Reasons for Facial Masking for COVID-19: Transmission, Severity of Disease and Immunity

AFC Staff
September 15, 2020

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• First two reasons for facial masking: Reduce transmission to others and yourself
• Theory – To reduce the severity of illness if exposed (viral inoculum theory)
  • Virologic evidence
  • Epidemiologic evidence (does proportion of asymptomatic infection change with facial masking from typical 40%)
  • Ecologic evidence
• Could facial masking drive up rates of immunity?
• 5 reasons for decreases in mortality with COVID-19 with second wave
Facial masking

• CDC recommended cloth face coverings April 3, 2020 due to frequency of asymptomatic transmission – “protect others”

• Message updated September 2020 in California to “protect yourself and others”
Absence of Apparent Transmission of SARS-CoV-2 from Two Stylists After Exposure at a Hair Salon with a Universal Face Covering Policy — Springfield, Missouri, May 2020

“Widespread mask wearing could get pandemic under control in 4, 6, 8 weeks”-CDC Director, July 14
What would help us combat COVID-19?

- Decrease transmission
- Decrease morbidity e.g. increase rates of asymptomatic infection

Could do both

Gandhi M. *JGIM* 2020
What is rate of asymptomatic COVID-19 infection now?

40% per the CDC on July 10

• Well-done study would do mass screening in single place (preferably closed setting), regardless of symptoms and follow over time (42%)²

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¹Oran Ann Intern Med; ²Chamie G, Marquez C...Havlir D. Medrxiv 2020; CDC July 14, 2020
Masking reduces viral inoculum to which wearer exposed

- 90-95% viral particles filtered
- 65-85% viral particles filtered depending on cloth/proper use

Ample evidence from virologic, epidemiologic, ecologic studies that reducing viral inoculum (dose) reduces severity of disease

What is the evidence that reduced viral inoculum (dose) leads to less severe disease?

LD50 - Virus dose at which 50% exposed hosts die, determined via experiments in which a range of doses are administered to animals to calculate a dose-mortality curve.
Human studies show relationship between inoculum and disease severity

Many animal studies have determined LD50 for viruses; generally unethical in humans

One CID study\textsuperscript{1} gave human volunteers wild-type influenza A at different doses; higher doses led to more severe disease (more cough, shortness of breath, etc.)

2\textsuperscript{nd} CID study\textsuperscript{2} showed Switzerland soldiers didn’t get sick with distance or masks but 30% ill without

\textsuperscript{1}Memoli M CID 2015; \textsuperscript{2}Bielecki M CID 2020
Indeed, high infectious dose as we overcrowded thought to explain higher mortality over time with 1918 influenza

Influenza Infectious Dose May Explain the High Mortality of the Second and Third Wave of 1918–1919 Influenza Pandemic

A. Cristina Paulo¹, Margarida Correia-Neves¹, Tiago Domingos², Alberto G. Murta³, Jorge P

• 2nd waves usually less severe (↑ immunity) but not with influenza pandemic 1918
• Study¹ postulates that exposure to higher infectious dose with 2nd wave after May 1st, 1918 → higher mortality
• Reminiscent of 1st wave of SARS-CoV-2 before we knew about masking – more exposure to high dose; greater deaths among HCWs early,² Italy,³ NYC,⁴,⁵ household contacts⁶

¹Paolo. PLOS One 2010; ²Lai JAMA 2020; ³Grasselli JAMA 2020; ⁴Goyal NEJM 2020; ⁵Richardson JAMA 2020; ⁶Wadhera JAMA 2020
Okay, has this been shown with SARS-CoV-2?

Syrian hamsters as a small animal model for SARS-CoV-2 infection and countermeasure development

Masaki Imai, Kiyoko Iwatsuki-Horimoto, Masato Hatta, Samantha Loeber, Peter J. Halfmann, Noriko Nakajima, Tokiko Watanabe, Michiko Ujie, Kenta Takahashi, Mutsumi Ito, Shinya Yamada, Shufang Fan

Higher dose given to hamsters, more sick they became

1Imai. PNAS July 14, 2020
Okay, what about the masked hamster?

