus (41). There is also some evidence from India that Delta Plus is resistant to monoclonal antibody cocktail treatment (Casirivimab and Imdevimab formulated by Regeneron and Roche) for COVID-19, which was authorised in recent months (37, 40). However, these results have not been released by the Indian SARS-CoV-2 Genomics Consortium.
Comparison with past outbreaks	Compared to the Delta strain, the proportion of Delta Plus sequences and cases are much lower (below 1% of the available sequences from India in June 2021); therefore, the rate of increase of cases and number of deaths reported is also much lower (41). This could be due to the molecular differences in the Delta Plus, with an extra mutation (K417N) location in the spike protein which covers the surface of the SARS-CoV-2 virus.

	The impact of the vigorous global vaccination roll out that commenced since January 2021 may also contribute to the outbreak dynamic of Delta Plus (27, 39).
Unusual features	The limited number of sequences of Delta Plus are not sufficient to determine the Delta Plus variant's transmissibility, the severity of its unique pattern of mutations at every level, or its impact on vaccination efficacy. Previous studies on the Beta variant, which carries the same K417N mutation, suggests that this mutation increases the ability of the virus to infect the cell and these traits are also seen in other highly transmissive and antibody resistant variants (28). Studies have also shown the mutations in the K417N location have helped the Beta variant evade antibodies, which could be a possible mechanism by which Delta Plus variant could evade vaccines and antibodies better than Delta variant (42-44). However, initial theories suggesting that the K417N mutation would result in increased transmissibility have been unfounded, with the impact of Delta Plus less than expected. The impact of individual mutations on proteins may not have a simple additive effect. From empirical data, there does not seem to be an increase in ACE2 binding due to K417N mutation in Delta Plus variant(44); and some experts suggest that the K417N mutation might actually weaken Delta Plus, similar to Alpha variant, which was not as transmissible or severe as Delta variant (44). A single mutation cannot be the sole target of vaccines and treatment modalities, and it is uncertain how long such variants will be in circulation or if their perceived impact will be as severe as expected (42). The preliminary data presented in this watching brief suggests that the impact of the Delta Plus variant has not been as severe as Delta variant, with lower transmission rates, case numbers, and severity of disease; with existing vaccines remaining effective.
Critical analysis	<u>Importance of VOC classification</u> The classification of VOCs is country-specific and depends very much on genomic sequencing capacity. The WHO classifies variants dependent upon transmissibility, disease severity (such as increased hospitalizations or deaths), the extent of reduction in neutralization by antibodies generated during previous infection or vaccination, reduced effectiveness of treatments, or diagnostic detection failures. Variants with these characteristics will be classified as a Variant of Concern (VOC), a Variant of Interest (VOI) or Variants that are being monitored (4, 6). However, national-level VOC classification may not necessarily follow the global standard or other countries (45, 46). This assignment of priority for concern usually depends on local assessment by countries according to their pre-defined criterion. Sublineages such as Delta Plus are not routinely reported separately to Delta variant in most countries. Inconsistent emphasis and disparity in surveillance systems of emerging variants could result in a huge gap in information available on circulating variants (47-49).

	Importance of improved genomic surveillance Country-level surveillance of variants depends on capacity for genomic sequencing and rigorous sample collection. Low genomic sequencing capacity may negatively impact some countries, for example, if a new strain were to emerge from a country with low genomic sequencing capacity, it would result in delayed identification of the new strain, while cases continued to increase. In this instance, the first case of Delta Plus may have emerged in Nepal, however, it had limited surveillance capacity and by the time it was identified, the Delta Plus variant had spread to more countries and resulted in more cases. Fortunately, based on empirical data, the impact of Delta Plus variant has not been as severe as Delta variant to date. A genomic surveillance system, like the COG-UK or GISAID, is required internationally to coordinate collection and documentation of the variants, as genomic sequencing is not readily available in many low-income and middle-income (47, 49). The emergence of Delta Plus may be an opportunity to consider how to close the gap in genomic information collected across countries, in preparation of a potentially more pathogenic strain yet to emerge. Vaccination disparity across regions Evolutionary biologists theorise that the emergence of new variants, like Delta, is likely driven by uncontrolled transmission (50). There is a strong push to improve vaccination rates globally, and in low-income countries specifically, to reduce the case numbers, and thereby reduce the opportunity for mutations of the virus and the potential for more pathogenic strains to emerge (51) In July 2021, the WHO issued strong messages to pharmaceutical companies promoting booster doses of their vaccine, particularly addressing affluent countries with excess doses of vaccine, and comparing vaccination coverage of low-income countries, where only 2.2% of the population had received at least one dose as of 26 September 2021 (52, 53). If the global difference in vaccinations persists between more affluent and low-income countries, more variants of concern could emerge, posing further challenge to current treatment modalities. Effective policies are required to control the pandemic worldwide and in additional to vaccination roll out, genomic surveillance will facilitate defining and implementing better countermeasures.
Key questions	1. How effective are N95 masks against the Delta Plus variant compared to other variants? 2. Are children more susceptible to Delta Plus variant? 3. What is the case-fatality rate of Delta Plus variant globally?

