SARS-CoV-2 –aerosol smitte – forebyggelse
Astrid Iversen, 2 juni, 2021

Baggrund

Globalt – og i Danmark - har der været en ret voldsom tøven – og nogle gange direkte modstand - fra diverse sundhedsfaglige myndigheder mod at erkende at SARS-CoV-2 er luftbåren (delvist beskrevet her (Lewis, 2021b)). Modstanden syntes ofte at skyldes en blanding af manglende bred faglighed, ideologiske overbevisninger, og modstand mod de praktiske og (relativt) kostbare foranstaltninger det ville medføre at stemple SARS-CoV-2 smitte som luftbåren – f.eks. øget brug at værnemidler, konsekvent brug af masker af god kvalitet, flere isolationsstuer både på hospitaler og plejehjem (Miller et al., 2021a), forbedret eller ny-installeret ventilation (Morawska et al., 2020), etc.).

Det at dyrkbar SARS-CoV-2 virus ikke er isoleret fra luftfiltre (men 'kun' fra luft) bliver jævnligt fremført som bevis for at virus ikke er luftbåren, senest i et kontroversielt review (Greenhalgh et al., 2021; Heneghan CJ et al., 2021). Andre infektionssygdomme (f.eks. tuberkulose og mæslinger) - som alle accepterer er associeret med luftbårne patogener - er heller ikke isoleret i dyrkbar tilstand fra luftfiltre – ikke desto mindre stiller ingen spørgsmålstegn ved at disse er luftbårne. Beviserne for dem er fundet eksperimentelt (se f.eks. punkt 8) og ved at studere smittespredning i den virkelige verden. Hvis man analyserer SARS-CoV-2 på samme måde – finder man lige så stærke beviser for at SARS-CoV-2 er luftbåren som man gør for f.eks. tuberkulose og mæslinger (se nedenfor). Alt er heller ikke stort og hvidt hvis noget er luftbåren – det kan være luftbåren i forskellig grad. SARS-CoV-2 er luftbåren, men ikke i ekstrem grad – man kan derfor komme langt med f.eks. ventilation som forebyggelse. Diskussionen omkring SARS-CoV-2 og aerosol smitte er således ikke nødvendigvis altid præget af en særlig konsekvent logik når man sammenligner med andre patogener.

Diskussionen er vigtig da den har stor betydning for hvordan man forebygger smittespredning.

Vigtige forebyggelse tiltag hvis SARS-CoV-2 <u>ikke er</u> luftbåren:

Hvis virus ikke er luftbåren spredes den primært via store dråber der udskilles med udåndingsluften og falder til jorden indenfor 1.5-2 meter.

Forebyggelses tiltag er **ens** indendørs og udendørs.

1) Reducer nær fysisk kontakt (hold 2 meters afstand)
2) Rengøring af overflader
3) Fysiske barrierer (f.eks. plastik skjold mellem borde på restaurant, i supermarked)
4) Maske brug kun ved nær fysisk kontakt

Vigtige forebyggelse tiltag hvis SARS-CoV-2 <u>er</u> luftbåren:

Hvis virus er luftbåren spredes den både via store dråber der udskilles med udåndingsluften og falder til jorden indenfor 1.5-2 meter - og ved udskillelse af virusfyldte aerosoler der kan 'rejse' som en sky op til 6 meter eller mere afhængig af volumen på stemmen (f.eks. hvisken versus råb og sang).

Forebyggelses tiltag er **forskellige** indendørs og udendørs.

- Udendørs bliver aerosolerne (oftest) fortyndet og båret væk af vinden – derfor spiller aerosol smitte kun en lille/ingen rolle udendørs.
- Indendørs kan de virusfyldte aerosoler ophobes og svæve rundt i dårligt ventilerede lokaler i 2-3 timer (som tobaksrøg) – derfor spiller aerosol smitte en stor rolle indendørs.

