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Pediatrics



Infection Prevention in the COVID era: a Pediatric Perspective

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Disclosures

- I have no conflicts of interest to disclose

Learning Objectives

- Compare attitudes and practices during different epidemics
- Describe the current COVID epidemiology
- Discuss the evidence behind current infection prevention practices
- Discuss the importance of infection prevention

Hindsight is 20/20: the Yellow Fever story

- Mosquito borne flavivirus that causes hepatitis, encephalitis, hemorrhage and often is fatal
 - No available effective antiviral therapy
- We don't usually think about it because it exists mostly in tropical areas of Africa and South America
- Epidemics used to be frequent in North America
 - Could kill 20% of a city's population in a few months

Yellow Fever Early US

- Late 1800s-1900s waves of epidemics hit the northern ports, then settled in the South
- Epidemiology unknown at that time leading to fear
 - Travel
 - Social distancing
- Blamed immigrants
- Politicians attacked each other
- Fights about quarantine
- Increased racial discrimination
- Controversy over treatment recommendations

Yellow Fever Story

- People believed miasmas or fomites likely the cause
- Cuba 1880s: Carlos Finlay postulated that mosquitos were the cause
 - Laughed to scorn by the medical community and populace in the US
- US invades Cuba and for every 1 soldier that dies in battle, 13 die from yellow fever

Yellow Fever Story

- Walter Reed's team in early 1900s proves mosquitos were the vector of the disease
 - Fomite vs mosquito trials
 - Fumigate and remove standing water and Yellow Fever is largely eradicated in the area
- Takes years for this to be accepted in the US, but eventually leads to eradication of the disease in the US
- Now a vaccine is available
- Virus persists in sylvatic cycle with occasional outbreaks in humans

COVID Pandemic: Remember when

- It's an isolated cluster of animal to human infection
- It doesn't transmit human to human
- It won't leave China
- It left China but it isn't pandemic
- It's not in the US
- It's not contagious before onset of symptoms
- We don't need to test aggressively
- Masks don't help or aren't needed
- Health care workers should always wear an N95
- Children don't get infected
- Children don't infect others
- Children don't get severe infection
- Is it transmitted by droplet, airborne?
- Quarantine? Isolate? How long?
- What do we do in clinic, hospital, home, school, work?

COVID-19: Unprecedented cooperation and research

- Isolation and sequencing of the virus
- Development of vaccines
- Better understanding of epidemiology
- Antiviral development
- We still have a long way to go

COVID: What do the numbers tell us?

- 15.6 million children have tested positive
- 18% of all positives are children
 - Children make up 22% of the population
- These numbers underestimate true case numbers since not all children become symptomatic, and not all get tested
 - Seroprevalence study estimates that 96% of children have antibody from either vaccine or prior infection
 - Qualitative so can't determine level of protecting antibody
 - 0-4 year old group: 88%

COVID and Children

- 2223 pediatric COVID-19 related deaths
- MIS-C
 - 9480 patients
 - 79 deaths
 - Cases are rare now
- Post COVID conditions: 2-66% depending on the definition or study
- Children are 2.5 times more likely to be diagnosed with new onset diabetes 30 days or more after infection with SARS-CoV-2

What version do we have now?

- Cruising through the alphabet
- Omicron
 - XBB.1.5 is the most common
 - Other Omicron variants
- Most of the antibody based medications for pre/post exposure prophylaxis/treatment aren't active against the current variants

COVID Transmission

- Can occur in absence of symptoms
- Presymptomatic vs asymptomatic
 - 1-2 days prior to onset of symptoms
 - Similar to influenza
 - Why many still argue for universal mask use
- Viral load decreases rapidly after symptom onset
 - Antigen test positivity may correlate with viable virus

How long is someone contagious: viable virus?

- Multiple early studies showed no viable virus after 10 days in mild/moderate disease
 - Few later studies have some viable virus for a few days more in some
 - Shorter in vaccinated individuals
 - Ongoing PCR positivity despite no viable virus
- Small percentage of people with severe disease had viable virus for longer period, but not beyond 20 days
- Case reports of viable virus beyond that, usually in immune compromised patients
 - One over 200 days

More COVID Epi information

- Incubation period
 - Alpha/beta mean 5 days
 - Delta mean 4.3 days
 - Omicron median 3-4 days
- Viability on surfaces
 - Up to 72 hours on plastics and stainless steel
 - No evidence for fomites playing a major role in transmission
- Mostly droplet transmission
 - Some evidence for airborne transmission in certain situations (esp aerosol generating procedures)
 - Not like measles airborne