References	1. The Hindustan Times. Delta Plus in India: 40 cases, 1st specimen found in April sample | What we know so far 2021 [updated 23 June 2021. Available from: https://www.hindustantimes.com/india-news/delta-plus-in-india-40-cases-1st-specimen-found-in-april-sample-what-we-know-so-far-101624448444003.htmlref. 2. Áine O'Toole ES, Anthony Underwood, Ben Jackson, Verity Hill, John T McCrone, Rachel Colquhoun, Chris Ruis, Khalil Abu-Dahab, Ben Taylor, Corin Yeats, Louis Du Plessis, Daniel Maloney, Nathan Medd, Stephen W Attwood, David M Aanensen, Edward C Holmes, Oliver G Pybus, Andrew Rambaut. Lineage AY.1, Virus Evolution 2021 [Available from: https://cov-lineages.org/lineage.html?lineage=AY.1. 3. Global initiative on sharing avian influenza data. AY.1 lineage 2021 [Available from: https://www.gisaid.org/hcov19-variants/. 4. US Center for Disease Control and Prevention. SARS-CoV-2 Variant Classifications and Definitions 2021 [updated 4 October 2021. Available from: https://www.cdc.gov/coronavirus/2019-ncov/variants/variant-info.html#Concern. 5. European Centre for Disease Prevention and Control. SARS-CoV-2 variants of concern as of 7 October 2021 2021 [updated 7 October 2021. Available from: https://www.ecdc.europa.eu/en/covid-19/variants-concern. 6. World Health Organization. Tracking SARS-CoV-2 Variants 2021 [Available from: https://www.who.int/en/activities/tracking-SARS-CoV-2-variants/. 7. World Health Organization (WHO). COVID-19 - China: Disease Outbreak News; 2021 [updated 12 January 2020. Available from: https://www.who.int/emergencies/disease-outbreak-news/item/2020-DON233. 8. Yadav PD, Sahay RR, Sapkal G, Nyayanit D, Shete AM, Deshpande G, et al. Comparable neutralization of SARS-CoV-2 Delta AY. 1 and Delta in individuals sera vaccinated with BBV152. bioRxiv. 2021. 9. Kitching C, Law S. New 'Delta Plus' Covid variant found in UK and is 'possibly more damaging to lungs: MSN News; 2021 [updated 23 June 2021. Available from: https://www.msn.com/en-gb/news/world/new-delta-plus-covid-variant-found-in-uk-and-is-possibly-more-damaging-to-lungs/ar-AALIml4. 10. Shaw N. New Delta Plus strain of Covid found in UK after spreading in India: DevonLife; 2021 [updated 23 June 2021. Available from: https://www.devonlive.com/news/uk-world-news/new-delta-plus-strain-covid-5562549. 11. Mohanty K.K. What Delta-plus variant is and why India is not worried about it yet: Firstpost; 2021 [updated 21 June 2021. Available from: https://www.firstpost.com/health/what-delta-plus-variant-is-and-why-india-is-not-worried-about-it-yet-9738321.html. 12. Williams H, Hutchinson D, Stone H. Watching Brief: The evolution and impact of COVID-19 variants B. 1.1. 7, B. 1.351, P. 1 and B. 1.617. Global Biosecurity. 2021;3(1). 13. Rai A. Delta Plus variant traced in 9 countries; UK, US, Japan, China on list: Hindustan Times; 2021 [updated 22 June 2021. Available from: https://www.hindustantimes.com/world-news/delta-plus-variant-traced-in-9-countries-uk-us-japan-china-on-list-101624366833126.html. 14. Alaa Abdel Latif, Julia L. Mullen, Manar Alkuzweny, Ginger Tsueng, Marco Cano, Emily Haag, Jerry Zhou, Mark Zeller, Emory Hufbauer, Nate Matteson, Chunlei Wu, Kristian G. Andersen, Andrew I. Su, Karthik Gangavarapu, Laura D. Hughes, and the Center for Viral Systems Biology. outbreak.info. AY.1 Lineage Report. 2021 [updated 9 October 2021. Available from: https://outbreak.info/situation-reports?pango=AY.1&loc=IND&loc=GBR&loc=USA&selected. 15. Elbe S, Buckland-Merrett G. Data, disease and diplomacy: GISAID's innovative contribution to global health. Global challenges. 2017;1(1):33-46.