Det er derfor det er nødvendigt at lave yderligere tiltag for at forebygge smitte indendørs (Morawska et al., 2020)(punkt 4 – maske brugs behov ændres – og punkt 5-7, samt evt. yderligere tiltag)

1) Reducer nær fysisk kontakt (hold 2 meters afstand)
2) Rengøring af overflader
3) Fysiske barrierer (f.eks. plastik skjold mellem borde på restaurant, i supermarked)
4) Maske brug ved fysisk kontakt indendørs og god maske-kvalitet
5) Kontrolleret udluftning, ventilation og/eller luftfiltrering
6) Forsamlingsloft (især vigtigt indendørs) for at mindske risikoen for superspredning
7) Begrænsninger på den tid man tilbringer indendørs (hjemme arbejde, lukketider for restauranter og barer, etc.)

9 observationer der støtter at SARS-CoV-2 kan smitte via aerosoler – og derfor er luftbåren (se også UK government links og andre links nedenfor)

1) Superspredningsbegivenheder. Smitte fra én til flere i samme lokale der ikke er i nær fysisk kontakt. Superspredningsbegivenheder menes at ligge bagved ca. 80% af smittespredningen og forårsages af 10-20% af de smittede (kan måske variere afhængig af corona virus variant) – ofte når den smittede selv kun er mildt symptomatisk eller asymptomatisk (se overview og yderligere referencer (Endo et al., 2020; Lewis, 2021a). Et eksempel på superspredning i et kor kan ses her (Miller et al., 2021b).

2) Smitte er sket i karantæne hoteller mellem personer der har boet i rum ved siden af hinanden – men aldrig har været i fysisk kontakt. De var kun forbundet via hotelgangen uden for deres rum. Denne var dårligt ventileret (Eichler et al., 2021). Endvidere viser data fra en superspredningsbegivenhed at en smittet i en kirke kunne smitte personer op til 15 m væk (video viste at de aldrig var i tættere fysisk kontakt)(Katelaris et al., 2021).

3) Smitte fra asymptomatiske og pre-symptomatiske personer menes at forårsage ca. 30% -og måske op til 59% - af smittespredningen (Johansson et al., 2021). Disse personer hverken hostede eller nøs. Almindelig tale producerer få store dråber og de undersøgte udskillte sandsynligvis også virus med de tusindvis af aerosoler som alle producerer ved almindelig tale.

4) Smitte med SARS-CoV-2 sker ca. 20 gange mere effektivt indendørs end udendørs (Bulfone et al., 2021) . God ventilation reducerer smittespredning indendørs (se UK government referencer nederst og (Morawska and Milton, 2020). Dette er også accepteret af WHO som for nyligt har publiceret et 'Roadmap to improve and ensure good indoor ventilation in the context of COVID19' (www.who.int/publications/i/ item/9789240021280).

5) Smitte er sket i institutioner på trods af extra gode hygiejne foranstaltninger (Klompas et al., 2021).

6) Infektiøs SARS-CoV-2 virus er blevet isoleret fra luftprøver i diverse scenarier (Lednicky et al., 2021; Lednicky et al., 2020a; Lednicky et al., 2020b; van Doremalen et al., 2020). Virus var 'levende' i luften i op til 3 timer og halveringstiden for virus ødelæggelse var 1.1 time (van Doremalen et al., 2020). Det betyder f.eks. at man kan blive smittet selv hvis man besøger en dårlig ventileret restaurant efter den smittede person har forladt stedet.

7) SARS-CoV-2 RNA er blevet påvist i hospitalers luftfiltre og ventilationssystemer hvor virus kun kunne blive transporteret hen via luften (Nissen et al., 2020).

8) Eksperimenter med ildere der kun var forbundet vis luftslanger har vist at virus fra et bur kunne overføres til det næste bur via luften – altså var luftbåren (Kutter et al., 2021). Om det skyldes aerosoler, mindre dråber, eller støv med virus der blev båret gennem luften vides ikke – men hvad det end var, var det luftbåren. Lignende forsøg med hamstere og tuberkulose førte i 1961 til at luftbåren smitte blev fastslået som en smittevej for tuberkulose.

9) Der er begrænset bevis for i hvor høj grad smitte sker via virus kontaminerede overflader – selvom det givet er en af flere smitteveje (Goldman, 2020). Der er ingen superspredningsbegivenheder der (så vidt jeg kan se) er linket til virus kontaminerede overflader (Editorial, 2021).

