

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

San Francisco, December 9, 2020

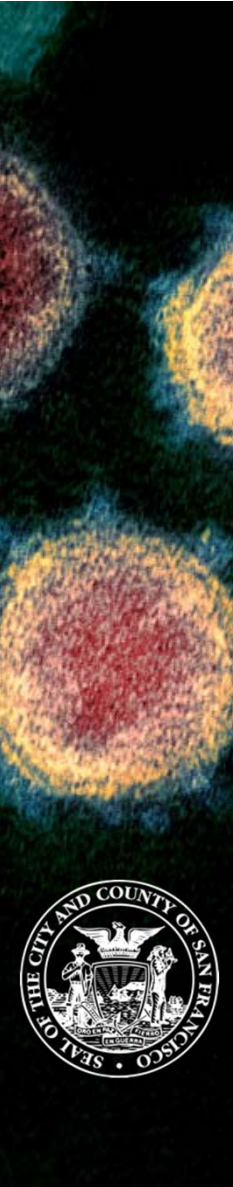
Tomás J. Aragón, M.D., Dr.P.H.

Health Officer, City & County of San Francisco

Director, Population Health Division

Department of Public Health

<https://taragonmd.github.io/> (blog)

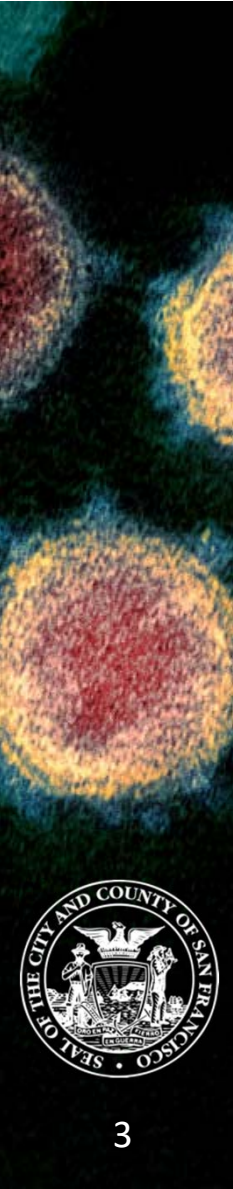


Overview

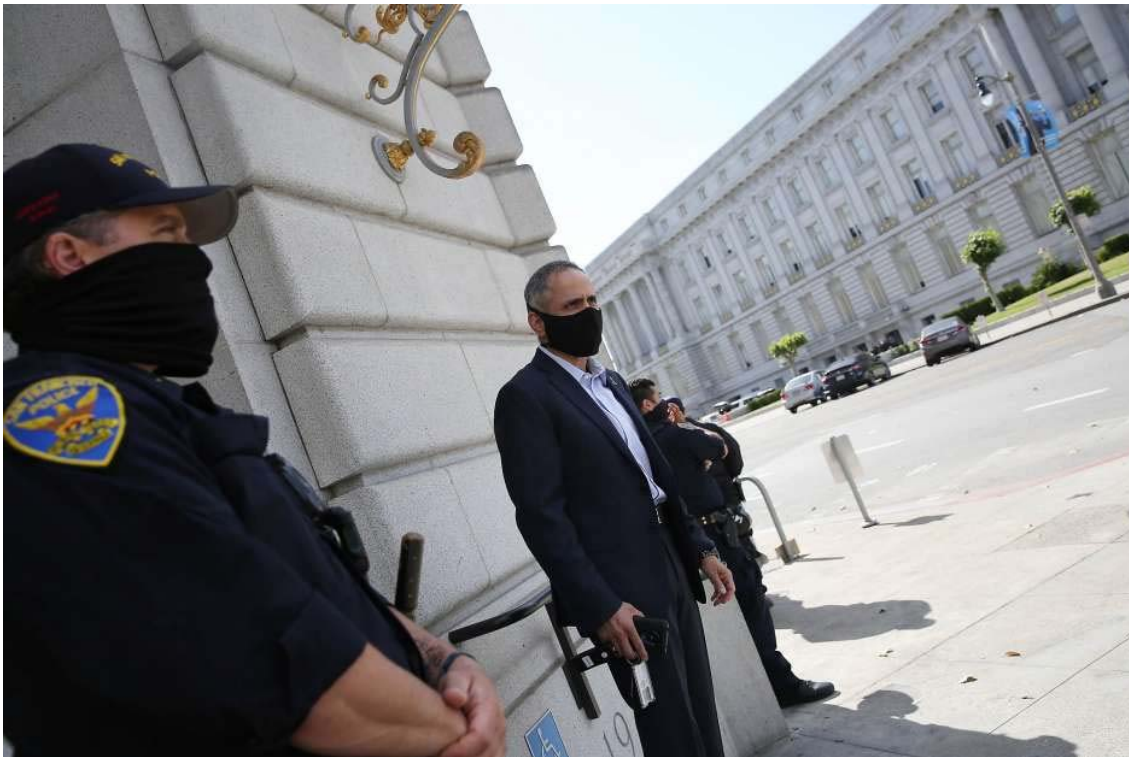
- Background and history
- Transmission dynamics
- Transmission containment