16. Xinhua News Agency. Peru reports first three cases of COVID-19 variant Delta Plus 2021 [updated 26 September 2021. Available from: https://www.macaubusiness.com/peru-reports-first-three-cases-of-covid-19-variant-delta-plus/.
17. Agenda. GE. Georgia confirms first cases of Delta plus variant, half of new coronavirus cases are Delta 2021 [updated 27 July 2021. Available from: https://agenda.ge/en/news/2021/2115.
18. Soliman M. Egypt detected its first case of the Delta Plus variant in mid-July: Health minister: ahramonline; 2021 [updated 23 August 2021. Available from: https://english.ahram.org.eg/NewsContent/1/64/419627/Egypt/Politics-/Egypt-detected-its-first-case-of-the-Delta-Plus-va.aspx.
19. World Today. The Czechia has the first case of a new delta plus mutation 2921 [updated 19 July 2021. Available from: https://www.world-today-news.com/the-czechia-has-the-first-case-of-a-new-delta-plus-mutation/.
20. Staff T. First case of Delta Plus COVID variant found in Israel — report: The Times of Israel; 2021 [updated 7 July 2021. Available from: https://www.timesofisrael.com/first-case-of-delta-plus-covid-variant-found-in-israel-report/#:~:text=July%201%2C%202021.%20%28Nati%20Shohat%2FFLASH90%29%20The%20first%20case,virus%20hotspots%20could%20be%20forced%20to%20enter%20quarantine.
21. archyw. Turkey detects delta plus variant for the first time, in three cases 2021 [updated 7 July 2021. Available from: https://www.archyworldys.com/turkey-detects-delta-plus-variant-for-the-first-time-in-three-cases/.
22. The Moscow Times. Russia Confirms First Delta Plus Variant Cases 2021 [updated 29 June 201. Available from: https://www.themoscowtimes.com/2021/06/29/russia-confirms-first-delta-plus-variant-cases-a74378.
23. tekdeeps. Covid-19: First case of Delta Plus in Denmark originating in Portugal 2021 [updated 26 June 2021. Available from: https://tekdeeps.com/covid-19-%E2%80%8Bfirst-case-of-delta-plus-in-denmark-originating-in-portugal/.
24. Kumar A. 856 Delta Plus cases, expanding cluster of AY.12 not seen in India: INSACOG: MirrorNowNews.com. ; 2021 [updated 1 September 2021. Available from: https://www.timesnownews.com/mirror-now/in-focus/article/856-delta-plus-cases-expanding-cluster-of-ay-12-not-seen-in-india-insacog/806566.
25. Malabadi RB, Kolkar KP, Meti NT, Chalannavar RK. Outbreak of Coronavirus (SARS-CoV-2) Delta variant (B. 1.617. 2) and Delta Plus (AY. 1) with fungal infections, Mucormycosis: Herbal medicine treatment. International Journal of Research and Scientific Innovations 2021g. 2021;8(6):59-70.
26. Roy B, Roy H. The Delta Plus variant of COVID-19: Will it be the worst nightmare in the SARS-CoV-2 pandemic? Journal of Biomedical Sciences. 2021;8(1):1-2.
27. Rahman FI, Ether SA, Islam MR. The “Delta Plus” COVID-19 variant has evolved to become the next potential variant of concern: mutation history and measures of prevention. Journal of Basic and Clinical Physiology and Pharmacology. 2021.
28. Menon S. Protein Evolutionary Analysis of SARS-CoV-2 Delta Plus and C. 1.2 Insights Virulence and Host Immunity.
29. Bhattacharya PK. RE: Delta Plus variants Corona virus in India: What may be the Impact in expected 3rd wave. 2021.
30. Jeong M. Delta plus variant of SARS-CoV-2: How does it compare with the delta variant? : MedicalNewsToday; 2021. [updated 6 July 2021. Available from: https://www.medicalnewstoday.com/articles/delta-plus-variant-of-sars-cov-2-how-does-it-compare-with-the-delta-variant.

31. Mahase E. Covid-19: How many variants are there, and what do we know about them? BMJ. 2021;374.
32. Debroy S. 10 more cases of Delta-plus takes total in Maharashtra to 76

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2021 [updated 17 august 2021. Available from: http://timesofindia.indiatimes.com/articleshow/85383716.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.
33. Riley S, Walters CE, Wang H, Eales O, Haw D, Ainslie KE, et al. REACT-1 round 12 report: resurgence of SARS-CoV-2 infections in England associated with increased frequency of the Delta variant. medRxiv. 2021.
34. Hassan J., Beachum L. Here's what we know about the delta-plus variant: The Washington Post; 2021 [updated 3 August 2021. Available from: https://www.washingtonpost.com/health/2021/08/03/delta-plus-coronavirus-variant-explained/.
35. Iyer m , Debroy S. Maharashtra: Delta-plus deaths force doctors to defend efficacy of vaccines

