



The COVID-19 Pandemic: Where We've Been, What We Know, What's Next

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April 18, 2022

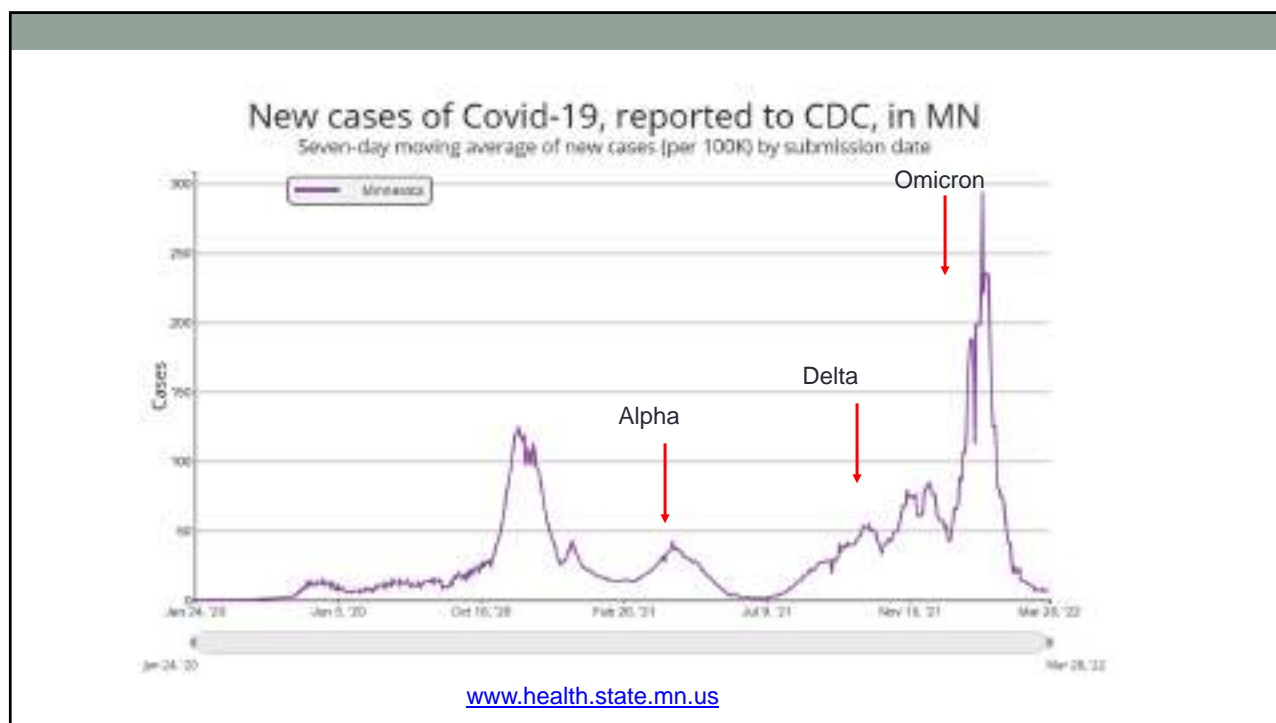
OBJECTIVES

Upon completion of this lecture, participants should be able to:

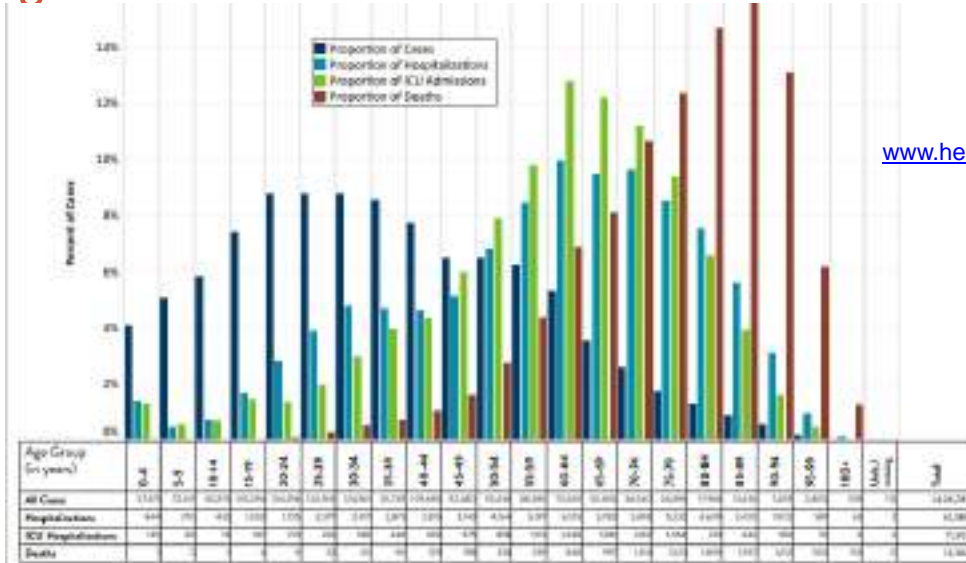
1. Describe the ongoing challenges of COVID-19 control
2. List the key takeaways the SARS-CoV-2 pandemic and how it can help us plan for future pandemics