Her er endvidere links til hvordan man kan forebygge SARS-CoV-2 aerosol smitte, transmission, superspredning, etc.:

UK government – ventilation (with confidence assesments):
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/928720/S0789_EMG_Role_of_Ventilation_in_Controlling_SARS-CoV-2_Transmission.pdf

UK government – transmission routes (with confidence assesments):
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/933225/S0824_SARS-CoV-2_Transmission_routes_and_environments.pdf

Group of scientists:
https://docs.google.com/document/d/e/2PACX-1vTgVkamic82Ux90zCWb5NFC6gYcDSWKYxKgh2y49uHQ5OJfGBAuQXs8igbmOaGqODI9wJ0UUnpo1dZu/pub

UK government – superspreading - evidence (with confidence assesments):
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/897562/S0473_SPI-M_Superspreading_and_clusters.pdf
" As of 26/05/2020, we have included 201 transmission events in our database, which we classified into 22 setting types. The vast majority of these setting types are either "indoor" or "indoor/outdoor" (21/22)."

Overstående ni observationer er stærkt inspireret af Greenhalgh-Heneghan discussionen (Greenhalgh et al., 2021; Heneghan CJ et al., 2021).

Corona virus – smitteveje, aerosoler, udluftning/ventilation

Airborne transmission of SARS-CoV-2

Kimberly A. Prather[1,*], Linsey C. Marr[2,*], Robert T. Schooley[3], Melissa A. McDiarmid[4], Mary E. Wilson[5,6], Donald K. Milton[7]
+ See all authors and affiliations

Science 16 Oct 2020:
Vol. 378, Issue 6514, pp. 303-304
DOI: 10.1126/science.abf0521

Article | Info & Metrics | eLetters | PDF

There is overwhelming evidence that inhalation of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) represents a major transmission route for coronavirus disease 2019 (COVID-19).

If airborne transmission is a significant factor in the pandemic, especially in crowded spaces with poor ventilation, the consequences for containment will be significant. Masks may be needed indoors, even in socially-distant settings. Health care workers may need N95 masks that filter out even the smallest respiratory droplets as they care for coronavirus patients.

239 Experts With One Big Claim: The Coronavirus Is Airborne

The W.H.O. has resisted mounting evidence that viral particles floating indoors are infectious, some scientists say. The agency maintains the research is still inconclusive.

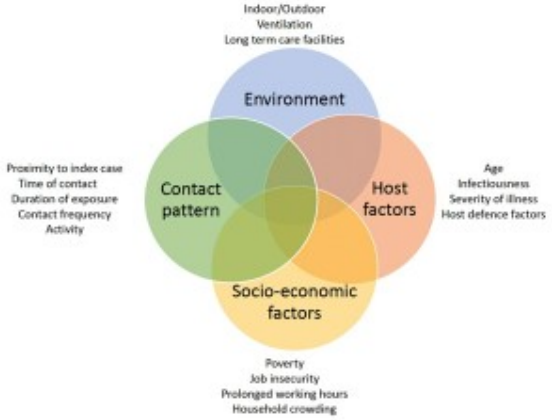
In early April, a group of 36 experts on air quality and aerosols urged the W.H.O. to consider the growing evidence on airborne transmission of the coronavirus. The agency responded promptly, calling Lidia Morawska, the group's leader and a longtime W.H.O. consultant, to arrange a meeting.

But the discussion was dominated by a few experts who are staunch supporters of handwashing and felt it must be emphasized over aerosols, according to some participants, and the committee's advice remained unchanged.

https://www.nytimes.com/2020/07/04/health/239-experts-with-one-big-claim-the-coronavirus-is-airborne.html