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2021 [updated 14 August 2021. Available from: http://timesofindia.indiatimes.com/articleshow/85313280.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.
36. Mishra S. How dangerous is the new Delta Plus variant? Here's what we know.: National Geographic; 2021 [updated 5 July 2021. Available from: https://www.nationalgeographic.co.uk/science-and-technology/2021/07/how-dangerous-is-the-new-delta-plus-variant-heres-what-we-know.
37. Tada T, Zhou H, Samanovic MI, Dcosta BM, Cornelius A, Mulligan MJ, et al. Comparison of neutralizing antibody titers elicited by mRNA and adenoviral vector vaccine against SARS-CoV-2 variants. bioRxiv. 2021.
38. Barrett A. Delta Plus: Everything you need to know about the new coronavirus variant: Science Focus; 2021 [updated 29 September 2021. Available from: https://www.sciencefocus.com/news/delta-plus-variant/.
39. Upadhyay S, Kumar A, Kumar P, Dubey PK, Tripathi A, Ali A, et al. Delta plus variant with neutral mutation is less virulent compared to wild type SARS-CoV2. 2021.
40. Planas D, Veyer D, Baidaliuk A, Staropoli I, Guivel-Benhassine F, Rajah M, et al. Reduced sensitivity of infectious SARS-CoV-2 variant B. 1.617. 2 to monoclonal antibodies and sera from convalescent and vaccinated individuals. bioRxiv. 2021.
41. Department of Biotechnology, Ministry of Science & Technology, Government of India. INSACOG WEEKLY BULLETIN - July 9th 2021 2021 [updated 9 July 2021. Available from: https://dbtindia.gov.in/sites/default/files/INSACOG_Weekly%20Bulletin_09%20July%202021.pdf
42. Baral P, Bhattarai N, Hossen ML, Stebliankin V, Gerstman BS, Narasimhan G, et al. Mutation-induced changes in the receptor-binding interface of the SARS-CoV-2 Delta variant B. 1.617. 2 and implications for immune evasion. Biochemical and biophysical research communications. 2021;574:14-9.
43. Protein Data Bank-101. SARS-CoV-2 Spike. 2020 [updated June 2020. Available from: https://pdb101.rcsb.org/motm/246.
44. Harvey WT, Carabelli AM, Jackson B, Gupta RK, Thomson EC, Harrison EM, et al. SARS-CoV-2 variants, spike mutations and immune escape. Nature Reviews Microbiology. 2021;19(7):409-24.

45. European Centre for Disease Prevention and Control. SARS-CoV-2 variants of concern as of 7 October 2021 2021 [updated 7 October 2021. Available from: SARS-CoV-2 variants of concern as of 7 October 2021.
46. Public Health England. Investigation of SARS-CoV-2 variants of concern: technical briefings: Gov.uk; 2021 [Available from: https://www.gov.uk/government/publications/investigation-of-novel-sars-cov-2-variant-variant-of-concern-20201201.
47. Brito AF, Semenova E, Dudas G, Hassler GW, Kalinich CC, Kraemer MU, et al. Global disparities in SARS-CoV-2 genomic surveillance. medRxiv. 2021.
48. Dzobo M, Musuka G, Mashe T, Dzinamarira T. Inadequate SARS-CoV-2 Genetic Sequencing capacity in Zimbabwe: A call to urgently address this key gap to control current and future waves. IJID Regions. 2021.
49. Park SY, Faraci G, Ward PM, Emerson JF, Lee HY. High-precision and cost-efficient sequencing for real-time COVID-19 surveillance. Scientific reports. 2021;11(1):1-10.
50. Cooper V, Harrison L.What Is Causing All These New Coronavirus Variants? Is It the COVID–19 Vaccines? : https://scitechdaily.com/what-is-causing-all-these-new-coronavirus-variants-is-it-the-covid-19-vaccines; 2021 [updated 11 September 2021. Available from: https://scitechdaily.com/what-is-causing-all-these-new-coronavirus-variants-is-it-the-covid-19-vaccines/.
51. Tregoning JS, Flight KE, Higham SL, Wang Z, Pierce BF. Progress of the COVID-19 vaccine effort: viruses, vaccines and variants versus efficacy, effectiveness and escape. Nature Reviews Immunology. 2021:1-11.
52. The Portugal News. WHO against vaccine booster doses 2021 [updated 14 July 2021. Available from: https://www.theportugalnews.com/news/2021-07-14/who-against-vaccine-booster-doses/61051.
53. Our World in Data. Coronavirus (COVID-19) Vacccinations 2021 [Available from: https://ourworldindata.org/covid-vaccinations.