The Scientific Basis for Delivering Oral Health Care During COVID-19

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Disclaimer: I have no conflict of interests
Objectives:

• Protections against the risks of respiratory disease transmission
• Risks of COVID-19 transmission in oral health care settings

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• Effectiveness of our current level of protections
• Risks from COVID-19 to oral health care workers
Patient visits at EIOH

March 16 to June 5: 5679
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Increased levels of protection against an infectious respiratory disease

Transmission source control
1. Pre- and onsite screening to avoid seeing suspected or conformed COVID-19 cases
2. Pre-rinse with antimicrobial mouth rinses

Direct protection against droplets and aerosols
N95 masks + eye protection goggles, or surgical face masks + full face shield,

Indirect protection against contact with contaminated objects (fomites)
Gloves, isolation gowns, head coverings, hand hygiene

Prior to COVID-19: STANDARD PRECAUTION
Level I masks, eye protection goggles, gloves, isolation gowns, hand hygiene

During COVID-19: TRANSMISSION-BASED PRECAUTION
N95 Masks or level III masks, face shields, eye protection goggles, gloves, isolation gowns, hand hygiene, head coverings. Plus enhanced administrative and engineering control measures
Effectiveness of protection
  o Shortage of PPE, especially N95 mask
  o Uncertain effectiveness of PPE: How effective is the N95?

Unknows of a novel respiratory infectious disease
  o Probability of transmission from an asymptomatic patient in healthcare settings?
  o Outcomes of the disease – probability of becoming symptomatic and dying from an infection acquired from an asymptomatic patient
  o Other factors that may affect disease transmission
    o Underlying conditions
    o Saliva viral load
    o Other PPE
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Heightened anxiety among dental healthcare professionals – shortage of PPE
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Heightened anxiety among dental healthcare professionals – shortage of PPE
Effectiveness of protection

- Shortage of PPE, especially N95 mask: Available now
- Uncertain effectiveness of PPE: How effective is the N95?

Unknowns of a novel respiratory infectious disease

- Probability of transmission from an asymptomatic patient in healthcare settings?
- Outcomes of the disease – probability of becoming symptomatic and dying from an infection acquired from an asymptomatic patient
- Other factors that may affect disease transmission
  - Underlying conditions
  - Saliva viral load
  - Other PPE
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PPE: effective and adequate against SARS-CoV-2?

N95 Masks: experimental evidence

Assessment of a respiratory face mask for capturing air pollutants and pathogens including human influenza and rhinoviruses

S. Steve Zhou¹, Salimatu Lukula¹, Cory Chiossone¹, Raymond W. Nims³, Donna B. Suchmann¹, M. Khalid Ijaz¹,²

*Thorac Dis 2018;10(3):2029-2069

Influenza A virus: RNA virus, 110nm
Rhinovirus: RNA virus, 25nm
SARS-CoV-2 virus: RNA virus, 120nm

Conclusions:
>99.7% efficiency of each test mask for exclusion of influenza A virus, rhinovirus 14, and S. aureus

>99.3% efficiency for paraffin oil and sodium chloride (pm2.5)
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N95 Masks: clinical evidence

Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis

Derek K Chu, Ellis A Akl, Stephanie Duda, Karlis Soh, Sally Vassiliou, Hugy J Schievenmann, et al. (on behalf of the COVID-19 Systematic Urgent Review Group) (EURG) study authors

Summary

Background Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causes COVID-19 and is spread person-to-person through close contact. We aimed to investigate the effects of physical distance, face masks, and eye protection on virus transmission in health-care and non-health-care (eg, community) settings.

Methods We did a systematic review and meta-analysis to investigate the protective effects for avoiding person-to-person virus transmission and to assess the use of face masks and eye protection to prevent transmission of viruses. We obtained data for SARS-CoV-2 and the betacoronaviruses that cause severe acute respiratory syndrome, and Middle East respiratory syndrome from 21 standard WHO-specific and COVID-19-specific sources. We searched these data sources from database inception to May 3, 2020, with no restriction by language, for comparative studies, and for context factors of acceptability, feasibility, resource use, and equity. We screened records, extracted data, and assessed risk of bias in duplicate. We did frequentist and Bayesian meta-analyses and random-effects meta-regressions. We rated the certainty of evidence according to Cochrane methods and the GRADE approach. This study is registered with PROSPERO, CRD42020177704.

Findings Our search identified 172 observational studies across 16 countries and six continents, with no randomised controlled trials and 44 relevant comparative studies in health-care and non-health-care settings (n=2679 patients). Transmission of viruses was lower with physical distancing of 1 m or more, compared with a distance of less than 1 m (n=10736), pooled adjusted odds ratio (OR) 0.38, 95% CI 0.39 to 0.38, risk difference (RD) 10–256, 95% CI –11.5 to –7.5, moderate certainty); protection was increased as distance was lengthened (change in relative risk (RR) 2-0.2 per m, p<0.001-0.04; moderate certainty). Face mask use could result in a large reduction in risk of infection (n=2647); AOR 0.15, 95% CI 0.07 to 0.34, RD 14.1%, 95% CI 1.5 to 27.7%, low certainty); with stronger associations with N95 or similar respirators compared with disposable surgical masks or similar (eg, reusable 12-layer cotton masks; p<0.001, posterior probability >95%, low certainty). Eye protection also was associated with less infection (n=3713); OR 0.22, 95% CI 0.12 to 0.39, RD 10.4%, 95% CI 1.2 to 7.5%; low certainty). Unadjusted studies and subgroup and sensitivity analyses showed similar findings.

Interpretation The findings of this systematic review and meta-analysis support physical distancing of 1 m or more, and provide quantitative estimates for models and contact tracing to inform policy. Optimum use of face masks, respirators, and eye protection in public health-care settings should be informed by these findings and contextual factors. Robot randomised trials are needed to better inform the evidence for these interventions, but this systematic appraisal of currently best available evidence might inform interim guidance.

Funding World Health Organization.

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Table: Evidence on face mask use

<table>
<thead>
<tr>
<th>Face mask type</th>
<th>Relative risk (95% CI)</th>
<th>P value</th>
<th>Study setting</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical mask</td>
<td>0.41 (0.35 to 0.49)</td>
<td>&lt;0.001</td>
<td>Health-care</td>
<td>Adjusted for age, gender, and interaction with others.</td>
</tr>
<tr>
<td>N95 mask</td>
<td>0.13 (0.09 to 0.19)</td>
<td>&lt;0.001</td>
<td>Health-care</td>
<td>Adjusted for age, gender, and interaction with others.</td>
</tr>
<tr>
<td>Other mask</td>
<td>0.27 (0.19 to 0.38)</td>
<td>&lt;0.001</td>
<td>Health-care</td>
<td>Adjusted for age, gender, and interaction with others.</td>
</tr>
</tbody>
</table>

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Figure: Forest plot showing unadjusted estimates for the association of face mask use with viral infection causing COVID-19, SARS, or MERS

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N95 masks may not be wise

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Reducing risk of infection with N95 masks.

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Effectiveness of N95 masks in reducing risk of infection.