COVID vaccine

- CDC recommends primary series for everyone ≥ 6 months of age
 - Updated booster for everyone ≥ 5
 - $\geq 6m-4y$ if got Moderna primary series
- Percent who got 1st, 2nd, and booster doses
 - <2 years: 8.9%, 4.7%, 0.6%
 - 2-4y: 10.9%, 6.1%, 0.6%
 - 5-11y: 40%, 32.9%, 4.8%
 - 12-17y: 72.2%, 61.8%, 7.8%
- AZ <20 y/o 1 or more doses: 38.7%

<https://www.azdhs.gov/covid19/data/index.php#vaccination-coverage-byage>

<https://covid.cdc.gov/covid-data-tracker/#vaccination-demographics-trends>

How well do the vaccines work?

- Moving target
 - Effectiveness tends to wane over time and with newer variants
 - Still a high degree of protection
- Omicron and children
 - Preventing infection: 17-71% depending on age and time from last dose
 - ED/Urgent Care visits: 38-86%
 - Hospitalization: 38-68%
 - Critical illness: 79%
- MIS-C: 78-90%
- Maternal vaccination decreased rates of infant hospitalization in the 1st 6 months of life
 - Also see this with influenza and pertussis vaccination

How robust is immunity from prior infection?

- Hard to say depending on what was measured
 - Many assessed antibody response
- Multiple studies, most before Omicron
 - Most suggest antibody production that lasts at least months
 - Many suggest decreased response from infection compared to vaccination, but some suggest the opposite
 - One Omicron era study suggested infection alone conferred 38% protection against reinfection
 - Protection waned with time from last infection
- Infection plus vaccination usually was better than infection alone

When is it safe for HCW to return to work?

- CDC HCW return to work recommendations (latest update Sept 2022): depends on the situation
- Mild to moderate dz, not immune compromised
 - Return after 7 days (and wear a mask)
 - Negative test within 48 hours
 - 24 hours since last fever without antipyretics
 - Symptoms have improved
 - Otherwise return after 10 days
- Different criteria/lengths for severe/critical disease, moderate/severe immune compromise
- Day 0 onset of symptoms or positive test if asymptomatic

How risky is returning to work: Korea study

- Omicron was circulating and lots of ill HCW
 - 5 HCW out per week per hospital unit in 2700 bed hospital
- Fully vaccinated HCW could return to work at 5d if they wore a tight-fitting mask
 - Similar to CDC recs at the time
- 248 HCW developed infection within 5 days of returned colleague
 - Only 18 had close contact suspicious for transmission at work
 - 9 had other close contact exposure (household, etc)
 - 1 ate meal in same close area with masks off (which was against policy)
 - 3 others developed symptoms very early in the typical incubation period suggesting possible alternative source of infection
- Median time to negative viable culture: 4 days
 - One lasted 7 days

How well do masks work?

- 2023 Cochrane review: randomized controlled trials
 - Moderate certainty evidence suggests that wearing masks made little to no difference in outcomes
 - Ding dong the mask is dead?
- What about other data?

2023 Cochrane review: physical interventions to reduce the spread of respiratory viruses

- Only evaluated randomized controlled trials
 - Most from pre pandemic era looking at influenza and other respiratory viruses
 - Hospital and community based trials
 - Many had moderate to high risk of bias
- Mask vs no mask
- N95 vs surgical/simple mask
- Hand hygiene
- No trials on face shields, gowns and gloves, or screening at entry ports

Cochrane: med/surg mask vs no mask

- 10 community based trials
 - 2 hospital trials were excluded because of variable mask usage data
 - 2 during the COVID pandemic
- Moderate certainty evidence suggests that wearing masks made little to no difference in outcomes

Cochrane: N95/P2 Respirator vs med/surg masks

- 5 trials, all prior to the pandemic
 - HCW and community based
- No benefit of N95/P2 over med/surg mask
 - These were not infections typically spread by airborne droplet nuclei
 - Didn't include COVID