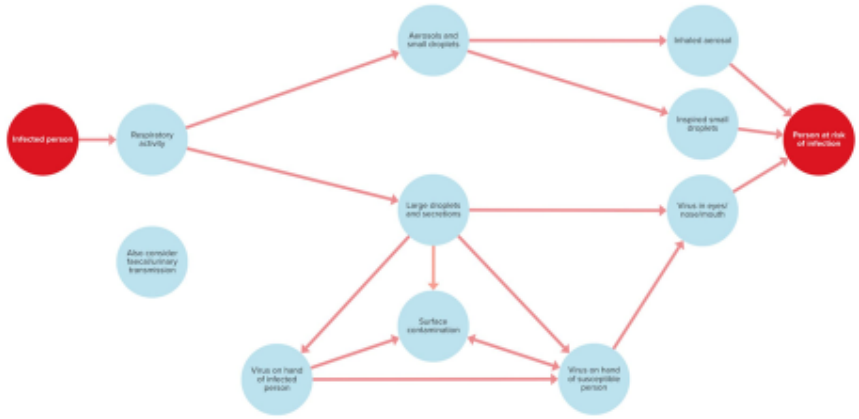
Astrid Iversen, 16 juni, 2021

Figure 1: Intersection of factors associated with risk of transmission



https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/933225/S0824_SARS-CoV-2_Transmission_routes_and_environments.pdf

Figure 2: Illustrative map of main transmission routes for SARS-CoV-2



"Hallmarks for superspreading events include a combination of factors, typically a highly infectious individual(s) gathered with a large number of individuals in enclosed and crowded environments [6]. There is evidence to suggest that activities that produce more aerosols (e.g. singing, aerobic activity) are also risk factors for these events."

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/933225/S0824_SARS-CoV-2_Transmission_routes_and_environments.pdf

Table 1: Summary of factors associated with risk of transmission

Factors associated with risk of transmission	Lowest risk of transmission	Highest risk of transmission
Environmental factors		
Proximity	Always maintain >2m	Regular close interaction < 1m
Duration	A few minutes or less	Several hours
Occupant density	People spaced out, large space	People closely packed, small space
Shared air	Outdoors, well ventilated indoor	Indoors with poor ventilation, recirculated air
Environmental conditions	Normal indoor temperatures, humidity and fresh air	Low temperature, low humidity
Viral emission	Passive activity, face coverings	Aerobic activity, singing, loud talking, no face Coverings
Shared surfaces	Rarely touch shared surfaces, good cleaning	Regular touching shared surfaces, infrequent cleaning
Human factors		
Contact frequency	Case isolation, infrequent contact	Daily, regular contact
Networked	Contacts maintained within a small bubble	Shared space with multiple strangers
Hygiene behaviours	Regular hand hygiene, use of face coverings	Poor hand hygiene, no face coverings
Occupational factors	Small network, not public facing	Care/health sector, public facing, long working hours
Socio-economic factors	Work from home, able to isolate	Poverty, crowded housing, inability to isolate for both space and financial reasons

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/933225/S0824_SARS-CoV-2_Transmission_routes_and_environments.pdf

Vigtige forebyggelse tiltag når SARS-CoV-2 er luftbåren dvs. også smitter via aerosoler

1) Reducer nær fysisk kontakt (hold ~2 meters afstand)

2) Rengøring af overflader

3) Fysiske barrierer (f.eks. plastik skjold mellem borde på restaurant, i supermarked)

4) Maske brug ved fysisk kontakt indendørs og god maske-kvalitet

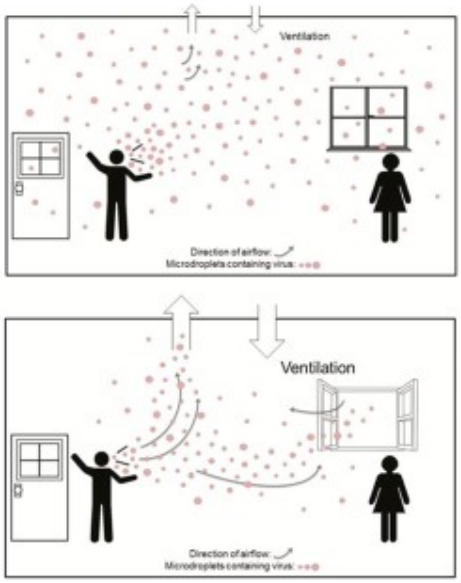
5) Kontrolleret udluftning, ventilation og/eller luftfiltrering

6) Forsamlingsloft (især vigtigt indendørs) for at mindske risikoen for superspredning

7) Begrænsninger på den tid man tilbringer indendørs (hjemme arbejde, lukketider for restauranter og barer, etc.)

