The San Francisco Response to the SARS-CoV-2/COVID-19 Pandemic

San Francisco, December 9, 2020

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Director, Population Health Division
Department of Public Health

https://taragonmd.github.io/ (blog)
Overview

• Background and history
• Transmission dynamics
• Transmission containment
Background and history
“Worst job in California: public health leader”

Dr. Tomás Aragon, director Population Health Division; Health Officer; City and County of San Francisco; walks out of the Department of Public Health as officers stand next to the building as they monitor a Black Lives Matter protest on Friday, June 5, 2020 in San Francisco, Calif.
Photo: Lea Suzuki / The Chronicle
San Francisco COVID-19 Data and Reports

<table>
<thead>
<tr>
<th>Total COVID-19 Positive Cases Reported</th>
<th>Total Deaths</th>
<th>Gender Distribution of Positive Cases</th>
<th>Total COVID-19 Tests Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>17,068</td>
<td>164</td>
<td>Female: 46%</td>
<td>937,750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Male: 54%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unknown: 0%</td>
<td></td>
</tr>
</tbody>
</table>

Data through 12/4/2020, updated daily

## How are we doing? City comparisons

<table>
<thead>
<tr>
<th>City</th>
<th>County</th>
<th>State</th>
<th>Cases/1000</th>
<th>Deaths/100,000</th>
<th>Tests/1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco</td>
<td>San Francisco</td>
<td>CA</td>
<td>13.4</td>
<td>14.2</td>
<td>4.44</td>
</tr>
<tr>
<td>Seattle</td>
<td>King</td>
<td>WA</td>
<td>10.6</td>
<td>34.8</td>
<td>1.70</td>
</tr>
<tr>
<td>Atlanta</td>
<td>Fulton</td>
<td>GA</td>
<td>27.2</td>
<td>55.5</td>
<td>N/A</td>
</tr>
<tr>
<td>Baltimore</td>
<td>Baltimore City</td>
<td>MD</td>
<td>19.9</td>
<td>59.6</td>
<td>3.84</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>Los Angeles</td>
<td>CA</td>
<td>27.0</td>
<td>65.1</td>
<td>3.02</td>
</tr>
<tr>
<td>Denver</td>
<td>Denver</td>
<td>CO</td>
<td>23.7</td>
<td>71.2</td>
<td>2.60</td>
</tr>
<tr>
<td>DC</td>
<td>DC</td>
<td>DC</td>
<td>22.7</td>
<td>90.5</td>
<td>N/A</td>
</tr>
<tr>
<td>Miami</td>
<td>Miami-dade</td>
<td>FL</td>
<td>64.5</td>
<td>126.6</td>
<td>N/A</td>
</tr>
<tr>
<td>Philadelphia</td>
<td>Philadelphia</td>
<td>PA</td>
<td>25.1</td>
<td>115.5</td>
<td>1.65</td>
</tr>
<tr>
<td>Boston</td>
<td>Suffolk</td>
<td>MA</td>
<td>31.7</td>
<td>142.4</td>
<td>N/A</td>
</tr>
<tr>
<td>New York City</td>
<td>New York City</td>
<td>NY</td>
<td>29.8</td>
<td>284.1</td>
<td>1.12</td>
</tr>
</tbody>
</table>


Updated Oct 19, 2020
HIV/AIDS pandemic and SARS-1 epidemic affects San Francisco Bay Area

1985: AIDS documentary: Dr. Merle Sande at San Francisco General Hospital

2003: CNN: Berkeley turns away students from SARS-hit regions

http://www.cnn.com/2003/EDUCATION/05/05/berkeley.sars.ban/
Preventing and controlling infectious diseases

- Transmission mechanisms
- Transmission dynamics
  - Effective reproductive number
  \[ R(t) = R_0 \times (c \times p \times d) \times (t) \]
  - Infection rate among susceptibles
  \[ I(t) = c \times p \times P(t) \]
- Transmission containment
- Control points
- Control strategies
- Control measures

https://escholarship.org/uc/item/7687z08g
City and County of San Francisco on January 18 and 21, 2020

Jan 18: View from jogging to Twin Peaks

Jan 21: DPH Department Operations Center activated
City and County of San Francisco on January 27 and February 25, 2020

Jan 27: Emergency Operations Center activated

Feb 25: Mayor London Breed declares State of Emergency
Press conference issuing shelter-in-place order for Bay Area region, Santa Clara County, Mar 16, 2020

Bay Area health officers issue shelter-in-place order for San Mateo County (Scott Morrow), Marin County (Matt Willis), Santa Clara County (Sara Cody), Alameda County (Erica Pan), San Francisco (Tomás Aragón), City of Berkeley (Lisa Hernandez), and Contra Costa County (Chris Farnitano). LA Times, April 21, 2020
Re number since beginning of pandemic, SF

Source: Dr. Maya Petersen
Transmission dynamics
California Blueprint, Tiered Framework

**Adjusted case rates**

- Los Angeles Co.: 9.6, 8.9
- San Diego Co.: 7.9, 7.6
- San Francisco Co.: 5.1, 2.5

**Risk-level tiers**

1. Widespread
2. Substantial
3. Moderate
4. Minimal

*Source: California Department of Public Health*

John Blanchard / The Chronicle
Positivity rates

Los Angeles Co. 4.3
San Diego Co. 3.8
San Francisco Co. 2.6

Risk-level tiers
1 Widespread
2 Substantial
3 Moderate
4 Minimal

Source: California Department of Public Health

John Blanchard / The Chronicle
COVID-19 cases, deaths, and hospitalizations as of December 7, 2020, United States

[Graph showing the trend of COVID-19 cases, deaths, and hospitalizations over time with notable spikes around Thanksgiving and new cases.