Problems with the data/design

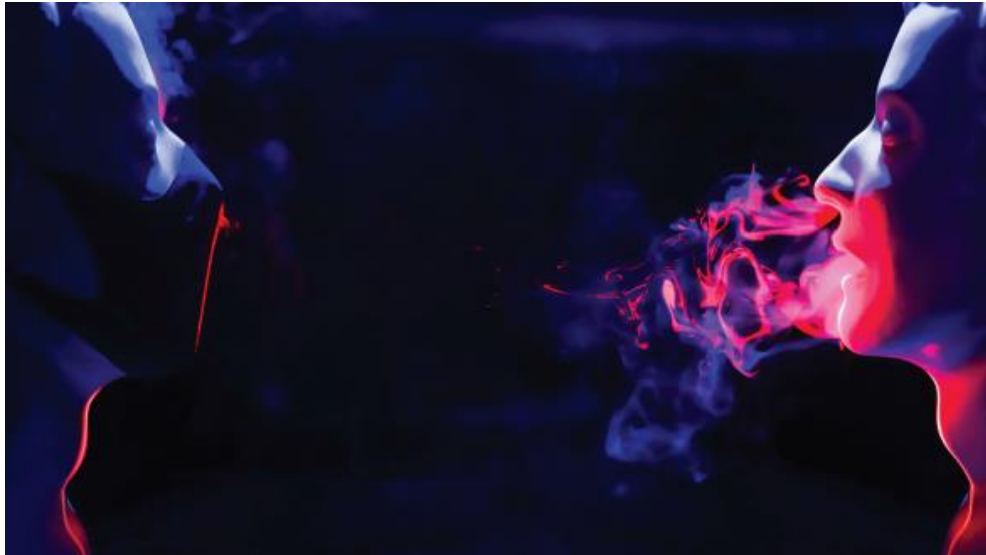
- Some authors of the studies proposed that there was a benefit seen, but high risk of bias and wide confidence intervals made that suspect
- Variable adherence to mask wearing instructions
- Short time of intervention
- Often didn't include younger family members in the intervention
- One college dorm trial included spring break during the intervention

Looking at masks from a different angle

- Experimental cough model data that show masks decrease flow of potentially infectious material
- Masks can filter small particles the size of viruses
- Data shows decreased respiratory virus detection in aerosols from cough in children wearing mask compared to no mask

Looking at masks from a different angle

- Depends on the type of material, fit and length of use



Other Mask Studies Suggest

- Meta analyses and other data suggest benefit
- 2021 MMWR study from Maricopa and Pima Counties that showed decreased outbreaks in schools that required masks
- 2021 MMWR study that showed decreased rate of COVID in masked students during an outbreak at a St. Louis University
- 2021 PLoS one study showed lower COVID rates in communities with higher mask usage

Cover Your Cough

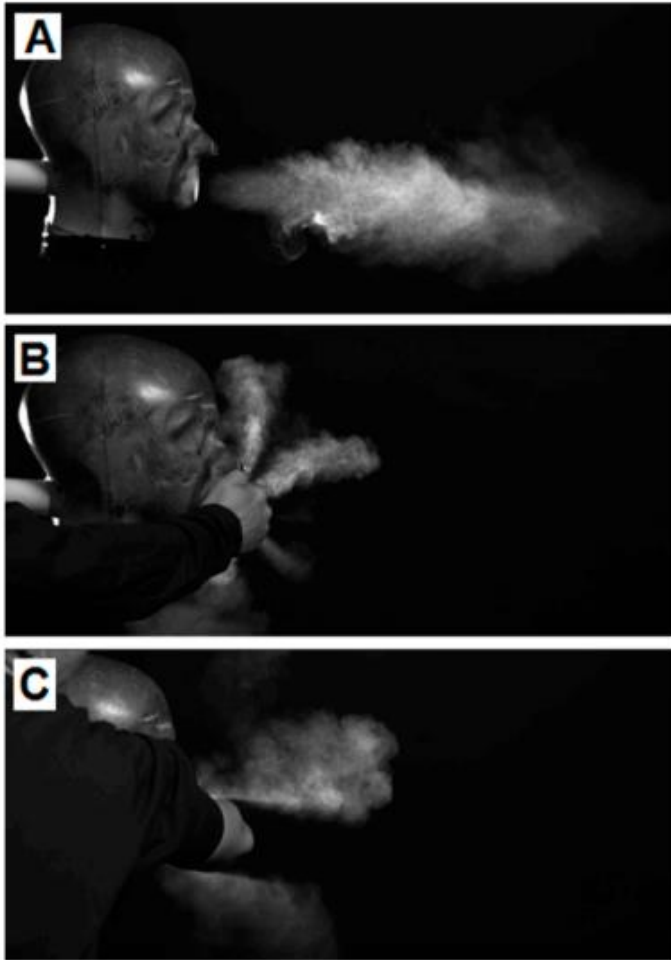


Figure 7. High-speed backlit photographs of test (A) the cough with no intervention, test (B) the cough with the hand over the mouth, test (C) the cough with a bare elbow.