Two Years of COVID-19

- First reported 12/31/2019
- 1/20/20 – first case in US
- 1/30/20 – WHO Public Health Emergency
- 3/11/20 – WHO declares global pandemic
- 486,000,000 cases; 6,136,114 deaths; 10 billion vaccine doses given
- MN Data
 - 1,429,051 (including reinfections)
 - 12,401 deaths
- 3 major variant surges in the US plus initial wide type



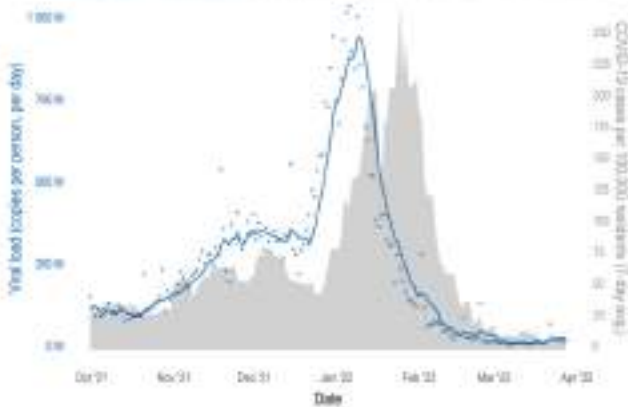
Age Distribution of MN COVID-19 Cases



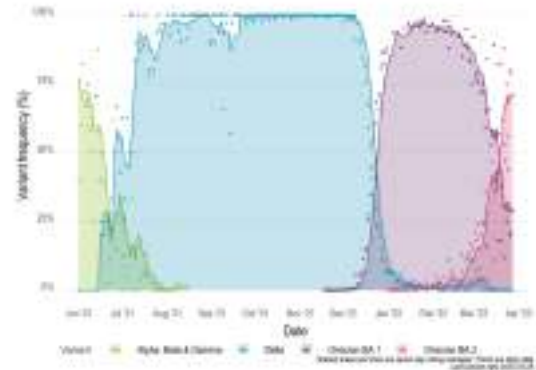
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Wastewater Surveillance

Viral load in wastewater compared to metro-area COVID-19 cases



COVID-19 Variants in Metro Plant Wastewater



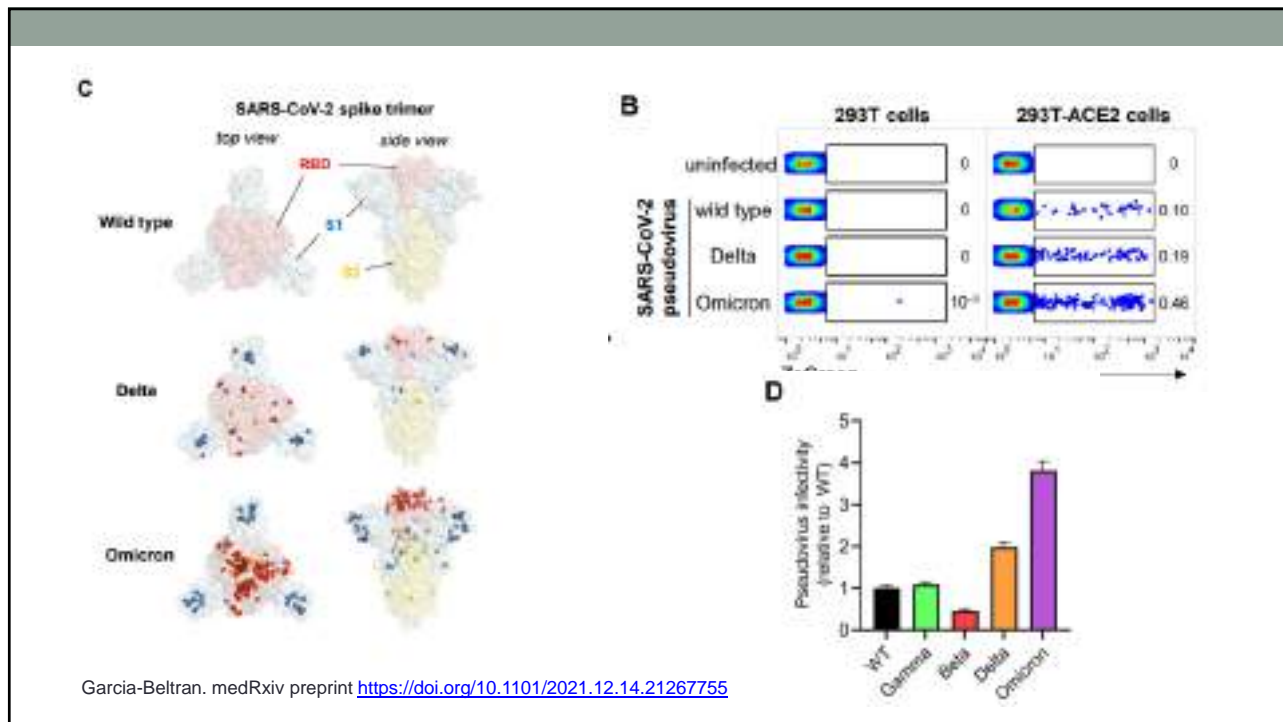
[COVID-19 Research - Metropolitan Council \(metrocouncil.org\)](https://www.metrocouncil.org/research/covid-19-research)