- Can’t give humans increasing doses of SARS-CoV-2
- Masked and unmasked hamster models (mask partitions) given various doses
  - Masked hamsters less likely to acquire SARS-CoV-2
  - If acquired, more mild disease

Jasper Fuk-Woo Chan, Shuofeng Yuan, Anna Jinxia Zhang, Vincent Kwok-Man Poon, Chris Chung-Sing Chan, Andrew Chak-Yiu Lee, Zhimeng Fan, Can Li, Ronghui Liang, Jianli Cao... Show more

Clinical Infectious Diseases, ciaa644, https://doi.org/10.1093/cid/ciaa644

1Chan J. CID 2020
What is the mechanism of higher viral inocula and more severe disease?

In viral infections where host immune responses play major role in pathogenesis, high doses of viral inocula can overwhelm and dysregulate innate immune defenses, increasing severity.

Downregulating “immunopathology” one mechanism of dexamethasone for severe COVID-19 disease

1 Rouse. Nature Reviews Immunology 2010; 2 RECOVERY trial NEJM July 17, 2020
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Do we see rates of asymptomatic infection increasing under “masked” conditions?

- Cruise ships good experiments - closed settings
- One of earliest estimates of asymptomatic infection rates - 18% from Diamond Princess\(^1\), 40% overall is estimate from CDC\(^2\)
- Later ship (Argentina) had outbreak and gave surgical masks to all passengers, N95 masks to all crew\(^3\): 128 of 217 passengers and staff eventually tested positive for SARS-CoV-2, but majority (81%) remained asymptomatic\(^3\)
- Pediatrics HD unit in Indiana with masks - all conversions without symptoms\(^4\)
- 95% asymptomatic in outbreaks in Oregon seafood plant\(^5\) and Arkansas Tyson chicken plant\(^6\) where workers issued masks (prior to that much more illness)

\(^1\)Mizumoto Eur. Surv. 2020; \(^2\)CDC July 14, 2020; \(^3\)Ing. BMJ Thorax 2020; \(^4\)Hains JAMA 2020; \(^5\)Clins S. AP 6/9/20; \(^6\)Keegan USA Today 6/27/20
Seroprevalence of SARS-CoV-2 Among Frontline Health Care Personnel in a Multistate Hospital Network — 13 Academic Medical Centers, April–June 2020

Community and Close Contact Exposures Associated with COVID-19 Among Symptomatic Adults ≥18 Years in 11 Outpatient Health Care Facilities — United States, July 2020

**Bottom line:** In HCWs (universally masking), antibody testing shows a lot of infection that went undetected (Sept 4, 2020)

**Bottom line:** Case control study - setting where masks not worn (restaurants) associated with more symptomatic disease (Sept 11)
Do we see rates of asymptomatic infection increasing under “masked” conditions?

• Ecologically, seems true
• In countries accustomed to masking since SARS (Hong Kong, Taiwan, Thailand, South Korea, Singapore, Vietnam), cases up with opening but not deaths
• Czech Republic mandated facial masking March 23; cases would go up with opening; flat deaths (352 total); now relaxed masking May 11
Ecologic evidence? Mortality in selected U.S. cities

<table>
<thead>
<tr>
<th>City</th>
<th>Cases/1,000</th>
<th>Deaths/100,000</th>
<th>Death per case (%)</th>
<th>Mask mandate</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco</td>
<td>11.2</td>
<td>9.7</td>
<td>0.87</td>
<td>April 17</td>
</tr>
<tr>
<td>Miami</td>
<td>58.9</td>
<td>95.7</td>
<td>1.63</td>
<td>July 2</td>
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<td>Atlanta</td>
<td>23.8</td>
<td>49.9</td>
<td>2.09</td>
<td>July 8</td>
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<tr>
<td>Los Angeles</td>
<td>23.6</td>
<td>57.1</td>
<td>2.42</td>
<td>June 18</td>
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<tr>
<td>Denver</td>
<td>18.4</td>
<td>69.5</td>
<td>3.77</td>
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<td>Boston</td>
<td>28.5</td>
<td>137.6</td>
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<tr>
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<td>20.1</td>
<td>86.7</td>
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<td>Seattle</td>
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<td>32.5</td>
<td>3.68</td>
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<tr>
<td>New York City</td>
<td>27.4</td>
<td>281.3</td>
<td>10.26</td>
<td></td>
</tr>
</tbody>
</table>