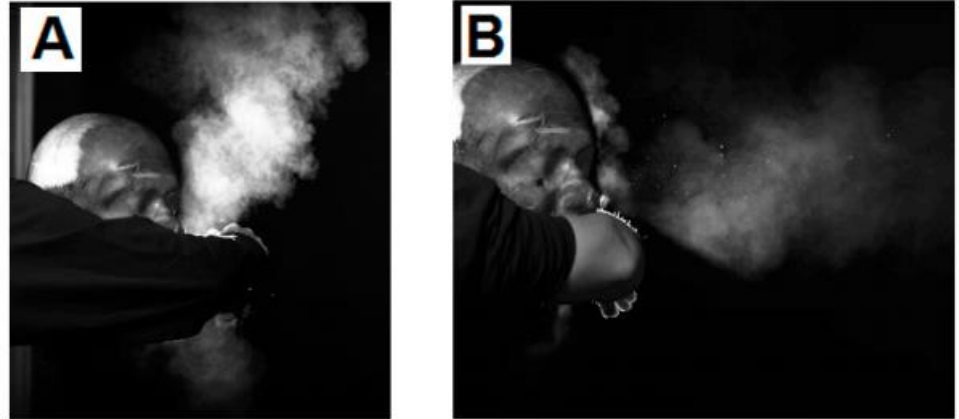


Figure 9. High-speed backlit photographs of the cough with (A) a sleeved elbow and (B) the elbow touching the mouth.



Figure 8. High-speed backlit photographs of the cough with balled fist.

Hand Hygiene: Cochrane 2023

- Modest improvement in risk of viral infection in hand hygiene trials
- 3 trials added masks to hand hygiene
 - Pre pandemic
 - Didn't show added benefit compared to hand hygiene alone
 - Had wide confidence intervals so benefit is possible
- Didn't assess bacterial transmission risk

Fomites in the waiting room

- New Zealand 2001 study: levels of coliform bacteria
 - 6 practices, 4 of which didn't regularly clean their toys
 - 90% of Soft toys had moderate to high contamination rates
 - Laundering or autoclaving didn't make much difference
 - Got recontaminated quickly
 - 27% of Hard toys moderate to high rates
 - Regularly cleaned ones showed no evidence of coliforms
 - Slow rate of recontamination
- Other clinic and hospital studies show high rates of bacterial contamination on toys
 - Soft worse than hard toys
- Hospital pseudomonas outbreak associated with contaminated bath toys with retained water

Fomites in the waiting room

- Viral RNA study Virginia 2010
 - Measured RNA from influenza, rhino/enterovirus and RSV
 - 3 separate dates in respiratory season in a single office
 - 21% had viral RNA present
 - Including toys from the well child waiting area
 - Higher rates from the sick area
 - Viral RNA not found on fingers of the adult who handled the toys
 - After disinfecting with wipes: lower rates but still present
 - Unknown if viral RNA=infectious viable virus

Recommendations to decrease transmission: AAP policy statement

- Ideally clean between use
- Daily cleaning acceptable
- Remove toys contaminated with body fluids so they can be cleaned
- Avoid soft toys because they are hard to clean effectively

Separate waiting rooms?

1985 Suburban Private Practice Study

- 70 patients/day
- Winter months
- Compared illness rates of children who went to the office to a cohort that did not go to the office
- Single waiting room
 - But did try to schedule well child visits in blocks to decrease exposure to ill children
- Shared toys

1985 Study

- Excluded children with underlying medical conditions, ill at presentation or had been to the office in the prior 2 weeks
- Collected data on number of children/adults in household, household illnesses, number of children that slept in the same room and day care attendance
- 127 office/home child pairs

1985 Study

- Found no difference in GI and Respiratory illness rates
 - Didn't evaluate for chickenpox or measles
- Few parents attributed illness to office visit
- Months after the study was done opened a separate sick waiting area that had been already planned
 - Improved parental satisfaction

Separate waiting areas?