Forebyggelses tiltag er forskellige udendørs (1-4) og indendørs (1-7)

Ikke alle tiltag er nødvendige altid – det afhænger af smittetrykket



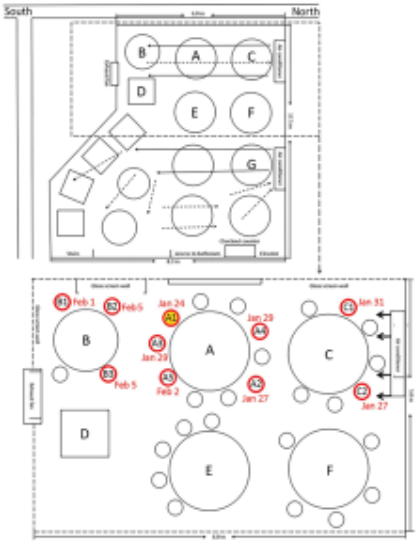
Corona virus – aerosol ophobning indendørs

- Provide sufficient and effective ventilation (supply clean outdoor air, minimize recirculating air) particularly in public buildings, workplace environments, schools, hospitals, and aged care homes.
- Supplement general ventilation with airborne infection controls such as local exhaust, high efficiency air filtration, and germicidal ultraviolet lights.
- Avoid overcrowding, particularly in public transport and public buildings.

Such measures are practical and often can be easily implemented; many are not costly. For example, simple steps such as opening both doors and windows can dramatically increase air flow rates in many buildings. For mechanical systems, organizations such as ASHRAE (the American Society of Heating, Ventilating, and Air-Conditioning Engineers) and REHVA (the Federation of European Heating, Ventilation and Air Conditioning Associations) have already provided guidelines based on the existing evidence of airborne transmission. The measures that we propose offer more benefits than potential downsides, even if they can only be partially implemented.

Morowska,L & Milton, D.K.
Clinical Infectious Diseases, Volume 71, Issue 9, 1 November 2020, Pages 2311–2313,

Langsom og dårlig ventilation kan også være farlig – et restaurant besøg I Kina hvor luftstrømmen er så langsom at en del af den rammer væggen og flyder tilbage i lokalet.



A diagram of the arrangement of a restaurant's tables and air conditioning airflow at site of an outbreak of coronavirus in Guangzhou, China. Red circles indicate the seating of future case-patients; the yellow-filled red circle indicates the index case, or first-documented, patient. Centers for Disease Control and Prevention