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Relationship between N95 mask use and infection risk.
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N95 Masks: clinical evidence against COVID-19 in health care settings

**Findings:**

Among physicians (ID, ICU, neurosurgery) with close contact with symptomatic COVID-19 patients:

- Infection rate without N95 masks: 132/4670 = 2.83%
- Infection rate with N95 masks: 1/1636 = 0.061%

N95 masks is highly effective in preventing COVID-19.
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#### Surgical Masks: compared to N95 masks

<table>
<thead>
<tr>
<th>Mask Type</th>
<th>Standards</th>
<th>Filtration Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Use Face Mask</td>
<td>China: YY/T0969</td>
<td>3.0 Microns ≥95% 0.1 Microns X</td>
</tr>
<tr>
<td>Surgical Mask</td>
<td>China: YY 0469</td>
<td>3.0 Microns ≥95% 0.1 Microns ≥30%</td>
</tr>
<tr>
<td>USA: ASTM F2100</td>
<td>Level 1</td>
<td>3.0 Microns ≥95% 0.1 Microns ≥95%</td>
</tr>
<tr>
<td></td>
<td>Level 2</td>
<td>3.0 Microns ≥98% 0.1 Microns ≥98%</td>
</tr>
<tr>
<td></td>
<td>Level 3</td>
<td>3.0 Microns ≥99% 0.1 Microns ≥99%</td>
</tr>
<tr>
<td>Europe: EN 14683</td>
<td>Type I</td>
<td>3.0 Microns ≥95% 0.1 Microns ≥95%</td>
</tr>
<tr>
<td></td>
<td>Type II</td>
<td>3.0 Microns ≥98% 0.1 Microns ≥98%</td>
</tr>
<tr>
<td></td>
<td>Type III</td>
<td>3.0 Microns ≥99% 0.1 Microns ≥99%</td>
</tr>
<tr>
<td>Respirator Mask</td>
<td>USA: NIOSH (42 CFR 84)</td>
<td>N95 / KN95</td>
</tr>
<tr>
<td></td>
<td>China: GB2626</td>
<td>N99 / KN99, N100 / KN100</td>
</tr>
<tr>
<td>Europe: EN 149:2001</td>
<td>FFP1</td>
<td>0.3 Microns ≥95%</td>
</tr>
<tr>
<td></td>
<td>FFP2</td>
<td>0.3 Microns ≥99%</td>
</tr>
<tr>
<td></td>
<td>FFP3</td>
<td>0.3 Microns ≥99% 0.3 Microns ≥99%</td>
</tr>
</tbody>
</table>

**3.0 Microns**: Bacteria Filtration Efficiency standard (BFE).

**0.1 Microns**: Particle Filtration Efficiency standard (PFE).

**0.3 Microns**: Used to represent the most penetrating particle size (MPPS), which is the most difficult size particle to capture.

X: No requirements.

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**No tight seal** (Protect others)

**Tight peripheral seal** (Protect self)

N95 masks perform significantly better in laboratory tests in protecting the wearer.
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Surgical Masks: compared to N95 masks in respiratory protection in clinical settings

Surgical mask vs N95 respirator for preventing influenza among health care workers: a randomized trial.

Table 2. Comparison of Laboratory-Confirmed Influenza Between the Surgical Mask and N95 Respirator Groups

<table>
<thead>
<tr>
<th>No. (%)</th>
<th>Surgical Mask (n = 212)</th>
<th>N95 Respirator (n = 210)</th>
<th>Absolute Risk Difference, % (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory-confirmed influenza</td>
<td>50 (23.6)</td>
<td>48 (22.9)</td>
<td>-0.73 (-8.8 to 7.3)</td>
<td>.96</td>
</tr>
<tr>
<td>RT-PCR influenza A</td>
<td>5 (2.4)</td>
<td>1 (0.5)</td>
<td>-1.88 (-4.13 to 0.38)</td>
<td>.22</td>
</tr>
<tr>
<td>RT-PCR influenza B</td>
<td>1 (0.5)</td>
<td>3 (1.4)</td>
<td>0.96 (-0.89 to 2.61)</td>
<td>.37</td>
</tr>
<tr>
<td>4x-Fold rise in serum titers A/Adelaide/55/2007 (H1N1)</td>
<td>25 (11.8)</td>
<td>21 (10)</td>
<td>-1.79 (-7.73 to 4.19)</td>
<td>.55</td>
</tr>
<tr>
<td>4x-Fold rise in serum titers A/Brisbane/10/2007 (H3N2)</td>
<td>42 (19.8)</td>
<td>40 (23.9)</td>
<td>3.02 (-4.82 to 11.89)</td>
<td>.38</td>
</tr>
<tr>
<td>4x-Fold rise in serum titers A/Brisbane/10/2007 (H3N2)</td>
<td>15 (7.1)</td>
<td>19 (9.0)</td>
<td>2.0 (-3.0 to 7.17)</td>
<td>.46</td>
</tr>
<tr>
<td>4x-Fold rise in serum titers B/Florida/4/2006a</td>
<td>17 (8.0)</td>
<td>25 (11.9)</td>
<td>3.89 (-1.82 to 9.59)</td>
<td>.18</td>
</tr>
</tbody>
</table>

Table 3. Comparison of RT-PCR Results for Other Respiratory Viruses Between the Surgical Mask and N95 Respirator Groups

<table>
<thead>
<tr>
<th>No. (%)</th>
<th>Surgical Mask (n = 212)</th>
<th>N95 Respirator (n = 210)</th>
<th>Absolute Risk Difference, % (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory syncytiot virus</td>
<td>2 (0.9)</td>
<td>1 (0.5)</td>
<td>-0.47 (-2.07 to 1.13)</td>
<td>&gt;.99</td>
</tr>
<tr>
<td>Metapneumovirus</td>
<td>1 (0.5)</td>
<td>3 (1.4)</td>
<td>-0.46 (-1.98 to 2.89)</td>
<td>&gt;.99</td>
</tr>
<tr>
<td>Parainfluenza virusb</td>
<td>1 (0.5)</td>
<td>2 (1.0)</td>
<td>0.48 (-1.12 to 2.09)</td>
<td>.82</td>
</tr>
<tr>
<td>Rhinovirus-enterovirus</td>
<td>8 (3.8)</td>
<td>10 (4.8)</td>
<td>0.99 (-2.87 to 4.85)</td>
<td>.62</td>
</tr>
<tr>
<td>Coronavirusc</td>
<td>9 (4.3)</td>
<td>12 (5.7)</td>
<td>1.47 (-2.68 to 5.62)</td>
<td>.49</td>
</tr>
<tr>
<td>Total</td>
<td>20 (9.4)</td>
<td>22 (10.5)</td>
<td>1.04 (-4.67 to 6.76)</td>
<td>.72</td>
</tr>
</tbody>
</table>

Conclusion: Use of a surgical mask compared with an N95 masks resulted in noninferior rates of laboratory confirmed influenza in health care workers.
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**Surgical Masks: compared to N95 masks**

Effectiveness of N95 respirators versus surgical masks in protecting health care workers from acute respiratory infection: a systematic review and meta-analysis.


**Table 1: Characteristics of studies included in the meta-analysis**

<table>
<thead>
<tr>
<th>Study</th>
<th>Setting</th>
<th>Participants</th>
<th>Outcomes</th>
<th>Interventions</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loeh et al. 2009</td>
<td>8 hospitals in Ontario, Canada. emergency departments, acute medical units, and pediatric units</td>
<td>446 nurses, individual-level randomization</td>
<td>Laboratory-confirmed respiratory infection, influenza-like illness, work-related absenteeism</td>
<td>Intervention: fit-tested N95 respirator, control: targeted use, surgical mask</td>
<td>No neoplasms or trials for N95 respirator, respiratory syncytial virus metapneumovirus, parainfluenza viruses, rhinovirus, coronavirus, and adenovirus.</td>
</tr>
<tr>
<td>MacIntyre et al. 2011, 2013</td>
<td>15 hospitals in Beijing, emergency departments and respiratory wards</td>
<td>1411 nurses and ward clerks, cluster-randomization by ward</td>
<td>Laboratory-confirmed respiratory infection, influenza-like illness</td>
<td>Intervention 1: continual use, fit-tested N95 respirator</td>
<td>Detection of influenza A and B, respiratory syncytial virus metapneumovirus, parainfluenza viruses, rhinovirus, coronavirus, adenovirus, respiratory syncytial virus, coronaviruses, 1, parainfluenza virus, and adenovirus.</td>
</tr>
<tr>
<td>MacIntyre et al. 2011, 2013</td>
<td>16 hospitals in Beijing, emergency departments and respiratory wards</td>
<td>1669 nurses and ward clerks, cluster-randomization by ward</td>
<td>Laboratory-confirmed respiratory infection, influenza-like illness</td>
<td>Intervention 1: continual use, fit-tested N95 respirator</td>
<td>Detection of influenza A and B, respiratory syncytial virus metapneumovirus, parainfluenza viruses, rhinovirus, coronavirus, adenovirus, parainfluenza virus, and adenovirus.</td>
</tr>
<tr>
<td>Cohort study</td>
<td>43 nurses in Ontario coronary care units and ICUs with SARS patients</td>
<td>Laboratory-confirmed respiratory infection</td>
<td>Intervention: N95 respirator, control: surgical mask</td>
<td>Retrospective</td>
<td>Only 20 nurses reported exposure and consistent use of face protective equipment.</td>
</tr>
<tr>
<td>Case-control studies</td>
<td>5 hospitals in Hong Kong, emergency departments and medicine units</td>
<td>13 infected (cases) and 261 noninfected (controls) nurses, doctors, health care assistants and domestic staff</td>
<td>Laboratory-confirmed respiratory infection</td>
<td>N95 respirator, surgical mask</td>
<td>No cases in N95 respirator or surgical mask groups</td>
</tr>
<tr>
<td>Zhang et al. 2012</td>
<td>25 hospitals in Beijing, emergency departments, respiratory wards, ICUs, outpatient departments, technical clinic departments, and management</td>
<td>51 infected (cases) and 204 noninfected (controls) nurses, technicians and other</td>
<td>Laboratory-confirmed respiratory infection</td>
<td>N95 respirator, surgical mask, cloth mask</td>
<td>Cases and controls matched 1:4 by hospital, ward, age and sex.</td>
</tr>
</tbody>
</table>