Variants 101

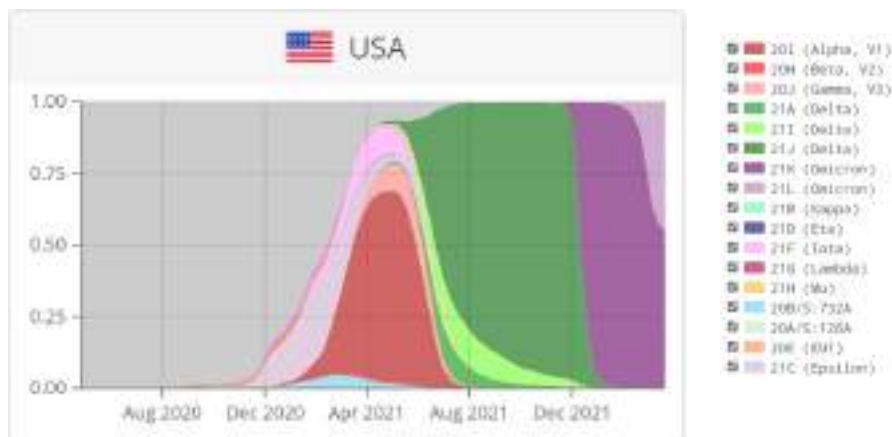
- WHO has been tracking since the first emergence in December 2020
 - Variant of Concern (VOC)
 - Increase in transmissibility OR
 - Increase in virulence or clinical disease presentation OR
 - Decrease in effectiveness of public health and social measures or available diagnostics, vaccines, therapeutics
 - Currently circulating VOCs
 - Omicron (multiple countries) and Delta (India)
 - Prior VOCs
 - Alpha (UK)
 - Beta (South Africa)
 - Gamma (Brazil)
- [Science Brief: Emerging SARS-CoV-2 Variants | CDC](#), [Tracking SARS-CoV-2 variants \(who.int\)](#)

Variants 101, cont.

- Variants of Interest (VOI)
 - Genetic changes that are predicted or known to affect virus characteristics
 - Identified to cause significant community transmission or multiple COVID-19 clusters
 - Currently circulating VOI
 - None!!
 - Previously circulating VOIs
 - Epsilon (US)
 - Zeta (Brazil)
 - Eta (multiple countries)
 - Theta (Philippines)
 - Iota (US)
 - Kappa (India)
 - Lambda (Peru)
 - Mu (Colombia)
- [Science Brief: Emerging SARS-CoV-2 Variants | CDC](#), [Tracking SARS-CoV-2 variants \(who.int\)](#)