https://www.medrxiv.org/content/10.1101/2020.04.16.20067728v1.full-text

https://www.nytimes.com/2020/04/20/health/airflow-coronavirus-restaurants.html

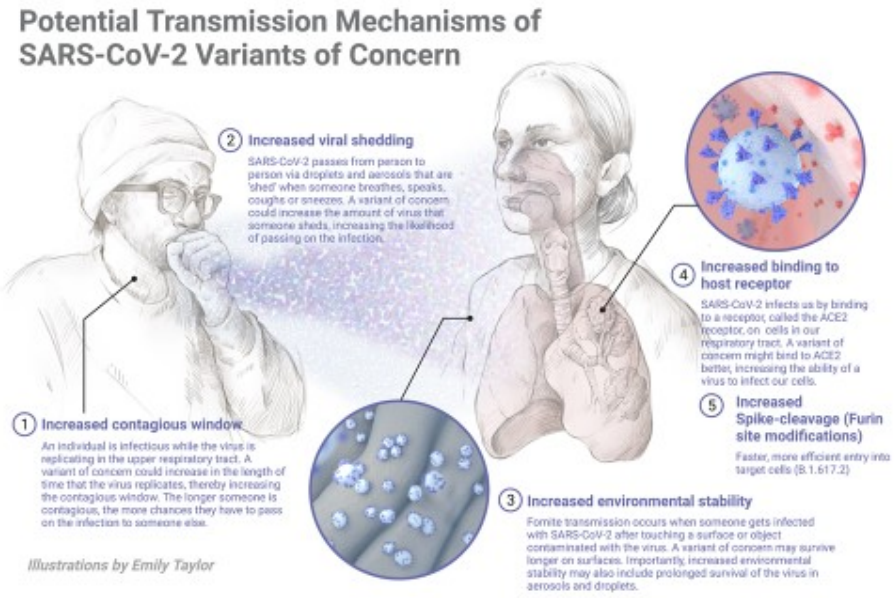
Mutationer og selektion

1) SARS-CoV-2 muterer 1-2 times per infektionsforløb

2) Alle virus varianter er i et 'kapløb' med hinanden om at smitte flest mulige hurtigst muligt– men 'reglerne for kapløbet' ændrer sig over tid når selektionstrykkene ændrer sig

3) Når der er mange varianter vinder den mest smitsomme variant!
(e.g., 501Y mutationen)

4) Når der er en hvis grad af immunitet i befolkningen (pga. tidligere smitte eller vaccination) vinder den variant der bedst undviger immun responserne!
(e.g., 484K mutationen)