**Conclusion:** Although N95 masks appeared to have a protective advantage over surgical masks in laboratory settings, clinical data did not show N95 masks are superior to surgical masks in protecting health care workers against transmissible acute respiratory infections in clinical settings.
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N95 Masks, Surgical Masks: summary

- Infection rate without N95 masks: 132/4670 = 2.83%
- Infection rate with N95 masks: 1/1636 = 0.061%
- N95 masks are highly effective in preventing COVID-19 transmission
- Inferior to N95 in laboratory testing due to lack of tight peripheral seal
- Not inferior to N95 in protection against infectious respiratory diseases in clinical settings
Effectiveness of protection

- Shortage of PPE, especially N95 mask: Available now
- Uncertain effectiveness of PPE: N95 mask is very effective

Unknowns of a novel respiratory infectious disease

- Probability of transmission from an asymptomatic patient in healthcare settings?
- Outcomes of the disease – probability of becoming symptomatic and dying from an infection acquired from an asymptomatic patient
- Other factors that may affect disease transmission
  - Underlying conditions
  - Saliva viral load
  - Other PPE
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Risk of COVID-19 transmission in health care settings

• COVID-19 is has high transmissibility in household (10.5-18.0%) and community (0.45-0.73%) settings (Burke et al 2020, Chen et al 2020)

• COVID-19 transmission is lower in health care settings, but many clusters have been reported in several countries (>3000 in China, 6000 in Italy, 9000 in US)

• There is no publication of confirmed transmission of COVID-19 in dental offices
  • Dr. Zhuan Bian, Dean of WHU School of Stomatology reported in last week’s AADR webinar (July 29, 2020) two clusters of suspected COVID-19 transmission in late January, 2020
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Prevalence of asymptomatic COVID-19 cases

Proportion of asymptomatic and pre-symptomatic cases among COVID-19 patients

40-45% in representative sampling studies

Oran DP, Topol EJ. Prevalence of Asymptomatic SARS-CoV-2 Infection. Annals of Internal Medicine. 2020;doi.org/10.7326/M20-3012(0)

Prevalence of asymptomatic and pre-symptomatic cases in the local community

Iceland 43/13080 0.33%
Vo, Italy 30/2812 1.07%
Indiana, US 35/4611 0.76%
San Francisco, US 39/4160 0.94%
Wuhan, China 300/9.9m 0.003%
Mudanjiang, China 19/658772 0.003%
URMC, Rochester, NY 259/18281 1.4%

Table: Summary of SARS-CoV-2 Testing Studies

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Tested, n</th>
<th>SARS-CoV-2 Positive, n (%)</th>
<th>Positive but Asymptomatic, n (%)</th>
<th>Notes*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iceland residents (6)</td>
<td>13 000</td>
<td>100 (0.8)</td>
<td>43 (43.0)</td>
<td>R</td>
</tr>
<tr>
<td>Vo, Italy residents (7)</td>
<td>5155</td>
<td>102 (2.0)</td>
<td>43 (82.2)</td>
<td>R, L</td>
</tr>
<tr>
<td>Diamond Princess cruise ship passengers and crew (8)</td>
<td>3711</td>
<td>712 (19.2)</td>
<td>331 (46.5)</td>
<td>-</td>
</tr>
<tr>
<td>Boston homeless shelter occupants (9)</td>
<td>408</td>
<td>147 (36.0)</td>
<td>129 (87.8)</td>
<td>-</td>
</tr>
<tr>
<td>New York City hospital patients (11)</td>
<td>214</td>
<td>33 (15.4)</td>
<td>29 (87.9)</td>
<td>L</td>
</tr>
<tr>
<td>U.S.S. Theodore Roosevelt aircraft carrier crew (12)</td>
<td>4954</td>
<td>856 (17.3)</td>
<td>500 (58.4)</td>
<td>L</td>
</tr>
<tr>
<td>Japanese citizens evacuated from Wuhan, China (2)</td>
<td>555</td>
<td>13 (2.3)</td>
<td>4 (38.1)</td>
<td>L</td>
</tr>
<tr>
<td>Greek citizens evacuated from the United Kingdom, Spain, and Turkey (14)</td>
<td>783</td>
<td>40 (5.1)</td>
<td>35 (87.5)</td>
<td>L</td>
</tr>
<tr>
<td>Charles de Gaulle aircraft carrier crew (13)</td>
<td>1760</td>
<td>1066 (59.4)</td>
<td>500 (47.8)</td>
<td>E</td>
</tr>
<tr>
<td>Los Angeles homeless shelter occupants (10)</td>
<td>178</td>
<td>43 (24.2)</td>
<td>27 (62.8)</td>
<td>-</td>
</tr>
<tr>
<td>King County, Washington, nursing facility residents (15)</td>
<td>76</td>
<td>48 (62.2)</td>
<td>31 (43.3)</td>
<td>L</td>
</tr>
<tr>
<td>Arkansas, North Carolina, Ohio, and Virginia inmates (16)</td>
<td>4693</td>
<td>3277 (69.8)</td>
<td>3146 (76.8)</td>
<td>L</td>
</tr>
<tr>
<td>New Jersey university and hospital employees (17)</td>
<td>829</td>
<td>41 (4.9)</td>
<td>27 (65.9)</td>
<td>-</td>
</tr>
<tr>
<td>Indiana residents (18)</td>
<td>4611</td>
<td>79 (1.7)</td>
<td>35 (44.8)</td>
<td>R</td>
</tr>
<tr>
<td>Argentine cruise ship passengers and crew (19)</td>
<td>217</td>
<td>128 (58.6)</td>
<td>104 (81.3)</td>
<td>-</td>
</tr>
<tr>
<td>San Francisco residents (29)</td>
<td>4160</td>
<td>74 (1.8)</td>
<td>39 (52.7)</td>
<td>-</td>
</tr>
</tbody>
</table>

* - estimated from incomplete source data; L - longitudinal data collected; R - representative sample.
† - a dash indicates that the study did not have a representative sample, collected no longitudinal data, and did not require estimation of missing data.
* - clarified via e-mail communication with co-author.
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Risk of COVID-19 transmission from asymptomatic cases

The epidemiological characteristics of infection in close contacts of COVID-19 in Ningbo city