Variant Subtypes - USA



<https://covariants.org/per-country>

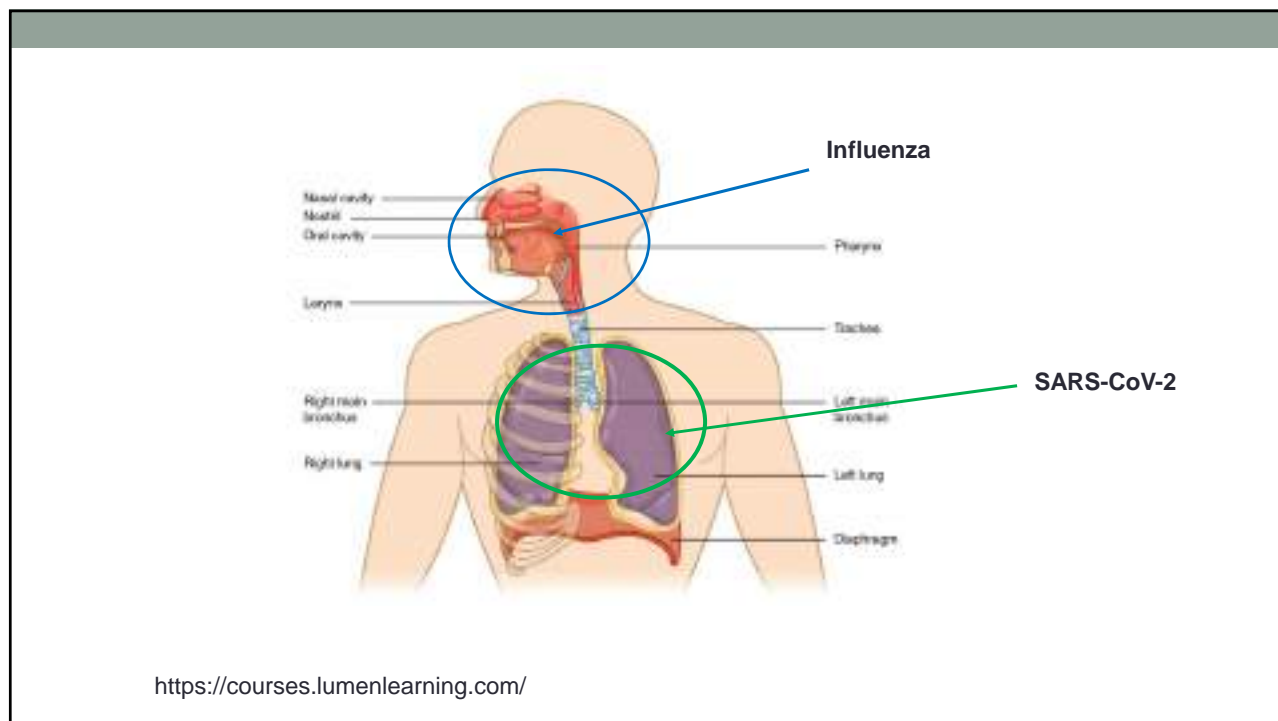
Personal Protective Equipment



Current CDC Recommendations

- Confirmed or suspect COVID-19 patients
 - Respirator, eye protection, gown, gloves
- During periods of substantial or high transmission
 - Respirators for all AGPs
 - Respirators for all patient care
 - Universal eye protection during all patient care
- Universal masking – N95 or well fitting medical mask

[Infection Control: Severe acute respiratory syndrome coronavirus 2 \(SARS-CoV-2\) | CDC](#)



Personal Protective Equipment, Masks

- Cloth masks can block up to 50-70% of fine droplets and particles
- Mask efficiency can vary 26.5-79%, modifications to ensure better fit: improved from 38.5% to 80.2%
- Study of 61 infected patients from May 2020-April 2021
 - Mask use reduced viral RNA by 48% in fine and 77% in coarse aerosols, cloth masks not different than medical masks.
- Study aboard USS Theodore Roosevelt found use of face coverings associated with 70% reduction in risk of infection
- Outbreaks in schools in AZ – outbreaks 3.5x more likely in schools without mask mandates
- Hamster model – transmission rate when source masked =17%, transmission rate when naïve hamsters masked = 33%, when neither masked 67%

[Science Brief: Community Use of Masks to Control the Spread of SARS-CoV-2 | CDC](#), Adenaiye. Clin Infect Dis; 2021, Chan. Clin Infect Dis; 71: 220, Clapp. JAMA Int Med; 181:2021

Conclusion – Masks Help



Personal Protective Equipment, Respirators

- SARS-CoV-2 is present in small aerosol particles
- Super-spreading events, reports of long-range transmission, asymptomatic/pre-symptomatic transmission
- Transmission to HCW noted despite mask & eye protection
- Tested fit of N95 vs half-face elastomeric – 0/36 in elastomeric failed vs 28% (18/64) wearing N95
- Increased viral load and infectivity of Delta and Omicron strains

Barros. JAMA Network Open: 2021, Klompas Clin Infect Dis 2021, Greenhalgh. Lancet; 397: 2021

Hospital Contamination

- 1850 air samples collected → 16% positive
- Patient areas > non-patient care areas
- Highest non-patient care areas: hallways adjacent to patient rooms
- 10 studies looked at viability
 - 2/10 found viable virus in 7/22 specimens tested
- Assessed size of particles more likely to be positive
 - Fine aerosol (18%) vs droplet or coarse aerosol (11%)
 - Only fine aerosols had viable virus

Ribaric. Indoor Air 32:2022

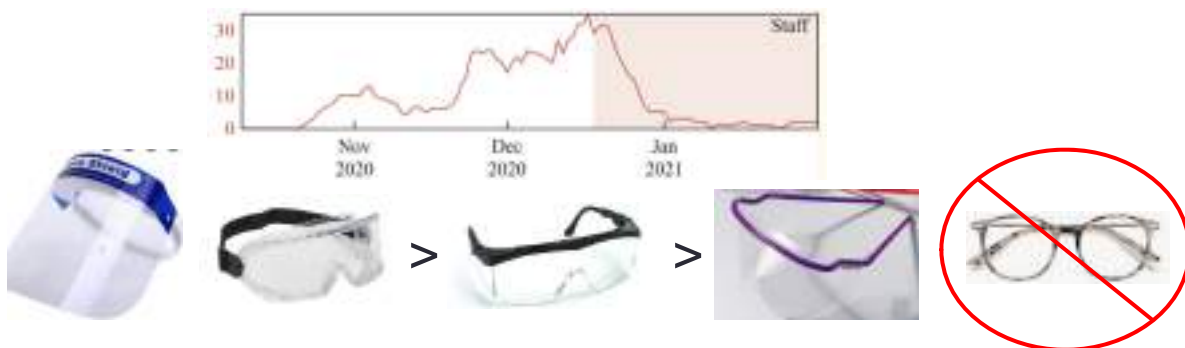
Conclusion

- Respirators provide superior protection in the healthcare environment
- Respirators for COVID-19 patient care
- During periods of substantial or high transmission
 - Respirators for all AGPs
 - Respirators for all patient care



Personal Protective Equipment – Eye Protection

- 8/348 HCW with higher risk exposures COVID-19+ – 63% only PPE gap was not wearing eye protection