- Case reports of infection acquired in the waiting room
- 2011 Montreal Study
 - 304 children visited peds ED in respiratory season
 - Common waiting area
 - No increased risk of subsequent respiratory infection
- 2014 Iowa study
 - Retrospective chart analysis of 84,595 families over 13 year period
 - Found 3% increase of influenza like illness visits by a family member 1-2 weeks after a well child visit

Other good infection prevention practices

- Pay attention to expiration dates, package integrity, storage temps, etc
- Regularly clean high touch areas
- Follow disinfection/sterilization practice recommendations
 - Pay attention to contact/drying time
- Avoid carpet
- Use nonporous furniture

Consequences of the pandemic

- Increased CLABSI and other HAIs
 - Burn out
 - Frank break down of infection prevention principles
 - Lack of PPE
 - Nurse to patient ratios
 - Severity of disease, increased interventions
 - Lack of support teams
 - IP staff
 - Line placement/maintenance teams
 - Daily rounding
 - Lack of resources to implement new initiatives

Infection Prevention Resources

- AAP Policy Statement: Infection Prevention and Control in Pediatric Ambulatory Settings
 - Published in Pediatrics 2017
- AAP Red Book
 - Inpatient and outpatient chapters
- CDC Healthcare Infection Control Advisory Committee (HICPAC)
 - <https://www.cdc.gov/infectioncontrol/guidelines/index.html>
- Your local infection preventionist if available

References

- Adneweg et al. Protection of COVID-19 vaccination and previous infection against Omicron BA.1, BA.2 and Delta SARS-CoV-2 infections. *Nat Commun.* 2022 Aug 12;13(1):4738
- Bailey et al. Simulating the Environmental Spread of SARS-CoV-2 via Cough and the Effect of Personal Mitigations. *Microorganisms.* 2022 Nov 12;10(11):2241
- Darby et al. COVID-19: mask efficacy is dependent on both fabric and fit. *Future Microbiol.* 2021 Jan;16:5-11
- Feigin and Cherry's Textbook of Pediatric Infectious Diseases, 8th ed. 2019
- Fischer et al. Mask adherence and rate of COVID-19 across the United States. *PLoS One.* 2021 Apr 14;16(4):e0249891
- Jefferson et al. Physical Interventions to interrupt or reduce the spread of respiratory viruses. *Cochrane Database Syst Rev.* 2023 Jan
- Jehn et al. Association Between K-12 School Mask Policies and School-Associated COVID-19 Outbreaks - Maricopa and Pima Counties, Arizona, July-August 2021. *MMWR Morb Mortal Wkly Rep.* 2021 Oct 1;70(39):1372-1373
- Jung et al. Risk of transmission of COVID-19 from healthcare workers returning to work after a 5-day isolation, and kinetics of shedding of viable SARS-CoV-2 variant B.1.1.529 (Omicron). *J Hosp Infect.* 2023 Jan;131:228-23
- Li et al. Face masks to prevent transmission of COVID-19: A systematic review and meta-analysis. *Am J Infect Control.* 2021 Jul;49(7):900-906
- Lobovits et al. Risk of illness after exposure to a pediatric office. *NEJM* 1985 Aug 15;313(7):425-8

References

- Merriman et al. Toys are a potential source of cross-infection in general practitioners' waiting rooms. *Br J Gen Pract.* 2002 Feb;52(475):138-40
- Meyerowitz et al. Transmission of SARS-CoV-2: A Review of Viral, Host, and Environmental Factors. *Ann Intern Med.* 2021 Jan;174(1):69-79
- Miller, J. The 1793 Yellow Fever Epidemic: The Washingtons, Hamilton and Jefferson. May 2020. Library of Congress
- Pappas et al. Respiratory viral RNA on toys in pediatric office waiting rooms. *Pediatr Infect Dis J.* 2010 Feb;29(2):102-4
- Quach et al. Do pediatric emergency departments pose a risk of infection? *BMC Pediatr.* 2011 Jan 7;11:2
- Rathore et al. Infection Prevention and Control in Pediatric Ambulatory Settings. *Pediatrics.* 2017 Nov;140(5):e20172857
- Rebman et al. SARS-CoV-2 Transmission to Masked and Unmasked Close Contacts of University Students with COVID-19 - St. Louis, Missouri, January-May 2021. *MMWR Morb Mortal Wkly Rep.* 2021 Sep 10;70(36):1245-1248
- Simmering et al. Are well-child visits a risk factor for subsequent influenza-like illness visits? *Infect Control Hosp Epidemiol.* 2014 Mar;35(3):251-6
- <https://covid.cdc.gov/covid-data-tracker/#pediatric-seroprevalence>