Chen Yi, Wang Aihong, Yi Bo, Ding Keqin, Wang Haibo, Wang Jianmei, Shi Hongbo, Wang Sijia,
Comparison of Transmissibility of Coronavirus Between Symptomatic and Asymptomatic Patients: Reanalysis of the Ningbo COVID-19 Data

Guosheng Yin, PhD; Huangjing Jin, BSc

The relative transmissibility of asymptomatic COVID-19 infections among close contacts

Daihai He,*, Shi Zhao,*, Qiandyi Lin,*, Zhan Zhuang,*, Peihua Gao,*, Maggie H. Wang,*, Lin Yang,*

Suppression of a SARS-CoV-2 outbreak in the Italian municipality of Vo’

Enrico Lavezzo, Elisa Franchin, [...] Andrea Crisanti

A study on infectivity of asymptomatic SARS-CoV-2 carriers

Ming Gao,*, Libai Yang,*, Xuefu Chen,*, Yiu Y Deng,*, Shifang Yang,*, Hanyi Xu,*, Zixing Chen,*, Xinglin Gao,*,

Rates of COVID-19 transmission (households/community):

Rate of transmission from symptomatic patients to close contacts: = 6.30%
Rate of transmission from asymptomatic patients to close contacts: = 4.11%

Rate of transmission from asymptomatic in healthcare settings: 0.0% (Gao et al, 2020, Chen et al, 2020)

Second generation transmission:

R₀ for infection acquired from symptomatic cases: 0.78
R₀ for infection acquired from asymptomatic cases: 0.20

Probability for infection acquired from symptomatic patient becoming symptomatic: 85%
Probability for infection acquired from asymptomatic patient becoming symptomatic: 50%
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Risk of COVID-19 transmission from asymptomatic cases: summary

Proportion of asymptomatic/pre-symptomatic cases: 40%

Prevalence of asymptomatic/pre-symptomatic cases: 0.33% - 1.0% at peak, 0.003% after lockdown

Rates of COVID-19 transmission (households/community):
Rate of transmission from symptomatic patients to close contacts: 6.30%
Rate of transmission from asymptomatic patients to close contacts: 4.11%

Rate of transmission from asymptomatic in healthcare settings: 0.0%

Second generation transmission:
Probability for infection acquired from symptomatic patient becoming symptomatic: 85%
Probability for infection acquired from asymptomatic patient becoming symptomatic: 50%
Effectiveness of protection

- Shortage of PPE, especially N95 mask: Available now
- Uncertain effectiveness of PPE: N95 mask is very effective

Unknowns of a novel respiratory infectious disease

- Probability of transmission from an asymptomatic patient in healthcare settings? Likely 0, at most 4.11%
- Outcomes of the disease – probability of becoming symptomatic and dying from an infection acquired from an asymptomatic patient
- Other factors that may affect disease transmission
  - Underlying conditions
  - Saliva viral load
  - Other PPE
## Delivering oral health care during COVID-19

### Infection fatality rate of COVID-19 patients

<table>
<thead>
<tr>
<th>Case Fatality Rate</th>
<th>Infection Fatality Rate</th>
<th>Infection Fatality Rate - Symptomatic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CFR</strong></td>
<td><strong>IFR</strong></td>
<td><strong>IFR-S</strong></td>
</tr>
<tr>
<td>Deaths/Diagnosed</td>
<td>Deaths/Infected</td>
<td>Deaths/Infected-symptomatic</td>
</tr>
<tr>
<td>3.89% (global)</td>
<td>0.65% (CDC)</td>
<td>1.30% (Basu 2020, US data)</td>
</tr>
<tr>
<td>3.38% (US) (JHU Data)</td>
<td>0.26% (Ioanninis 2020)</td>
<td>0.60% (WHO)</td>
</tr>
<tr>
<td>0.75% (Meyerowitz-Katz 2020)</td>
<td>1.04% (Grewelle 2020)</td>
<td>1.04% (Grewelle 2020)</td>
</tr>
</tbody>
</table>

### Age-adjusted Infection Fatality Rate

<table>
<thead>
<tr>
<th>Region</th>
<th>Age group</th>
<th>Population Fraction</th>
<th>Mortality Rate in %</th>
<th>Fraction of COVID-19 (reported deaths)</th>
<th>Fraction of Total Deaths</th>
<th>IFR in % (lower limit)</th>
<th>IFR in % from DP mean (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lombardia</td>
<td>30-39</td>
<td>0.120</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.01</td>
<td>0.01 (0.00-0.02)</td>
</tr>
<tr>
<td></td>
<td>40-49</td>
<td>0.161</td>
<td>0.11</td>
<td>0.01</td>
<td>0.07</td>
<td>0.03</td>
<td>0.04 (0.02-0.08)</td>
</tr>
<tr>
<td></td>
<td>50-59</td>
<td>0.159</td>
<td>0.28</td>
<td>0.04</td>
<td>0.026</td>
<td>0.11</td>
<td>0.17 (0.08-0.30)</td>
</tr>
<tr>
<td></td>
<td>60-69</td>
<td>0.120</td>
<td>0.75</td>
<td>0.11</td>
<td>0.083</td>
<td>0.46</td>
<td>0.70 (0.35-1.26)</td>
</tr>
<tr>
<td></td>
<td>70-79</td>
<td>0.101</td>
<td>2.10</td>
<td>0.28</td>
<td>0.250</td>
<td>1.65</td>
<td>2.53 (1.26-4.52)</td>
</tr>
<tr>
<td></td>
<td>80-89</td>
<td>0.060</td>
<td>6.60</td>
<td>0.41</td>
<td>0.417</td>
<td>4.65</td>
<td>7.12 (3.55-12.74)</td>
</tr>
<tr>
<td></td>
<td>≥ 90</td>
<td>0.012</td>
<td>18.80</td>
<td>0.15</td>
<td>0.215</td>
<td>11.42</td>
<td>17.50 (8.72-31.83)</td>
</tr>
</tbody>
</table>

**Table 2. Age distribution of fatalities and IFR**: We show the age-distribution of reported COVID-19 and our estimation of excess mortality for Lombardia, Bergamo and Emilia-Romagna, and the corresponding IFR estimates - the lower limit and estimated IFR from normalizing 70-89 IFR to DP princess data, as explained in the text. The errors are small for fraction of Total Deaths and IFR lower limit, and we report 95% for IFR from DP. We also show age fraction and yearly mortality for 2017: the latter traces IFR above age of 60 within 20%. Age averaged yearly mortality rate is 0.98% for Lombardia, 0.91% for Bergamo, and 1.13% for Emilia-Romagna. We also show Crude Mortality Rate per year, which traces IFR above age of 60 to within 20%.

**Figure 4**: Assessing Age-Specific IFRs from Other U.S. Locations

## Delivering oral health care during COVID-19

What is the probability for a dentist to get infected by a patient who is asymptomatic, become symptomatic, and die from COVID-19?