Shah. Infect Control Hosp Epidemiol;2021, Byambasuren. Antimicrob Resist Infect Control;10:2021, Hamilton. J Hosp Infect; 111:2021

Conclusion

- Eye protection prevents HCW COVID-19 infection
- Wear eye protection while providing care for COVID-19 patients
- Universal eye protection during times of high transmission
- Wear eye protection when splash/spray likely



Personal Protective Equipment, Gowns

- Risk of Contact transmission ~1/10,000
- One study cultured viable virus from caregivers gown
- Several early studies demonstrate possible transmission from indirect contact
- Requires transfer from surface to hands and hands to mouth/eye/nose → Hand hygiene

Surface contamination in hospitals

- 16% (712/4408) samples + for SARS-CoV-2
- Patient care areas > non-patient care areas
- ICU>non-ICU

Bae, Emerg Infect Dis 26:2020; CDC Science Brief: SARS-CoV-2 and Surface Transmission; Cai, Emerg Infect Dis 26:2020, Xie, BMC Public Health 20:2020; Ribaric, Indoor Air 32:2022

Conclusion

- Gowns will prevent contamination – especially when splash/spray, AGP
- Wear Gowns when providing care to COVID-19 patients
- Follow standard precautions - gowns when splash/spray likely



Barriers to Appropriate PPE Use

- Safety culture/leader support
- Long, complex guidelines
- Frequently changing recommendations
- Impractical to implement
- Lack of training
- Inadequate supplies
- Individual perception of risk

Houghton. Cochrane Database of Systematic Reviews 2020 Issue 4

Future of PPE

- More widespread use of N95/respiratory protection
 - All AGPs/AGPs in patients with influenza-like illness
- Increased compliance with eye protection

CDC Current Definition of Higher Risk Exposure

- Higher Risk Exposure
 - HCW not wearing a respirator (or if wearing a facemask, the person with SARS-CoV-2 is not masked)
 - Not wearing eye protection and patient not masked
 - Not wearing all recommended PPE when performing an AGP
- Pre-Omicron High risk exposure definition
 - HCW not wearing all recommended PPE during an AGP
 - Prolonged close contact with a SARS-CoV-2 patient AND
 - Not wearing eye protection and positive patient was not wearing a mask
 - Not wearing a droplet mask or respirator

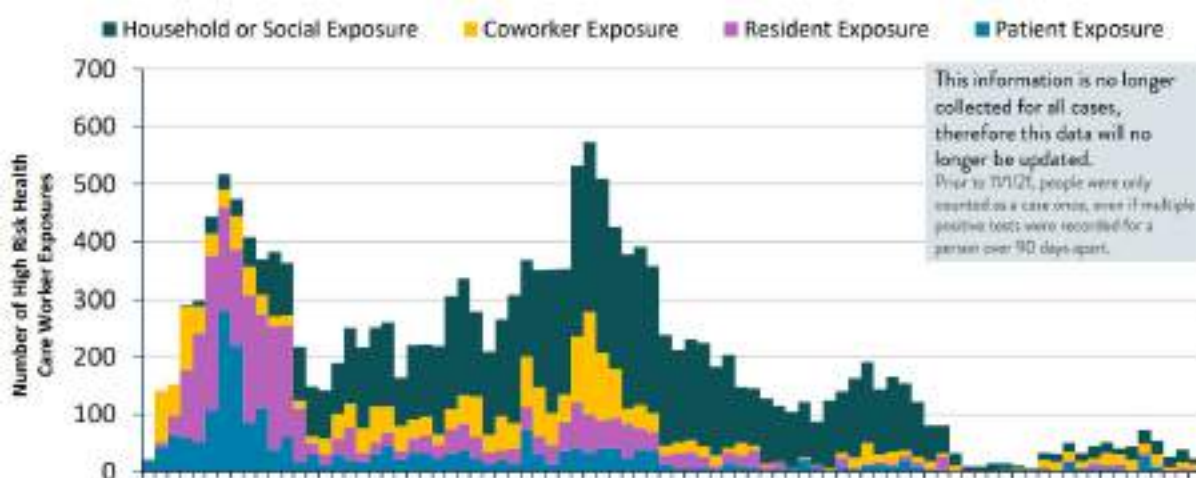
[Interim Guidance for Managing Healthcare Personnel with SARS-CoV-2 Infection or Exposure to SARS-CoV-2 | CDC](#)

Risk Factors of HCW Transmission

- 3.8% (120/3234) HCW serologically + for SARS-CoV-2
 - Not wearing PPE when: NP Swab, AGP, eye exam
 - Risk with and without PPE: clinical exams, mobilization of patient in bed
- 39/1273 staff with exposures tested positive
 - Rate of positivity double in those without PPE
 - Synergistic effect between patient contact >15 min and <1m
- March-July 2020
 - 96/1534 staff tested, 96+
 - 90/96 symptomatic
 - 25% high risk exposure at work
- Mayo study – 581 exposed HCW, 345 high risk and tested, 8+