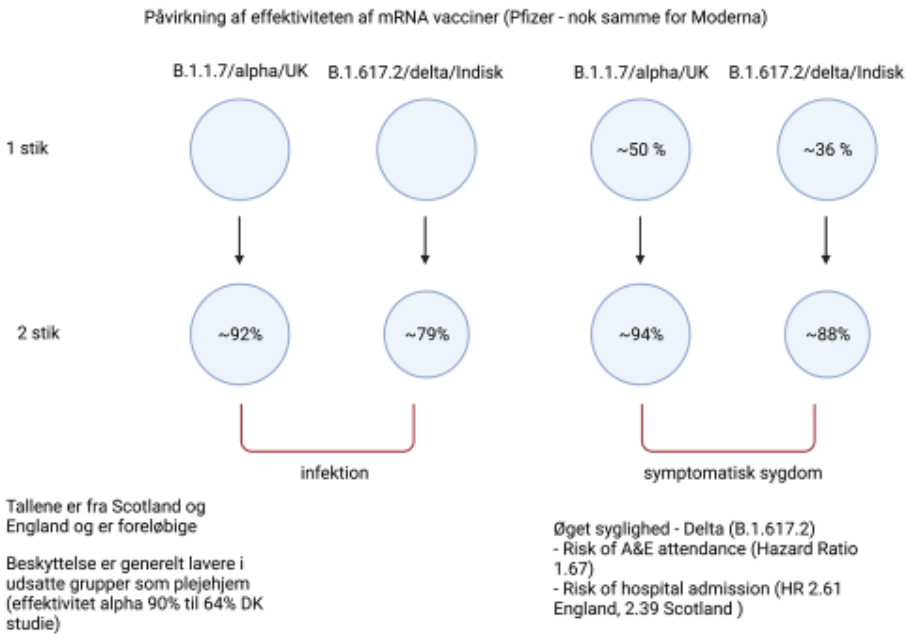


3 June 2021 Risk assessment for SARS-CoV-2 variant: Delta (VOC-21APR-02, B.1.617.2) **Public Health England**

Indicator	RAG*	Confidence	Assessment and rationale
Transmissibility between humans		HIGH	**Transmissibility appears greater than wild type (first wave) SARS-CoV-2** Delta continues to demonstrate a substantially increased growth rate compared to Alpha, across multiple analyses. Delta cases are rising whilst Alpha cases are declining. Secondary attack rates, including household secondary attack rates, are higher for Delta, but these are not yet corrected for vaccination status. There is in vitro evidence suggestive of increased replication in biological systems that model human airway. It is highly likely that Delta is significantly more transmissible than Alpha.
Infection severity		LOW	**Increased severity (hospitalisation risk) when compared to Alpha** Early evidence from England and Scotland suggests there may be an increased risk of hospitalisation compared to contemporaneous Alpha cases. A large number of cases are still within the follow up period. In some areas, hospital admissions show early signs of increasing, but the national trend is not clear.
Immunity after natural infection		LOW	**Experimental evidence of functional evasion of natural immunity but insufficient epidemiological data** Pseudovirus and live virus neutralisation using convalescent sera from first wave and Alpha infections shows a reduction in neutralisation. National reinfection surveillance data are being analysed. There is no increase in numbers of reinfections in the SIREN national healthcare worker cohort.
Vaccines		HIGH	**Epidemiological and laboratory evidence of reduced vaccine effectiveness** There are now analyses from England and Scotland supporting a reduction in vaccine effectiveness for Delta compared to Alpha. This is more pronounced after one dose (absolute reduction in vaccine effectiveness against symptomatic infection of approximately 15-20% after 1 dose). Iterated analysis continues to show vaccine effectiveness against Delta is higher after 2 doses but that there is a reduction for Delta compared to Alpha. There is a high level of uncertainty around the magnitude of the change in vaccine effectiveness after 2 doses of Oxford-AstraZeneca vaccine. Although this is observational data subject to some biases, it holds true across several analytic approaches and the same effect is seen in both English and Scottish data. It is strongly supported by pseudovirus and live virus neutralisation data from multiple laboratories. There are no data on whether prevention of transmission is affected and insufficient data to assess vaccine effectiveness against severe disease. The acquisition of an additional mutation which may be antigenically significant in a small number of cases is noted.
Overall assessment			Delta is predominant and all analyses find that it has a very substantial growth advantage. The observed high growth rate is most likely to be due to a combination of place based context, transmissibility and immune escape. Both English and Scottish analyses continue to support the finding of reduced vaccine effectiveness which has increased to high confidence. New early data from England and Scotland suggest a possible increased risk of hospitalisation compared to Alpha. The priority investigations are vaccine effectiveness against hospitalisation and transmission, household secondary attack rate corrected for vaccination, characterisation of the generation time, viral load and period of infectivity, and epidemiological studies of reinfections.

The therapeutics risk assessment is under review for all variants and is not included.

*refer to scale and confidence grading slide



Referencer

Bulfone, T.C., Malekinejad, M., Rutherford, G.W., and Razani, N. (2021). Outdoor Transmission of SARS-CoV-2 and Other Respiratory Viruses: A Systematic Review. J Infect Dis *223*, 550-561.

Editorial (2021). Coronavirus is in the air — there's too much focus on surfaces. Nature *590*.

Eichler, N., Thornley, C., Swadi, T., Devine, T., McElnay, C., Sherwood, J., Brunton, C., Williamson, F., Freeman, J., Berger, S*., et al.* (2021). Transmission of Severe Acute Respiratory Syndrome Coronavirus 2 during Border Quarantine and Air Travel, New Zealand (Aotearoa). Emerg Infect Dis *27*, 1274-1278.

Endo, A., Centre for the Mathematical Modelling of Infectious Diseases, C.-W.G., Abbott, S., Kucharski, A.J., and Funk, S. (2020). Estimating the overdispersion in COVID-19 transmission using outbreak sizes outside China. Wellcome Open Res *5*, 67.

Goldman, E. (2020). Exaggerated risk of transmission of COVID-19 by fomites. Lancet Infect Dis *20*, 892-893.

Greenhalgh, T., Jimenez, J.L., Prather, K.A., Tufekci, Z., Fisman, D., and Schooley, R. (2021). Ten scientific reasons in support of airborne transmission of SARS-CoV-2. Lancet *397*, 1603-1605.

Heneghan CJ, Spencer EA, Brassey J , Plüddemann A, Onakpoya, I., Evans, D., Conly, J., and Jefferson, T. (2021). SARS-CoV-2 and the role of airborne transmission: a systematic review [version 1; peer review: 1 approved with reservations, 2 not approved]. F1000Research *10*.

Johansson, M.A., Quandelacy, T.M., Kada, S., Prasad, P.V., Steele, M., Brooks, J.T., Slayton, R.B., Biggerstaff, M., and Butler, J.C. (2021). SARS-CoV-2 Transmission From People Without COVID-19 Symptoms. JAMA Netw Open *4*, e2035057.