### Parameters values used in the risk calculations.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence of asymptomatic cases in the community(^a)</td>
<td>1.40 %</td>
</tr>
<tr>
<td>Transmission rate from asymptomatic cases in the community(^20, 50)</td>
<td>4.11 %</td>
</tr>
<tr>
<td>Transmission rate from symptomatic cases in the community(^20, 50)</td>
<td>6.30 %</td>
</tr>
<tr>
<td>Transmission rate from symptomatic cases in healthcare settings without PPE(^20, 29, 31–33)</td>
<td>2.83 %</td>
</tr>
<tr>
<td>Transmission rate from symptomatic cases in healthcare settings with PPE(^20, 29, 31–33)</td>
<td>0.061 %</td>
</tr>
<tr>
<td>Transmission rate from asymptomatic cases in healthcare settings with PPE (^24, 26–28)(^20, 50)</td>
<td>0.0398 %</td>
</tr>
<tr>
<td>Proportion of infections acquired from symptomatic cases becomes symptomatic(^20, 50)</td>
<td>85 %</td>
</tr>
<tr>
<td>Proportion of infections acquired from asymptomatic cases becomes symptomatic(^20, 50)</td>
<td>50 %</td>
</tr>
<tr>
<td>Infection fatality rate (global, includes asymptomatic) (^53)</td>
<td>1.04 %</td>
</tr>
<tr>
<td>Infection fatality rate (US, symptomatic only) (^463)</td>
<td>1.30 %</td>
</tr>
</tbody>
</table>

### Formulas for daily and annul risk calculations.

<table>
<thead>
<tr>
<th>Event</th>
<th>Daily risk</th>
<th>Annual risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contacting at least one asymptomatic patient</td>
<td>1 - (p_0^m)</td>
<td>1 - (p_0^m)</td>
</tr>
<tr>
<td>Getting Infected without PPE</td>
<td>1 - (p_1)</td>
<td>1 - (p_1)</td>
</tr>
<tr>
<td>Getting Infected with PPE</td>
<td>1 - (p_1(1-e)^m)</td>
<td>1 - (p_1(1-e)^m)</td>
</tr>
<tr>
<td>Becoming symptomatic with PPE</td>
<td>(s_1(1-p_1(1-e)^m))</td>
<td>(s_1(1-p_1(1-e)^m))</td>
</tr>
<tr>
<td>Dying from the disease in age group (a)</td>
<td>(d_a s_1(1-p_1(1-e)^m))</td>
<td>(d_a s_1(1-p_1(1-e)^m))</td>
</tr>
</tbody>
</table>

\(p_0\) the prevalence of asymptomatic patients in the local population

\(p_1\) the probability that a DHP (without PPE) gets infected after contacting an asymptomatic patient;

\(e\) the effectiveness of the PPE (N95 masks);

\(s\) the probability of becoming symptomatic after getting infected from asymptomatic patient

\(d_a\) the probability of dying from the disease in age group \(a\).

\(n\) number of patients seen per day,

\(y\) number of 8-h days worked per year seeing 10 patients per day

---

\(^24\) Source: [University of Rochester] (www.urmc.rochester.edu)
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What is the probability for a dentist to get infected by a patient who is asymptomatic, become symptomatic, and die from COVID-19?

Age-adjusted probabilities of dying from COVID-19 when seeing 10 patients per day (assuming 212 8-hour work days per year) at asymptomatic prevalence rate of 1.4%

<table>
<thead>
<tr>
<th>Age</th>
<th>IFR (%)*</th>
<th>Daily</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>1.3</td>
<td>36.21×10⁻⁸</td>
<td>76.32×10⁻⁶</td>
</tr>
<tr>
<td>30-39</td>
<td>0.01</td>
<td>0.28×10⁻⁸</td>
<td>0.59×10⁻⁶</td>
</tr>
<tr>
<td>40-49</td>
<td>0.04</td>
<td>1.11×10⁻⁸</td>
<td>2.35×10⁻⁶</td>
</tr>
<tr>
<td>50-59</td>
<td>0.17</td>
<td>4.74×10⁻⁸</td>
<td>9.98×10⁻⁶</td>
</tr>
<tr>
<td>60-69</td>
<td>0.70</td>
<td>19.50×10⁻⁸</td>
<td>41.10×10⁻⁶</td>
</tr>
<tr>
<td>70-79</td>
<td>2.53</td>
<td>70.48×10⁻⁸</td>
<td>148.53×10⁻⁶</td>
</tr>
<tr>
<td>80-89</td>
<td>7.12</td>
<td>198.33×10⁻⁸</td>
<td>418.01×10⁻⁶</td>
</tr>
<tr>
<td>&gt;=90</td>
<td>17.50</td>
<td>487.48×10⁻⁸</td>
<td>1027.41×10⁻⁶</td>
</tr>
</tbody>
</table>

*overall infection fatality rate based on national data in the US in symptomatic cases; age adjusted infection fatality rate based on population data in the region of Lombardy, Italy
Delivering oral health care during COVID-19

What is the probability for a dentist to get infected by a patient who is asymptomatic, become symptomatic, and die from COVID-19?

Age-adjusted probability of dying from COVID-19 when seeing 10 patients per day (assuming 212 8-hour work days per year) at prevalence rate 0.003%

<table>
<thead>
<tr>
<th>Age group</th>
<th>IFR (%)</th>
<th>Daily</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>1.3</td>
<td>7.76×10⁻¹⁰</td>
<td>1:1,288,660,000</td>
</tr>
<tr>
<td>30-39</td>
<td>0.01</td>
<td>0.06×10⁻¹⁰</td>
<td>1:166,666,667,000</td>
</tr>
<tr>
<td>40-49</td>
<td>0.04</td>
<td>0.24×10⁻¹⁰</td>
<td>1:41,666,667,000</td>
</tr>
<tr>
<td>50-59</td>
<td>0.17</td>
<td>1.01×10⁻¹⁰</td>
<td>1:9,900,990,000</td>
</tr>
<tr>
<td>60-69</td>
<td>0.70</td>
<td>4.18×10⁻¹⁰</td>
<td>1:2,392,344,000</td>
</tr>
<tr>
<td>70-79</td>
<td>2.53</td>
<td>15.10×10⁻¹⁰</td>
<td>1:662,252,000</td>
</tr>
<tr>
<td>80-89</td>
<td>7.12</td>
<td>42.50×10⁻¹⁰</td>
<td>1:235,294,000</td>
</tr>
<tr>
<td>&gt;=90</td>
<td>17.50</td>
<td>104.46×10⁻¹⁰</td>
<td>1:95,730,000</td>
</tr>
</tbody>
</table>

*overall infection fatality rate based on national data in the US in symptomatic cases(54); age adjusted infection fatality rate based on population data in the region of Lombardy, Italy(55)
Delivering oral health care during COVID-19

Risk for dental healthcare professionals during the COVID-19 global pandemic: An evidence-based assessment

Yanfang Ren ¹, Changyong Feng ², Linda Rasubala ³, Hans Malmstrom ⁴, Eli Elhai ⁵

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COVID-19
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ABSTRACT

Objective: Heightened anxiety among dental healthcare professionals (DHPs) during the COVID-19 pandemic stems from uncertainties about the effectiveness of personal protective equipment (PPE) against dental aerosols and risk levels of asymptomatic patients. Our objective was to assess the risk for DHPs providing dental care during the pandemic based on available scientific evidence.

Methods: We reviewed the best available evidence and estimated the annualized risk \( p = \frac{d_1}{h_1} \times \frac{1 - p_1}{h_2} \times (1 - p_2) \) for a DHP during the COVID-19 pandemic, based on the following basic parameters: \( p_1 \), the probability that a DHP gets infected by an asymptomatic patient; \( c \), the effectiveness of the PPE; \( n \), the probability of becoming symptomatic after getting infected from asymptomatic patient; \( d_1 \), the probability of dying from the disease in age group a; \( n \), number of patients seen per day; and \( y \), number of days worked per year.

Results: With the assumption that DHPs work full-time and wear a N95 mask, the annualized probability for a DHP to acquire COVID-19 infection in a dental office, become symptomatic, and die from the infection is estimated at 1.13/10,000 (0.00113%).

Conclusions: Risk of COVID-19 transmission in dental office is very low based on available evidence on effectiveness of PPE and prevalence of asymptomatic patients. Face shields and pre-procedure oral rinses may further reduce the risk.

Clinical significance: DHPs should follow guidelines on pre-appointment protocols and on PPE use during dental treatments to keep the risk low.

Delivering oral health care during COVID-19

Heightened anxiety among dental healthcare professionals

- Shortage of PPE, especially N95 mask: Available now
- Uncertain effectiveness of PPE: It is very effective
- Unknowns of a novel respiratory infectious disease
  - Probability of transmission from an asymptomatic patient in healthcare settings? Likely 0, at most 4.11%
  - Outcomes of the disease – probability of becoming symptomatic and dying from an infection acquired from an asymptomatic patient: Extremely low
  - Other factors that may affect disease transmission
    - Underlying conditions
    - Saliva viral load
    - Other PPE

1. When you think about returning to work, what level of anxiety do you feel (where 1 is the least anxious you’ve ever felt and 10 is the most anxious)?