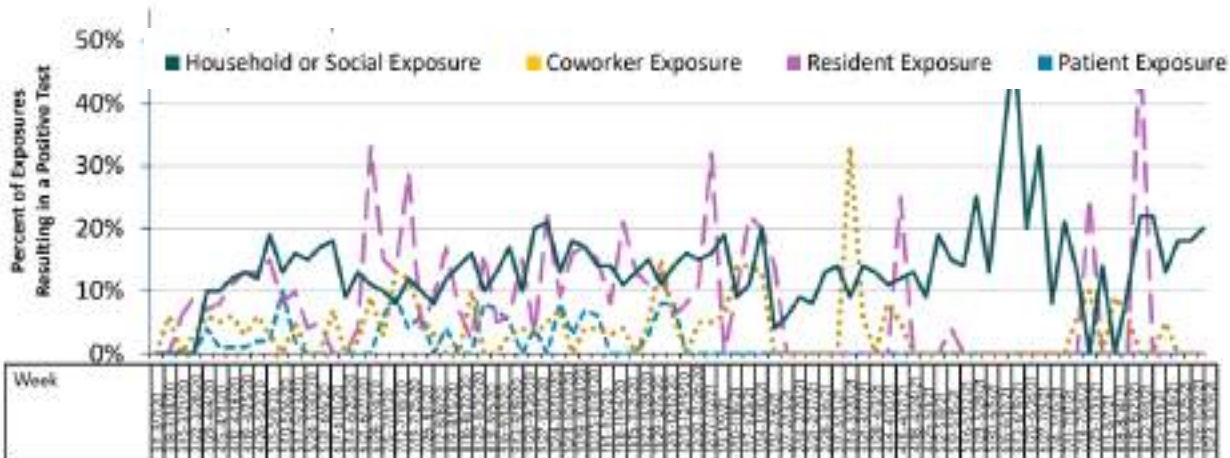
Zabarsky. Am J Infect Control;49:2021, Shah. Infect Control Hosp Epidemiol:2021, Paris. Am J Infect Control; 50:2022, La Torre. Int J Env Research and Pub Health;18:2021

MN High Risk HCW Exposures, 3/20-10/21



www.health.state.mn.us

MN HCW Exposure Positive Tests, 3/20-10/21



www.health.state.mn.us

HCW COVID-19 Transmission Risk

- Not wearing PPE
- Prolonged close contact with infected patients
- Risk of infection higher with co-workers compared to patients

HAIs and COVID-19 Patients

- Ventilator-associated pneumonia (VAP)
 - 94 pts with COVID vs 144 pt without COVID
 - COVID patients 2x more likely to develop VAP (48% vs 13%)
 - COVID patient mortality 38% vs 21% in non-COVID
- *S. aureus*/MRSA
 - Meta analysis of *S. aureus*/MRSA co-infection (18 studies)
 - 33% reported co-infection
 - 28% of those with co-infection due to *S. aureus*, ½ of the *S. aureus* MRSA
- Bloodstream Infections
 - Matched case-cohort study – 235 COVID-19 pts and 235 controls
 - 14.9% ICU BSI in COVID-19 vs 3.4% in non-COVID-19
 - 3.4% CLABSI vs 0.9% COVID-19 vs non-COVID-19
 - Risk greater after 7 days of ICU admission
 - Risk greater in those with tocilizumab or anakinra but not corticosteroids

Maes. Crit Care; 25:2021, Adeiza. Hygiene and Infect Control; 15:2020, Kumar, Int J Infect Dis; 104:2021, Buetti. Intensive Care Med; 47:2021,

HAI and COVID-19 Patients, cont.

- Predictors and outcomes of HAI in COVID-19 patients
 - 1,565 pts March-June 2020
 - 3.7% developed HAI
 - Associated with tocilizumab and steroid use
 - 315 patients and 109 episodes of superinfection (69 patients)
 - Median time to infection 19 days
 - 40% bacteremia, 23% VAP, 28% UTI
 - Risk factors: colonization with CRE, mechanical ventilation, tocilizumab/baricitinib use, prior treatment with pip/tazo
 - Hospital stay longer in those that developed infection, no difference in mortality

Kumar, Int J Infect Dis; 104:2021, Falcone. J Antimicrob Chemother: 2020

Impact of COVID-19 on HAIs

Comparison of HAI data reported to NHSN 2020 vs. 2019

	2020 Q1	2020 Q2	2020 Q3	2020 Q4
CLABSI	↓ -11.8%	↑ 27.9%	↑ 46.4%	↑ 47.0%
CAUTI	↓ -21.3%	No Change [†]	↑ 12.7%	↑ 18.8%
VAE	↑ 11.3%	↑ 33.7%	↑ 29.0%	↑ 44.8%
SSI: Colon surgery	↓ -9.1%	No Change [†]	↓ -6.9%	↓ -8.3%
SSI: Abdominal hysterectomy	↓ -16.0%	No Change [†]	No Change [†]	↓ -13.3%
Laboratory-identified MRSA bacteremia	↓ -7.2%	↑ 12.2%	↑ 22.5%	↑ 33.8%
Laboratory-identified CDI	↓ -17.5%	↓ -10.3%	↓ -8.8%	↓ -5.5%