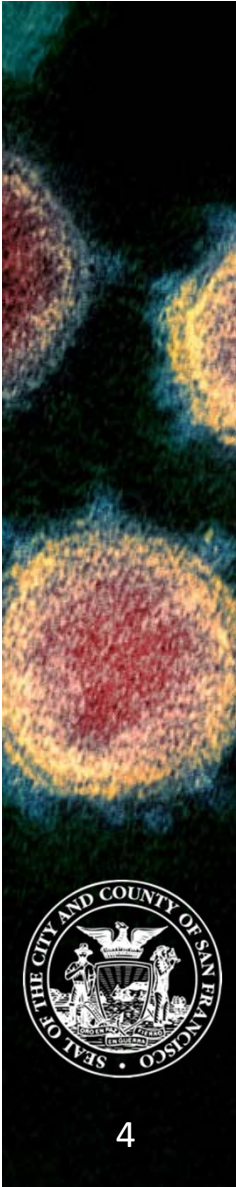
Background and history



“Worst job in California: public health leader”



SF Chronicle, June 12, 2020.
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



2020-12-04

<https://data.sfgov.org/stories/s/San-Francisco-COVID-19-Data-and-Reports/fjki-2fab/>

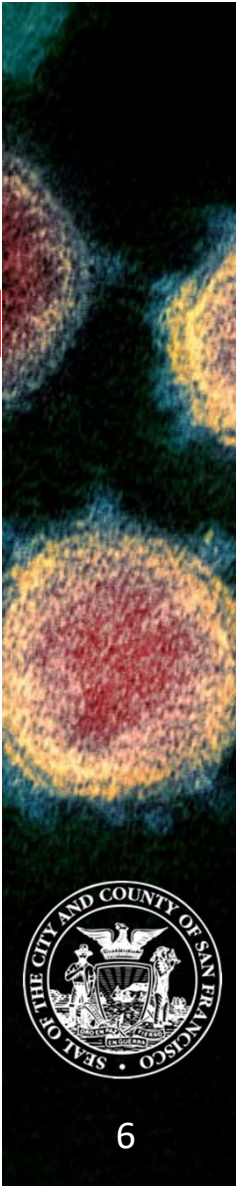


How are we doing? City comparisons

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

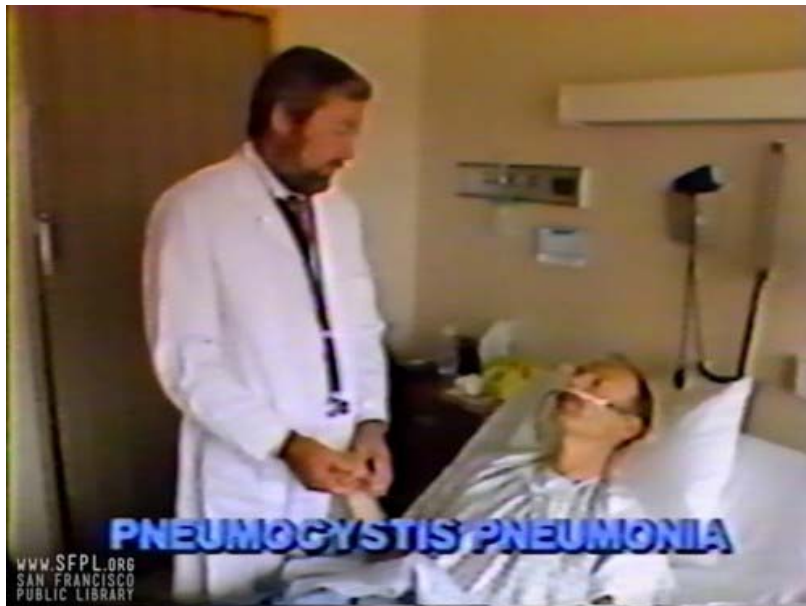
Source: JHU CSSE (<https://www.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6>)