Highest death rates occurred before masking recommended by CDC or mask mandates as of September 4, 2020

Courtesy of Dr. Jim Marks, ZSFGH
One model shows – after lockdown lifts - universal masking will keep death rates low

Social distancing after lockdown ends on 31 May:
- Estimated deaths: 1,160,000

Lockdown instead of universal masking continues indefinitely:
- Estimated deaths: 180,000

50% masking by 30 Apr, SD continues after lockdown is lifted on 31 May:
- Estimated deaths: 240,000

80% masking by 30 Apr, SD continues after lockdown is lifted on 31 May:
- Estimated deaths: 60,000

-Lowest death rate requires 80% compliance rate with masking
-Lockdown is a blunt instrument but masking takes behavior change

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Remember immunity is antibodies and cell-mediated

- **Memory T cells**: CD8+ T cell (Cytotoxic, kills cells) and CD4+ T cell (Many types, can help activate or dampen immune response)
- **Memory B cells**: Plasma cell (Makes antibodies)

Accumulating data that asymptomatic/mild infection $\rightarrow$ strong T-cell (and memory B-cell) immunity
Asymptomatic infection and immunity

• Hopeful studies on strong T-cell and B-cell immunity developing with asymptomatic/mild infection over past 4 weeks\textsuperscript{1-5}
• No re-infection in macaques after challenge\textsuperscript{4}
• Beyond hopeful T-cell and B-cell data, the strongest indicator of some immunity we have at this point is that there have been very few CASES OF RE-INFECTION OUT THERE (Hong Kong, Nevada, Europe) with so much circulating virus out there x 9 months (28 million cases and counting)
• Greater population-level immunity will slow down viral spread by definition

\textsuperscript{3}Rodda Nature 2020; \textsuperscript{2}Sekine Cell 2020; \textsuperscript{3}Neidleman. Cell Reports Med 2020; \textsuperscript{4}Chandrashekar Science 2020; \textsuperscript{5}Gudbjartsson NEJM 2020; \textsuperscript{6}Gandhi NEJM 2020
Any public health measure that could increase the proportion of asymptomatic SARS-CoV-2 infections may both make the infection less deadly and increase population-wide immunity without severe illnesses and deaths….would be beneficial.
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Data from U.S.

NCHS Mortality Reporting System:
Pneumonia, Influenza and COVID-19 Mortality
Data through the week ending August 29, 2020, as of September 3, 2020

- First wave April-May
- Continuation of first wave, July-August
Data from Germany

March 3

August 31
Data from Spain

Very strong rebound in cases since late June. Nine weeks later, Deaths did not follow. Only a minor increase of daily deaths in August, up to an average of 18/day.
Data from the UK
5 possible reasons for decreasing mortality

*Younger Age?
*Better infection control/testing SNFs/ vulnerable at beginning
*Population-wide masking?
*Population-level immunity?
*Better treatments, preparedness

Although, in Germany, falling mortality in all age groups
How do we increase mask-wearing in a non-judgmental harm reduction manner?

• In the way that HIV doctors and staff always do, how do we apply harm reduction and non-judgmental messaging?
Conclusion

- Facial masking reduces transmission, may reduce severity of disease by reducing severity of infection, and may increase population-level immunity
- Pillar of pandemic control for now
- Mortality may be decreasing due to masking and certainly from better treatments – more study needed