Winer-Lastinger. Infect Control Hosp Epidemiol; 43:2021

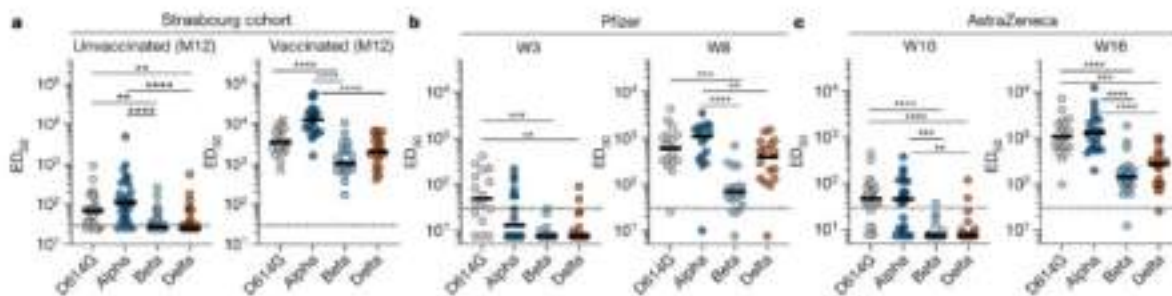
Vaccines and Breakthrough Infections

- Pfizer and Moderna – 95% efficacy
- Jansen – 67% efficacy in preventing moderate to severe/critical illness, booster 85% effective against hospitalization
- Risk of COVID-19 hospitalization and death following vaccination
 - Pfizer showed 61% effectiveness against symptomatic disease
 - 43% reduction in hospitalization
 - 51% reduction in death
- Retrospective study looking at breakthrough infections – 456 unvaccinated persons vs 456 vaccinated
 - Severe disease in 10.5% of vaccinated vs 26.5% unvaccinated
 - Overall risk of severe disease or death 3x higher in unvaccinated

Butt. International J Infect Dis; 110:2021, Lopez Bernal. BMJ; 373:2021

Vaccines and Variants

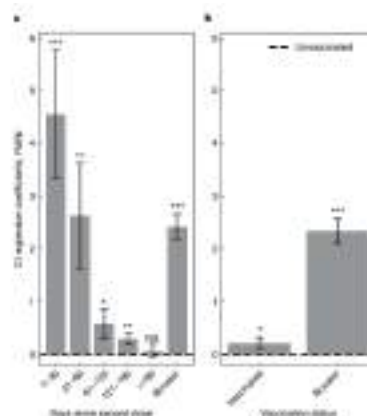
Fig. 2: Sensitivity of the SARS-CoV-2 variants D614G, Alpha, Beta and Delta to sera from convalescent individuals and vaccinated individuals.



Planas. Nature; 596:2021,

Vaccines and Delta

- Increased risk of breakthrough infections with greater time since vaccination
 - Looked at breakthrough infections in June-July 2021
 - 2.26 fold higher risk of breakthrough infection if received second dose in Jan/Feb vs March/April
- Booster showed increase CT value (decreased viral load) in those with Delta.



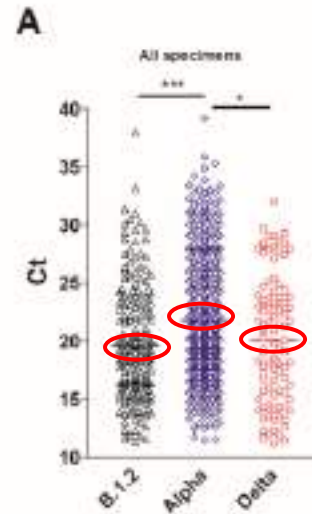
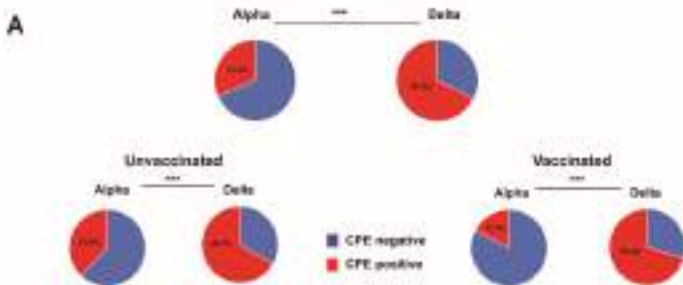
Mizrahi. Nature:2021, Levine-Tiefenbrum. Nature Med; 27:2021

Vaccines and Delta, cont.

- Delta caused increase in breakthrough vs Alpha (28% vs 12.4%)
- Increase in days since vaccination Delta (136) vs Alpha (20)
- No difference in hospital admission or mortality
- Vaccine breakthrough more likely to be symptomatic in Delta vs Alpha (93.3% vs 61%)