<table>
<thead>
<tr>
<th>Level</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 or 2</td>
<td>12%</td>
</tr>
<tr>
<td>3-5</td>
<td>41%</td>
</tr>
<tr>
<td>6-8</td>
<td>32%</td>
</tr>
<tr>
<td>9 or 10</td>
<td>15%</td>
</tr>
</tbody>
</table>
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Increased risk in individuals with underlying health and genetic conditions
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Saliva viral load and transmission of COVID-19

Close contact: 0.5 – 1 meter (20-40 inches)

Talking: 0.2 meter
Coughing: 0.5 meter
Sneezing: > 1.0 meter

Large droplets (>100 μm): Fast deposition due to the domination of gravitational force
Medium droplets between 5 and 100 μm
Small droplets or droplet nuclei, or aerosols (<5 μm): Responsible for airborne transmission

Wei & Li, 2016
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Saliva viral load in symptomatic and asymptomatic COVID-19 patients

Saliva viral RNA load in symptomatic, hospitalized patients:

Sputum: Average viral RNA load: $7.00 \times 10^6$ copies per ml (maximum $2.35 \times 10^8$/ml) (Wölfel et al 2020)

From $2.1 \times 10^7$ to $1.7 \times 10^8$ copies per ml (2 patients) (Yoon et al 2020)

Saliva (coughed from back of throat): Average viral load: $3.3 \times 10^6$ copies per ml (range $9.9 \times 10^2$ – $1.2 \times 10^8$/ml) (To et al 2020).

Saliva (no description of method): From $4.2 \times 10^6$ to $1.2 \times 10^7$ copies per ml (2 patients) (Yoon et al 2020)

Saliva viral RNA load in asymptomatic cases:

No data available for saliva viral load in asymptomatic adult patients.

2/98 asymptomatic cases with saliva test positive, but nasopharyngeal swabs negative for SARS-CoV-2 RNA (Wyllie et al 2020)

Detected in saliva in 2 out of 3 asymptomatic children with an average viral load of $3.2 \times 10^5$ copies per ml (Seon et al 2020)
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Probability for saliva aerosols to contain viral RNA copies

Sputum: mean $7.0 \times 10^6$ copies per ml (Wölfel et al 2020)

Probabilities for a droplet or aerosol to contain one copy of viral RNA
(Stadnytskyi et al 2020)

- 50 µm: 37%
- 10 µm: 0.37%
- 3 µm: 0.01%

Saliva: mean $3.3 \times 10^6$ copies per ml (To et al 2020)

Probabilities for a droplet or aerosol to contain one copy of viral RNA

- 50 µm: 21.5%
- 10 µm: 0.17%
- 3 µm: 0.0047%

Undiluted saliva

Saliva flow rate: 0.3-0.5 ml/m
High speed handpiece: 10-15 ml/m
95% water (without saliva removal)

High or low volume evacuation
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Probability for saliva aerosols to contain viable viruses

Where do the viruses in saliva come from?

- From upper and lower respiratory tracts
- May be shed in oral cavity or salivary glands?

Sars-CoV-2 RNA is detectable in coughed, drooled and self collected saliva from hospitalized COVID-19 patients (70-100%).

Sars-CoV-2 RNA was detected in saliva collected from duct openings in 1/11 hospitalized patients, and in 3/4 patients on ventilators in intensive care unit (Chen et al 2020)

Are there viable viruses in saliva from COVID-19 patients?

- Viable viruses were found in 3 of 5 hospitalized patients with mean viral RNA load of 3.3x10⁶ copies per ml (To at el 2020)
- Saliva is naturally viricidal (antiviral proteins, peptides, miRs, sialic acid) (review by Farshidfar et al 2020)
- Strong inhibition against H1N1 influenza viruses by infant and adult saliva (Gilbertson et al 2019, Limsuwat et al 2016)
Will pre-rinse with disinfectants mouth rinses in activate or eliminate the viruses?

- 0.5%, 1%, and 1.5% povidone-iodine completely inactivated SARS-CoV-2 within 15 seconds of contact in vitro (Bidra et al 2020)

<table>
<thead>
<tr>
<th>Test Product</th>
<th>PVP-I Concentration (%) After 1:1 Dilution</th>
<th>Incubation Time (in seconds)</th>
<th>Virus Titer*</th>
<th>LRV*</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVP-I 3.0% Oral Rinse Antiseptic</td>
<td>1.5</td>
<td>15</td>
<td>&lt;0.67</td>
<td>3.0</td>
</tr>
<tr>
<td>PVP-I 1.5% Oral Rinse Antiseptic</td>
<td>0.75</td>
<td>15</td>
<td>&lt;0.67</td>
<td>3.0</td>
</tr>
<tr>
<td>PVP-I 1.0% Oral Rinse Antiseptic</td>
<td>0.5</td>
<td>15</td>
<td>&lt;0.67</td>
<td>3.0</td>
</tr>
<tr>
<td>Ethanol 70%</td>
<td>N/A</td>
<td>15</td>
<td>1.5</td>
<td>2.17</td>
</tr>
<tr>
<td>Water</td>
<td>N/A</td>
<td>15</td>
<td>3.67</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Log$_{10}$ CCID$_{50}$ of virus per 0.1 mL. The assay lower limit of detection is 0.67 Log$_{10}$ CCID$_{50}$/0.1 mL.

*LRV (log reduction value) is the reduction of virus compared to the virus control.

- 0.12% chlorhexidine rinse for 30 seconds reduced viral RNA load for 2 hours at hospital days 3 and 6 (Yoon et al 2020)
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Probability for dental aerosols to reach dental health care providers

Where do all the aerosols go? How much can reach the breathing zones of dental providers?

<0.25% entering the breathing zone of the DHCW*

<1.0 % reaching the body surfaces of the DHCW*

>90 % trapped on the body surfaces of the patients*

*without accounting for the effects of HVE or LVE
*ultrasonic scaling & handpiece at 30000RPM

White bar, 0.3 μm; light grey bar, 0.5 μm; dark grey bar, 1 μm; black bar, 2 μm; striped bar, 10 μm; checked bar, 20 μm

The effectiveness of an air cleaner in controlling droplet/aerosol particle dispersion emitted from a patient’s mouth in the indoor environment of dental clinics
Saliva viral load and viruses in aerosols: summary

- Saliva viral RNA load in symptomatic, hospitalized patients: $3.3 \times 10^6$ copies per ml
- Saliva viral RNA load in asymptomatic patients: unknown in adults, $3.2 \times 10^5$ copies per ml in children
- Probabilities for saliva droplet or aerosol to contain viral RNA: 50µm 21.5%, 10µm 0.17%, 3µm 0.0047% in undiluted saliva. Saliva may be diluted 20 times if not removed by HVE. As saliva is usually removed by HVE, saliva remnants that may contain viruses may be diluted hundreds of times when using a high speed handpiece.
- Viruses in saliva, if any, are more likely from the respiratory tracts than shed from oral cavity and salivary glands in asymptomatic patients. Pre-rinse may effectively temporarily remove them.
- Saliva is naturally viricidal – probability that saliva contains viable virus is low
- Pre-rinse with antimicrobial mouth rinses may effectively inactivate in 15 seconds
- Probability for dental aerosols (20µm or smaller) to reach dental providers is very low
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Additional PPE against droplets
Delivering oral health care during COVID-19

Goggles/face shields: clinical evidence

Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis

Derek K Che, Elle AAK, Stephanie Duda, Karla Sohi, Sally Yacouel, Hafiyar Schirren, on behalf of the COVID-19 Systematic Review Group (EUGiC) study authors*

Summary

Background Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causes COVID-19 and is spread person-to-person through close contact. We aimed to investigate the effects of physical distance, face masks, and eye protection on virus transmission in health-care and non-health-care (eg, community) settings.