Updated Oct 19, 2020



HIV/AIDS pandemic and SARS-1 epidemic affects San Francisco Bay Area

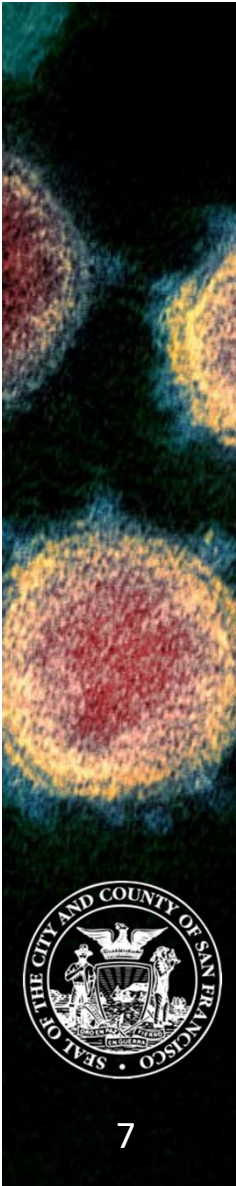
1985: AIDS documentary: Dr. Merle Sande at San Francisco General Hospital



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
$$R(t) = R_0 x(t) = (c p d) x(t)$$
 - Infection rate among susceptibles
$$I(t) = c p P(t)$$
- Transmission containment
 - Control points
 - Control strategies
 - Control measures

Preventing and Controlling Infectious Diseases, COVID-19 Edition
Population Health Division, San Francisco Department of Public Health

Chain model

1 Microbial agent in 2 Reservoir or 3 Source → 4 Portals of exit → 5 Modes of transmission (contact rate, distance & duration) → 6 Portals of entry → 7 Susceptible host

Reservoir / Source

- 1 air
- 2 water
- 3 food
- 4 people
- 5 animals and vectors
- 6 vehicles
- 7 soil and debris

Modes of transmission

- 1 contact - direct
- 2 contact - indirect (fomites, fecal)
- 3 droplet
- 4 airborne
- 5 vehicle-borne
- 6 vector-borne
- 7 vertical (mother to fetus or newborn)

The 7 Habits of Uninfected People

- 1 physical distancing (6+ feet esp. if susceptible or vulnerable)
- 2 frequent hand washing; avoid touching eyes, nose, and mouth
- 3 face covering or mask, respiratory hygiene, and cough etiquette
- 4 staying home when sick; don't go to school, work, social events
- 5 keeping vaccinations up-to-date (e.g., flu, hep A)
- 6 safe consuming of water, food, products (includes harm reduction)
- 7 understanding infection prevention/control (study this document)

Transmission containment strategies

- 1 reduce reservoir and / or source (mitigate hazard, disinfection)
- 2 reduce contact (decrease rate and duration, increase distance)
- 3 reduce fraction of population that is infectious
- 4 reduce biological infectiousness (e.g., ART in HIV)
- 5 reduce biological susceptibility (e.g., PREP, vaccine)
- 6 interrupt transmission (infection control, N95s, face masks, etc.)
- 7 reduce fraction of population that is susceptible

Infectious disease control measures / tools

- behavior change of reservoir/source and/or susceptibles
- testing (diagnostic, and targeted and/or mass screening)
- case definition (epidemiological, clinical, and laboratory criteria)
- case finding for isolation, treatment, surveillance
- isolation (separation of infectious person ("case"))
- case management (transport, house, feed, isolate, treat, clear)
- contact tracing for quarantine, PEP, surveillance
- quarantine (separation of exposed individuals)
- social distancing (for individuals or groups)
 - * keeping 6 or more feet from others
 - * school closures, cancellation of classes
 - * cancellation of mass gatherings
 - * travel restrictions
- shelter at home ("shelter in place") (avoiding potential exposures)
- vaccination (targeted and/or mass)
- pre- or post-exposure prophylaxis (PEP, PEP, vaccine, IgG, drug)
- treatment (infectious cases or co-risk factor)
- infection prevention (aka infection control)
- environmental measures (disinfection, ventilation, separators, etc.)
- cordon sanitaire (preventing exit from affected region)
- protective sequestration (preventing entry into unaffected region)