Katelaris, A.L., Wells, J., Clark, P., Norton, S., Rockett, R., Arnott, A., Sintchenko, V., Corbett, S., and Bag, S.K. (2021). Epidemiologic Evidence for Airborne Transmission of SARS-CoV-2 during Church Singing, Australia, 2020. Emerg Infect Dis *27*, 1677-1680.

Klompas, M., Baker, M.A., Rhee, C., Tucker, R., Fiumara, K., Griesbach, D., Bennett-Rizzo, C., Salmasian, H., Wang, R., Wheeler, N.*, et al.* (2021). A SARS-CoV-2 Cluster in an Acute Care Hospital. Ann Intern Med.

Kutter, J.S., de Meulder, D., Bestebroer, T.M., Lexmond, P., Mulders, A., Richard, M., Fouchier, R.A.M., and Herfst, S. (2021). SARS-CoV and SARS-CoV-2 are transmitted through the air between ferrets over more than one meter distance. Nat Commun *12*, 1653.

Lednicky, J., Lauzardo, M., Alam, M., Elbadry, M., Stephenson, C., Gibson, J., and Morris Jr., J. (2021). Isolation of SARS-CoV-2 from the air in a car driven by a COVID patient with mild illness. medRxiv https://www.medrxiv.org/content/10.1101/2021.01.12.21249603v1.full.
Lednicky, J.A., Lauzardo, M., Fan, Z.H., Jutla, A., Tilly, T.B., Gangwar, M., Usmani, M., Shankar, S.N., Mohamed, K., Eiguren-Fernandez, A.*, et al.* (2020a). Viable SARS-CoV-2 in the air of a hospital room with COVID-19 patients. Int J Infect Dis *100*, 476-482.

Lednicky, J.A., Shankar, S.N., Elbadry, M.A., Gibson, J.C., Alam, M.M., Stephenson, C.J., Eiguren-Fernandez, A., Morris, J.G., Mavian, C.N., Salemi, M.*, et al.* (2020b). Collection of SARS-CoV-2 Virus from the Air of a Clinic Within a University Student Health Care Center and Analyses of the Viral Genomic Sequence. Aerosol Air Qual Res *20*, 1167-1171.

Lewis, D. (2021a). Superspreading drives the COVID pandemic — and could help to tame it. Nature *590*, 544-546.

Lewis, D. (2021b). Why indoor spaces are still prime COVID hotspots. Nature *592*, 22-25.

Miller, S.L., Mukherjee, D., Wilson, J., Clements, N., and Steiner, C. (2021a). Implementing a negative pressure isolation space within a skilled nursing facility to control SARS-CoV-2 transmission. Am J Infect Control *49*, 438-446.

Miller, S.L., Nazaroff, W.W., Jimenez, J.L., Boerstra, A., Buonanno, G., Dancer, S.J., Kurnitski, J., Marr, L.C., Morawska, L., and Noakes, C. (2021b). Transmission of SARS-CoV-2 by inhalation of respiratory aerosol in the Skagit Valley Chorale superspreading event. Indoor Air *31*, 314-323.

Morawska, L., and Milton, D.K. (2020). It Is Time to Address Airborne Transmission of Coronavirus Disease 2019 (COVID-19). Clin Infect Dis *71*, 2311-2313.

Morawska, L., Tang, J.W., Bahnfleth, W., Bluyssen, P.M., Boerstra, A., Buonanno, G., Cao, J., Dancer, S., Floto, A., Franchimon, F.*, et al.* (2020). How can airborne transmission of COVID-19 indoors be minimised? Environ Int *142*, 105832.

Nissen, K., Krambrich, J., Akaberi, D., Hoffman, T., Ling, J., Lundkvist, A., Svensson, L., and Salaneck, E. (2020). Long-distance airborne dispersal of SARS-CoV-2 in COVID-19 wards. Sci Rep *10*, 19589.

van Doremalen, N., Bushmaker, T., Morris, D.H., Holbrook, M.G., Gamble, A., Williamson, B.N., Tamin, A., Harcourt, J.L., Thornburg, N.J., Gerber, S.I.*, et al.* (2020). Aerosol and surface stability of HCoV-19 (SARS-CoV-2) compared to SARS-CoV-1. medRxiv.