<table>
<thead>
<tr>
<th>Metric</th>
<th>Total Reported</th>
<th>On Dec. 7</th>
<th>14-Day Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases</td>
<td>15.1 million+</td>
<td>202,424</td>
<td>+17%</td>
</tr>
<tr>
<td>Deaths</td>
<td>285,070</td>
<td>1,533</td>
<td>+47%</td>
</tr>
<tr>
<td>Hospitalized</td>
<td>102,148</td>
<td></td>
<td>+23%</td>
</tr>
</tbody>
</table>

Day with data reporting anomaly. Hospitalization data from the Covid Tracking Project; 14-day change trends use 7-day averages.

Average daily COVID-19 cases per 100,000 as of December 7, 2020, United States

COVID-19 Hospitalization and Death by Race/Ethnicity, United States, November 30, 2020

<table>
<thead>
<tr>
<th>Rate ratios compared to White, Non-Hispanic persons</th>
<th>American Indian or Alaska Native, Non-Hispanic persons</th>
<th>Asian, Non-Hispanic persons</th>
<th>Black or African American, Non-Hispanic persons</th>
<th>Hispanic or Latino persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1.8x</td>
<td>0.6x</td>
<td>1.4x</td>
<td>1.7x</td>
</tr>
<tr>
<td>Hospitalization&lt;sup&gt;2&lt;/sup&gt;</td>
<td>4.0x</td>
<td>1.2x</td>
<td>3.7x</td>
<td>4.1x</td>
</tr>
<tr>
<td>Death&lt;sup&gt;3&lt;/sup&gt;</td>
<td>2.6x</td>
<td>1.1x</td>
<td>2.8x</td>
<td>2.8x</td>
</tr>
</tbody>
</table>

### Cases and deaths by race/ethnicity, United States, December 8, 2020

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>Cases per 100,000 people</th>
<th>Deaths per 100,000 people</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native Hawaiian/Pacific Islander</td>
<td>5,481</td>
<td>64</td>
</tr>
<tr>
<td>American Indian/Alaska Native</td>
<td>4,644</td>
<td>93</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>3,541</td>
<td>81</td>
</tr>
<tr>
<td>Black/African American</td>
<td>3,226</td>
<td>117</td>
</tr>
<tr>
<td>White</td>
<td>2,214</td>
<td>62</td>
</tr>
<tr>
<td>Asian</td>
<td>1,437</td>
<td>51</td>
</tr>
</tbody>
</table>

Source: [https://covidtracking.com/race](https://covidtracking.com/race)
Daily cases and deaths, California, 12/08/20

Total cases in California

1,389,707 positive cases
23,272 new cases
1.7% increase from prior day total

Total deaths in California

20,047 total deaths
112 new deaths
0.6% increase from prior day total
Tests and test positivity, California, 12/08/20

Total tests reported in California:

- **296,424** new tests reported
- **25,789,775** total tests reported
- 1.2% increase from prior day total

Positivity rate in California:

- **8.7%** test positivity (14-day average)
- 2.7% increase from 14 days ago
Hospitalized patients, California, 12/08/20

COVID-19 hospitalized patients in California

**11,511** COVID-19 hospitalized patients
+513 patients
4.5% increase from prior day

ICU beds in California

**1,679** ICU beds available
35 decrease from prior day
7-day average daily COVID-19 case rates, San Francisco, posted December 7, 2020
COVID-19 hospitalizations, San Francisco, December 6, 2020
Effective reproductive number, Re, 11/27/20
### Effective reproductive numbers for Bay Area counties, December 7, 2020

<table>
<thead>
<tr>
<th>County</th>
<th>Effective reproductive number (Re)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alameda</td>
<td>1.48</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>1.41</td>
</tr>
<tr>
<td>Marin</td>
<td>1.40</td>
</tr>
<tr>
<td>San Francisco</td>
<td>1.43</td>
</tr>
<tr>
<td>San Mateo</td>
<td>1.62</td>
</tr>
<tr>
<td>Santa Clara</td>
<td>1.38</td>
</tr>
</tbody>
</table>

Source: Joshua Schwab, Maya Petersen ([https://github.com/LocalEpi/LEMMA](https://github.com/LocalEpi/LEMMA))
COVID-19 daily case rates, Bay Area, SF Chronicle, December 9, 2020