Transmission equations

EQ 1: $R(t) = R_0 x(t) = c p d [1 - h f - r(t)]$

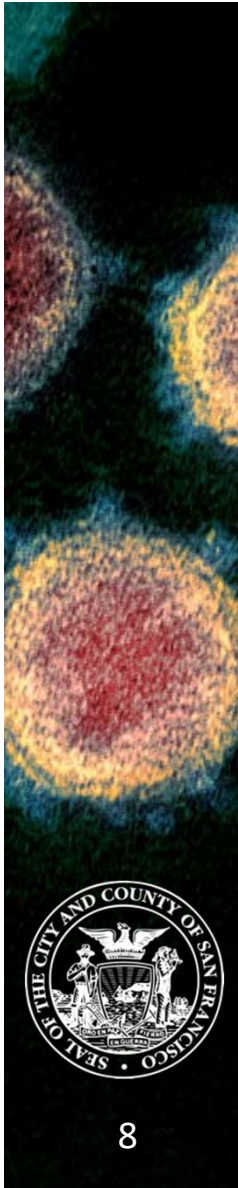
EQ 2: $I(t) = c p P(t)$

Special transmission drivers

- 1 asymptomatic infectiousness
- 2 pre-symptomatic infectiousness
- 3 short serial (generation) time
- 4 airborne transmission
- 5 fomite transmission
- 6 fecal-oral transmission

Updated: 2020-05-02
Tomás J Aragón, MD, DrPH
Health Officer, City & County of San Francisco
Details here: <https://escholarship.org/uc/item/7687z08g>
Also visit population health blog: <https://taragonmd.github.io/>

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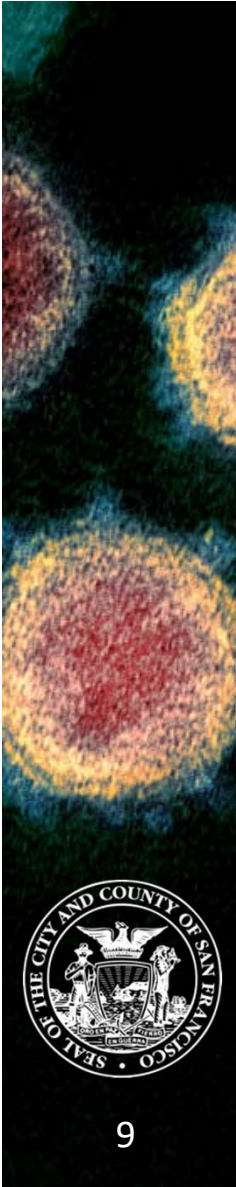
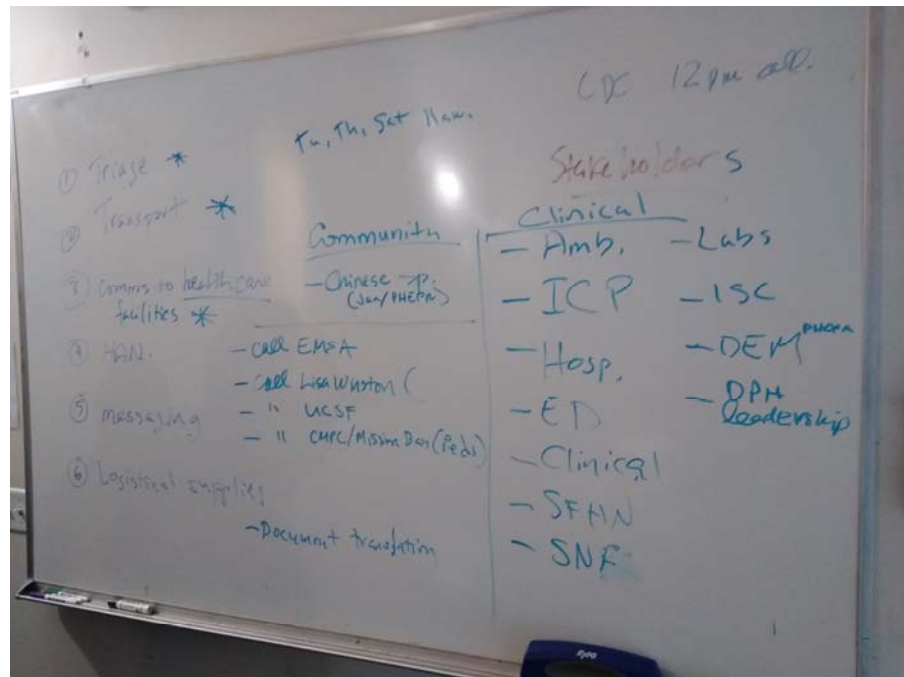