Methods We did a systematic review and meta-analysis to determine the optimum distance for avoiding person-to-person virus transmission and to assess the use of face masks and eye protection to prevent transmission of viruses. We obtained data for SARS-CoV-2 and the betacoronaviruses that cause severe acute respiratory syndrome, and Middle East respiratory syndrome from 21 standard WHO-specific and COVID-19-specific sources. We searched these data sources from database inception to May 3, 2020, with no restriction by language, for comparative studies and for contextual factors of acceptability, feasibility, resource use, and equity. We screened records, extracted data, and assessed risk of bias in duplicate. We did frequentist and Bayesian meta-analyses and random-effects meta-regressions. We rated the certainty of evidence according to Cochran methods and the GRADE approach. This study is registered with PROSPERO, CRD42021207784.

Findings Our search identified 172 observational studies across 16 countries and six continents, with no randomised controlled trials and 44 relevant comparative studies in health-care and non-health-care settings (n = 25697 patients). Transmission of viruses was lower with physical distancing of 1 m or more, compared with a distance of less than 1 m (n = 10736, pooled adjusted odds ratio [aOR] 0.38, 95% CI 0.19 to 0.75; risk difference [RD] −0.05 to −0.26, 95% CI −0.06 to −0.02; moderate certainty); protection was increased as distance was lengthened (change in relative risk [CRR] 2.0 per m, p = 0.04-0.04; moderate certainty). Face mask use could result in a large reduction in risk of infection (n = 2647, aOR 0.15, 95% CI 0.07 to 0.34; RD −0.14, 93% CI −0.24 to −0.04; lower certainty); with stronger associations with N95 or similar respirators compared with disposable surgical masks or similar (eg, reusable 22–12-layer cotton masks; p = 0.09-0.99; posterior probability <5%, low certainty). Use of eye protection also was associated with less infection (n = 3713, aOR 0.22, 95% CI 0.12 to 0.39, RD −0.16, 95% CI −0.25 to −0.07; lower certainty). Unadjusted studies and subgroup and sensitivity analyses showed similar findings.

Interpretation The findings of this systematic review and meta-analysis support physical distancing of 1 m or more and provide quantitative estimates for models and contact tracing to inform policy. Optimum use of face masks, respirators, and eye protection in public and health-care settings should be informed by these findings and contextual factors. Robust randomised trials are needed to better inform the evidence for these interventions, but this systematic appraisal of currently best available evidence might inform interim guidance.

Funding World Health Organization.

*Correspondence to Derek K Che, IHI-Opioids, University of California, San Francisco, California, USA. E-mail: dche@ucsf.edu

Figure 6: Forest plot showing the association of eye protection with risk of COVID-19, SARS, or MERS transmission. Forest plot shows unadjusted estimates. SARS=severe acute respiratory syndrome, MERS=Middle East respiratory syndrome. RR=relative risk, aOR=adjusted odds ratio.
Importance of eye protection


11. Scalinci SZ, Trovato Battagliola E. Conjunctivitis can be the only presenting sign and symptom of COVID-19. JDiCases. 2020;20:e00774.

Delivering oral health care during COVID-19

Findings:
During testing of an influenza laden cough aerosol with a volume median diameter (VMD) of 8.5μm, wearing a face shield reduced the inhalational exposure of the worker by 96% in the period immediately after a cough in a distance of 46 cm (18 inches).

Increasing the distance between the patient and worker to 183cm (72 inches) reduced the exposure to influenza that occurred immediately after a cough by 92%.

Less effective against smaller aerosols (3.4 μm) in longer distances
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Face shields: community use?

On March 19, 2020, California became the first state to issue a stay-at-home order in response to the coronavirus disease 2019 (COVID-19) pandemic. It was quickly recognized that widespread diagnostic testing with contact tracing, use of personal protective equipment as South Korea and Singapore, would not be available in time to significantly contain the spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Over the following months, additional nonpharmacologic infection prevention strategies, including social distancing, bars on large gatherings, and the closure of restaurants and retail stores, were applied to “flatten the epidemic curve” and limit the peak effects of a surge of patients on health care systems. Yet, even as the benefits of mitigation bundles have not fully been realized, there are widespread calls to re-open businesses, given the economic and social consequences of extreme physical distancing strategies. Recently published, infectious disease and public health experts have outlined recommendations for gradually reopening society, using combinations of containment and mitigation strategies. Proposed containment strategies have followed the South Korean model and include rapidly expanding public health infrastructure, widespread testing and contact tracing, while ensuring that safe medical care is delivered by healthcare and workers wearing adequate personal protective equipment (PPE), such as N95 respirators, medical masks, eye protection, gowns, and gloves. However, there is an growing recognition that containment strategies that rely on testing, tracing, and isolation because the necessary testing capacity may not be available for weeks to months, and in the US ability to test, trace, and quarantine is unclear. In addition, countries where testing was not limited and containment was achieved, e.g., Singapore, have seen substantial second waves of infections and mandated even more distancing interventions than the US and other countries are trying to scale back. The Infectious Diseases Society of America (IDSA) has included personal protective equipment (PPE), surgical masks, and face shields in its recommendations for testing, contact tracing, and personal protective equipment. The IDSA’s guidelines are that high-risk healthcare workers who are to care for patients with COVID-19 are to wear PPE and use face shields, which can be quickly and affordably produced and distributed, should be included as part of strategies to safely and significantly reduce transmission in the community setting.

Face masks and face shields

The supply chain for medical masks is concentrated in China, and the origins of the outbreak theory varied widely in factory closures and critical shortages. To preserve medical masks for health care facilities, the Centers for Disease Control and Prevention has recommended that...
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The scientific basis for transmission-based precautions

- Pre-screening & onsite screening
- Pre-rinsing
- Physical distancing (patients)
- N95 or surgical masks
- Face shields
- Eye protective goggles

- N95 or surgical masks
- Isolation gowns
- Head covering
- Gloves
- Hand hygiene
- Surface disinfections

Wei & Li, 2016
Delivering oral health care during COVID-19

Opportunities for further improvements: engineering controls

- Properly maintain ventilation systems.
  - Ventilation systems that provide air movement in a clean-to-less-clean flow direction reduce the distribution of contaminants and are better at protecting staff and patients. For example, in a dental facility with staff workstations in the corridor right outside the patient operatories, supply-air vents would deliver clean air into the corridor, and return-air vents in the rear of the less-clean patient operatories would pull the air out of the room. Thus, the clean air from the corridor flows past the staff workstations and into the patient operatories. Similarly, placing supply-air vents in the receptionist area and return-air vents in the waiting area pulls clean air from the reception area into the waiting area.
  - Consult an HVAC professional to investigate increasing filtration efficiency to the highest level compatible with the HVAC system without significant deviation from designed airflow.
  - Consult an HVAC professional to investigate the ability to safely increase the percentage of outdoor air supplied through the HVAC system (requires compatibility with equipment capacity and environmental conditions).
  - Limit the use of demand-controlled ventilation (triggered by temperature setpoint and/or by occupancy controls) during occupied hours and when feasible, up to 2 hours post occupancy to assure that the ventilation rate does not automatically change. Run bathroom exhaust fans continuously during business hours.
  - Consider the use of a portable HEPA air filtration unit while the patient is undergoing, and immediately following, an aerosol-generating procedure.
    - Select a HEPA air filtration unit based on its Clean Air Delivery Rate (CADR). The CADR is an established performance standard defined by the Association of Home Appliance Manufacturers and reports the system's cubic feet per minute (CFM) rating under as-used conditions. The higher the CADR, the faster the air cleaner will work to remove aerosols from the air.
    - Rather than just relying on the building's HVAC system capacity, use a HEPA air filtration unit to reduce aerosol concentrations in the room and increase the effectiveness of the turnover time.
    - Place the HEPA unit near the patient's chair, but not behind the DHCP. Ensure the DHCP are not positioned between the unit and the patient's mouth. Position the unit to ensure that it does not pull air into or past the breathing zone of the DHCP.
  - Consider the use of upper-room ultraviolet germicidal irradiation (UVGI) as an adjunct to higher ventilation and air cleaning rates.