Huai Luo. medRxiv preprint <https://doi.org/10.1101/2021.08.15.21262077>

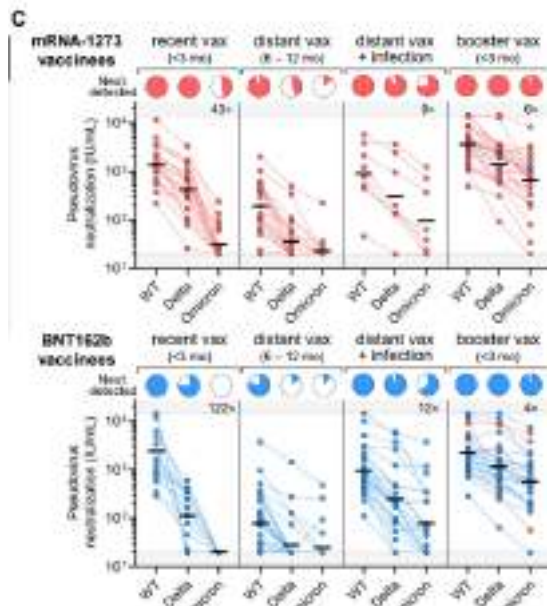
Alpha vs Delta Infections



Huai Luo. medRxiv preprint <https://doi.org/10.1101/2021.08.15.21262077>

Boosters and Omicron

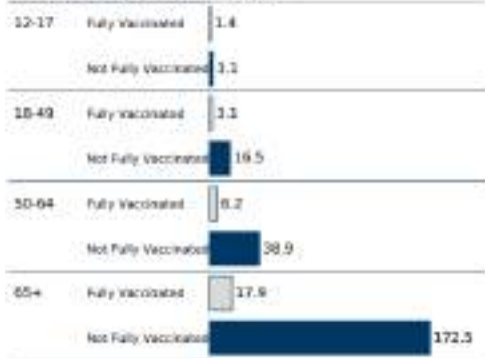
- Boosting generating higher levels of neutralization antibodies
 - mRNA vaccine booster increased breadth and cross reactivity of neutralization antibodies



Garcia-Beltran. medRxiv preprint <https://doi.org/10.1101/2021.12.14.21261100>

MN Data – Hospitalization and Death in Vaccinated and Non-Vaccinated

Hospitalizations: Rate by age group per 100,000
Week starting: 5/2/2021 to 2/13/2022



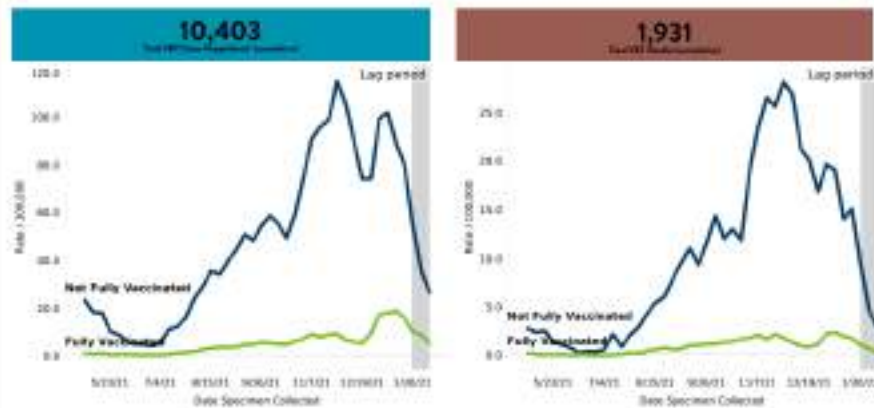
Deaths: Rate by age group per 100,000
Week starting: 5/2/2021 to 2/13/2022



www.health.state.mn.us

VBT Hospitalizations and Deaths

These graphs show the rate of hospitalization and death among vaccinated and unvaccinated COVID-19 cases since vaccine was widely available to the general adolescent and adult population in May 2021. Fully-vaccinated is defined as 14-or more days after they have completed all recommended doses of a COVID-19 vaccine.



www.health.state.mn.us

* More information about vaccine breakthrough and data updated every Monday are available on <https://www.health.state.mn.us/diseases/coronavirus/vbt.html>

Impact of COVID-19 on Healthcare Workers

- 60% of acute care RNs report burn out; 75% report feeling stressed

	<35 year olds	>55
Burnout	66%	33%
Anxious	66%	35%
Organization cares about my wellbeing	19%	42%
Optimistic for the future (0-10 scale)	3.77	5.89

- Compared to 2021 study 30% increase in those intending to leave job (40% →52%)
- 89% report staffing shortages

[covid-19-two-year-impact-assessment-written-report-final.pdf \(nursingworld.org\)](https://www.nursingworld.org/covid-19-two-year-impact-assessment-written-report-final.pdf)

Learning From the Past – Ebola, H1N1, SARS

- PPE challenges
- Inconsistent and frequently changing recommendations
- Better disease test/reporting/tracking
- Increased surge capacity
- Fear

Yen. J Hosp Infect;87:2014, Morgan. Infect Control Hosp Epidemiol; 36:2015

Planning For the Future

- Preparing for surge
- Addressing air/ventilation
- Emotional support of HCW
- Maintaining cache of PPE/Supply chain stabilization
- Testing capacity
- Appropriate use of community-level controls
- Need to address the racial/ethnic disparities in health
- Changes to how/when we use PPE – the *New* Standard Precautions

Khanna. Indian J Ophthalmology;68:2020, Wei. JAMA; 181:2021, Fang. Clin Infect Dis; 72:2021

Thank you

- Questions?



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