Long term hospitalization and ICU projections, San Francisco, December 6, 2020
Acute care bed projections and capacity runway based on $\text{Re} = 1.45$, San Francisco, Dec 7, 2020
ICU bed projections and capacity runway based on Re = 1.45, San Francisco, December 7, 2020
Two possible futures, San Francisco, CA

- 1,410 Hospitalizations at median
- Hospitalizations peak Feb 10, 2021
- 517 additional deaths
- Longer duration

- 200 Hospitalizations at median
- Hospitalizations peak Dec 21, 2020
- 70 additional deaths
- Shorter duration
Transmission containment
PDSA problem-solving with causal thinking

1. **Plan:**
   - Problem definition
   - Root cause analysis
   - Consequence (risk) analysis
   - Countermeasure selection

2. **Do:**
   - Countermeasure execution

3. **Study:**
   - Countermeasure evaluation (causal analysis)

4. **Act:**
   - Act on what you learn to improve.


Problem

TTSI = test, trace, support, isolate

Contacts E number, rate, distance, duration
SIP = shelter in place
SGN = social gathering number
IVO = indoor vs. outdoor
FC = face covering
PD = physical distancing
HW = hand washing
PCMS = prevention, containment, mitigation, suppression

B = Behavioral
E = Environmental & engineering

Causal Framework for Problem-Solving (8/22/20)

Drivers (causes)

MOBILITY B
Networking B

Setting E
Indoor vs. outdoor
Ventilation E

Contacts B
Activity B
Sensing, drinking
Face coverings B

Transmission events

Testing → Cases

Recovered

Deaths

Prevalence of Infectives estimates (biased?) Percent positivity

Countermeasures

SIP
IVO
SGN
IPC

INSIGHTS
- most drivers are behavioral
- outcome measures are insufficient to infer drivers
- metrics facilitate (necessary but not sufficient)
1. monitoring
2. early warning
3. PCMS interventions
4. investigation & evaluation
## Risk factors for SARS-CoV-2 transmission

<table>
<thead>
<tr>
<th>No.</th>
<th>Risk category</th>
<th>subcategory</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mobility</td>
<td></td>
<td>Leaving household</td>
</tr>
<tr>
<td>2</td>
<td>Gatherings</td>
<td></td>
<td>Mixing with persons outside your household</td>
</tr>
<tr>
<td>3</td>
<td>Aerosol transmission</td>
<td>Respiratory protection</td>
<td>Protect self; also achieves source control</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Source control</td>
<td>Reduces droplets and aerosols</td>
</tr>
<tr>
<td>5</td>
<td>Setting</td>
<td>Indoors vs outdoors</td>
<td>Indoors risk generally higher risk than outdoors</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Home, transportation, school, work, and worship</td>
</tr>
<tr>
<td>6</td>
<td>Ventilation</td>
<td></td>
<td>Air exchange may not be adequate</td>
</tr>
<tr>
<td>7</td>
<td>Contacts</td>
<td>Number and Rate</td>
<td>Number of persons and frequency of contact</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Distance ≤ 6 ft.</td>
<td>Aerosols travel &gt; 6 feet from source</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Duration &gt; 15 min</td>
<td>Prolonged duration (cumulative exposure)</td>
</tr>
<tr>
<td>10</td>
<td>Activity</td>
<td>Eating or drinking</td>
<td>Face covering off</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Drinking alcohol</td>
<td>Face covering off; behavioral disinhibition</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Talking or louder</td>
<td>Aerosol generation</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>Singing</td>
<td>Aerosol generation</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>Exercising</td>
<td>Aerosol generation and increased breathing rate</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>Playing wind instrument</td>
<td>Aerosol generation and increased exhalation</td>
</tr>
<tr>
<td>16</td>
<td>Hand hygiene</td>
<td></td>
<td>Availability of water, soap, and hand sanitizers</td>
</tr>
<tr>
<td>17</td>
<td>Fomite contamination</td>
<td></td>
<td>Environmental disinfection</td>
</tr>
</tbody>
</table>
Risk-based criteria

**Masks reduce airborne transmission**
Infectious aerosol particles can be released during breathing and speaking by asymptomatic infected individuals. No masking maximizes exposure, whereas universal masking results in the least exposure.

- Gathering w persons outside your household
- Ventilation (outdoor; open windows, cleaner)
- Contacts (number, rate, distance, duration)
- FM, N95 respirator, handwashing, disinfection
- Activity (eat, drink, breathe, talk, sing, touch)
California Regional Stay-At-Home Order

- stay **home** (except essential ...)
- avoid **gathering** w persons outside your household
- avoid **crowds** (especially indoors)
- avoid **traveling**
- follow **guidelines**
  - face covering (or N95 respirator)
  - ventilation (outdoors better)
  - physical distancing
  - hand washing
  - disinfection

CDC Public Health Strategies to Address High Levels of Community Transmission of SARS-CoV-2

[https://www.cdc.gov/mmwr/volumes/69/wr/mm6949e2.htm](https://www.cdc.gov/mmwr/volumes/69/wr/mm6949e2.htm)
Questions?