- HVAC system and ventilation:
  - Air flow direction and pattern
  - Air filtration efficiency
  - Percentage of outside air
  - Air change rate per hour (ACH)

- Portable HEPA air filtration unit
  - Clean air delivery rate (CADR)
  - Cubic feet per minute (CFM) rating
  - Add to the effectiveness of HVAC (ACH)
  - Near the patient’s chair, not behind DHCP

- Upper-room ultraviolet germicidal irradiation (UVGI)
  - Adjunct to higher ventilation and air cleaning rate

* Did not mention “negative pressure rooms”
Portable air cleaners (purifiers, filters, scrubbers)

How It Works
360° air intake and output maximizes efficiency in filtering and circulating the air and allows placement in any area of the room.

Powerful fan motor draws in room air and releases cleaner air 360°

SurroundSeal™ technology helps minimize air leaks

Activated carbon pre-filter captures large particles and helps reduce odors

High Efficiency Particulate Air filter

Allergen Guide
Captures PM2.5 and Particles as small as 0.3 Micron

Particulate matter (PM) refers to small particles floating in the air. Particles are measured in microns (1 micron = 0.001 mm).

<table>
<thead>
<tr>
<th>Fine Particles PM2.5</th>
<th>Larger Particles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viruses .005 - .03</td>
<td>Tobacco Smoke .01 - 4</td>
</tr>
<tr>
<td>Bacteria .3 - 60</td>
<td>Household Dust 0.5-10+</td>
</tr>
<tr>
<td>Pet Dander 2.5 - 10</td>
<td>Mold Spores 3-40</td>
</tr>
<tr>
<td>Pollen 10-100</td>
<td></td>
</tr>
</tbody>
</table>

**Most penetrating size (0.3µm)**
Portable air cleaners

Portable air cleaner (PAC) is effective in improving air qualities and aerosol controls

In residential/office/industrial buildings


In healthcare facilities


In dental clinics


Portable air cleaners

Reduction of microbial concentration in the air of dental operating rooms. I. High-efficiency particulate air filters.

Effectiveness in removing viable particles

<table>
<thead>
<tr>
<th>Activity</th>
<th>No. of Trials</th>
<th>Position A+ (VP/cu ft)</th>
<th>Position B (VP/cu ft)</th>
<th>No. of Trials</th>
<th>Position A (VP/cu ft)</th>
<th>Position B (VP/cu ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental procedures</td>
<td>26</td>
<td>7.8 ± 3.9†</td>
<td>7.6 ± 3.1</td>
<td>14</td>
<td>2.2 ± 1.9</td>
<td>2.9 ± 1.9</td>
</tr>
<tr>
<td>Movement of persons (no</td>
<td>12</td>
<td>3.5 ± 2.4</td>
<td>4.6 ± 2.7</td>
<td>7</td>
<td>0.6 ± 0.6</td>
<td>1.6 ± 5.7</td>
</tr>
<tr>
<td>patient in room)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (no persons in room)</td>
<td>7</td>
<td>0.9 ± 0.5</td>
<td>1.3 ± 0.8</td>
<td>5</td>
<td>0.1 ± 0.1</td>
<td>0.3 ± 0.2</td>
</tr>
</tbody>
</table>

Table 2: Effect of air filtration on microbial concentration in the air of dental operating rooms

<table>
<thead>
<tr>
<th>Activity</th>
<th>Room size (cu ft)</th>
<th>No. of Trials</th>
<th>Room size (cu ft)</th>
<th>No. of Trials</th>
<th>Decrease in Microbial Concentration (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental procedures</td>
<td>1,600</td>
<td>15</td>
<td>21.0</td>
<td>23</td>
<td>2.2 ± 2.2</td>
</tr>
<tr>
<td></td>
<td>1,800</td>
<td>13</td>
<td>2.6</td>
<td>13</td>
<td>0.7 ± 3.7</td>
</tr>
<tr>
<td>Movement of persons (no</td>
<td>3,240</td>
<td>26</td>
<td>7.6</td>
<td>14</td>
<td>2.9 ± 1.6</td>
</tr>
<tr>
<td>patient in room)</td>
<td>1,600</td>
<td>3</td>
<td>1.9</td>
<td>3</td>
<td>1.0 ± 0.8</td>
</tr>
<tr>
<td></td>
<td>1,800</td>
<td>4</td>
<td>1.5</td>
<td>4</td>
<td>0.6 ± 0.6</td>
</tr>
<tr>
<td></td>
<td>3,240</td>
<td>12</td>
<td>4.6</td>
<td>7</td>
<td>1.6 ± 0.8</td>
</tr>
<tr>
<td>None (no persons in room)</td>
<td>1,600</td>
<td>5</td>
<td>1.7</td>
<td>3</td>
<td>0.8 ± 0.6</td>
</tr>
<tr>
<td></td>
<td>1,800</td>
<td>3</td>
<td>1.1</td>
<td>3</td>
<td>0.3 ± 0.1</td>
</tr>
<tr>
<td></td>
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<td>7</td>
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</tr>
</tbody>
</table>

Fig 1.—Dental operating room with blower-filter module against wall and air sampling locations. A, orifice positioned one foot from patient’s mouth; and B, orifice positioned about 10 feet from patient’s mouth.

Fig 3.— Clearance rates of peak concentrations of viable particles in dental operating rooms and without filtration of air. Peak values during periods of dental activity. A, 1,600 cu ft (100% = 185); B, 1,800 cu ft (100% = 8); and C, 3,240 cu ft (100% = 26).

†Statistically significant.
Portable air cleaners

The effectiveness of an air cleaner in controlling droplet/aerosol particle dispersion emitted from a patient's mouth in the indoor environment of dental clinics

PAC placements and particle removal efficiency

Dental office particle and airflow measurements and computer fluid dynamic modeling (0.3, 0.5, 1, 2, 10, 20 µm)

**CADR:**
- 659 m³ h⁻¹ (0.3 µm),
- 731 m³ h⁻¹ (0.5 µm),
- 741 m³ h⁻¹ (1 µm),
- 791 m³ h⁻¹ (2 µm),
- 1260 m³ h⁻¹ (10 µm)
- 1260 m³ h⁻¹ (20 µm)

Percentage of particles entering the breathing zone of the DHCW

White bar, 0.3 μm; light grey bar, 0.5 μm; dark grey bar, 1 μm; black bar, 2 μm; striped bar, 10 μm; checked bar, 20 μm

Percentage of particles reaching the body surface of the DHCW

Percentage of particles trapped by the patient's body surface

Percentage of particles removed by the air cleaner
Portable air cleaners

The effectiveness of an air cleaner in controlling droplet/aerosol particle dispersion emitted from a patient's mouth in the indoor environment of dental clinics

Conclusions:
- PAC is effective in removing aerosols
- Location of the PAC is important
- May need to consider the directions of airflow
Upper-room ultraviolet germicidal irradiation (UVGI)

Ultraviolet light between 200 and 280nm wave lengths (UV-C lights)

WHO: Implementing the WHO Policy on TB Infection Control in Health-Care Facilities, Congregate Settings and Households

Application of CFD Simulation to Predicting Upper-Room UVGI Effectiveness. Carl A. Gilkeson and Catherine J. Noakes
Upper-room ultraviolet germicidal irradiation (UVGI)

It works! especially in rooms with well-mixed air, useful if HVAC could not be improved and ACH is low.
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The scientific basis for transmission-based precautions

- Pre-screening & onsite screening
- Pre-rinsing
- Physical distancing (patients)
- N95 or surgical masks
- Face shields
- Eye protective goggles
- Isolation gowns
- Head covering
- Gloves
- Hand hygiene
- Surface disinfections
- Improved ventilation
- Portable air cleaners
- Upper-room UV

Wei & Li, 2016