City and County of San Francisco on January 18 and 21, 2020

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



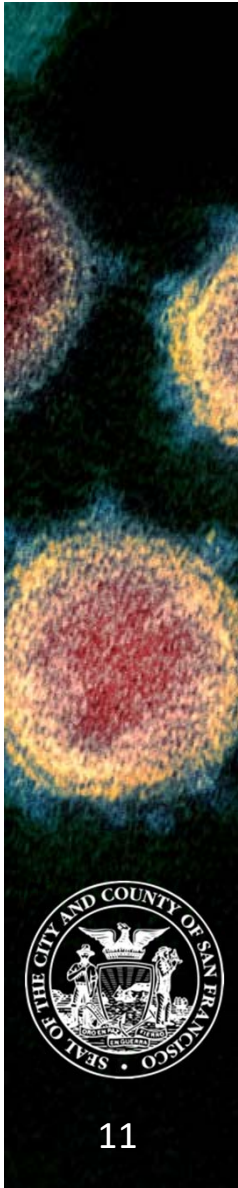
Feb 25: Mayor London Breed declares State of Emergency



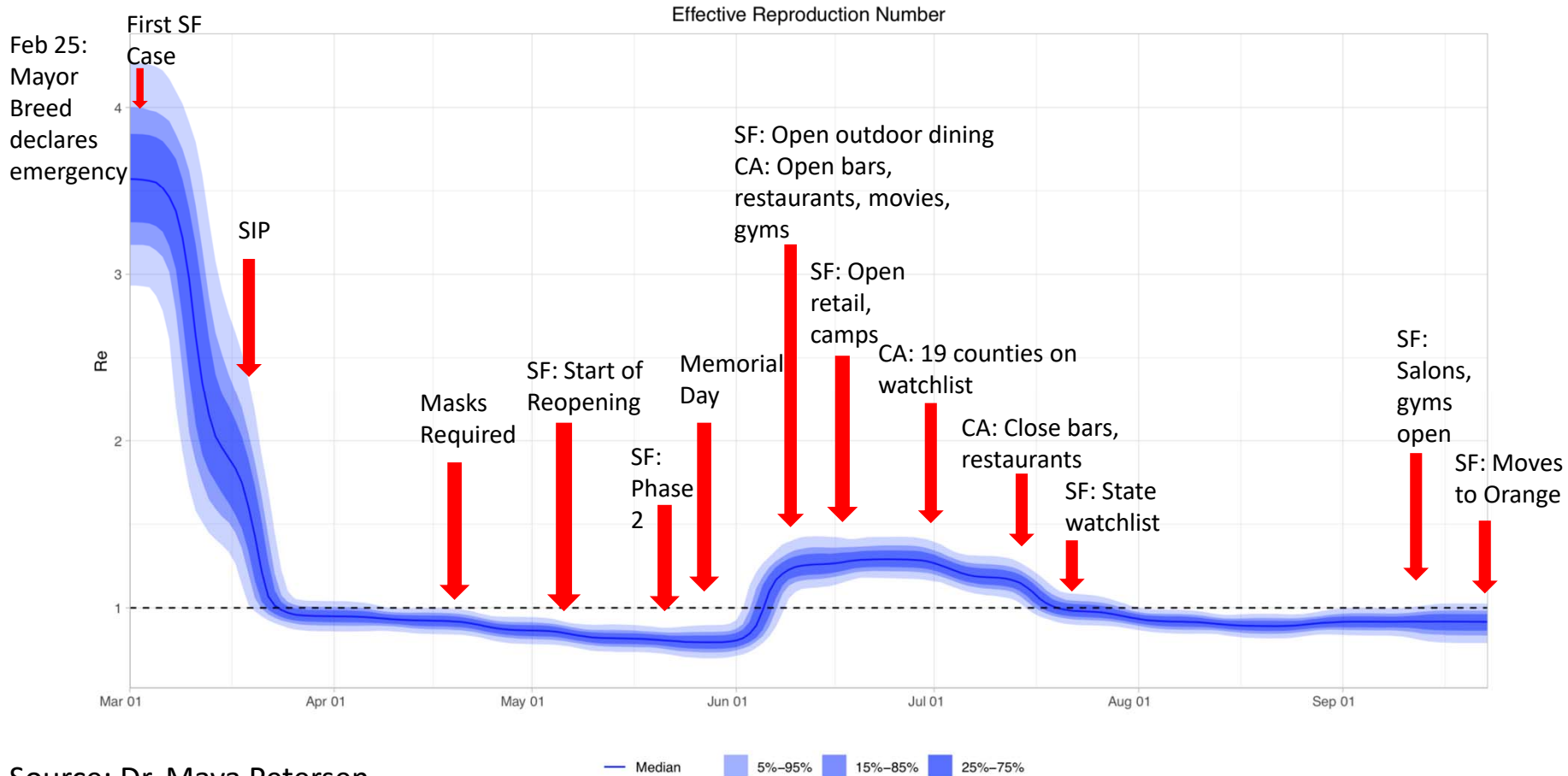
Press conference issuing shelter-in-place order for Bay Area region, Santa Clara County, Mar 16, 2020



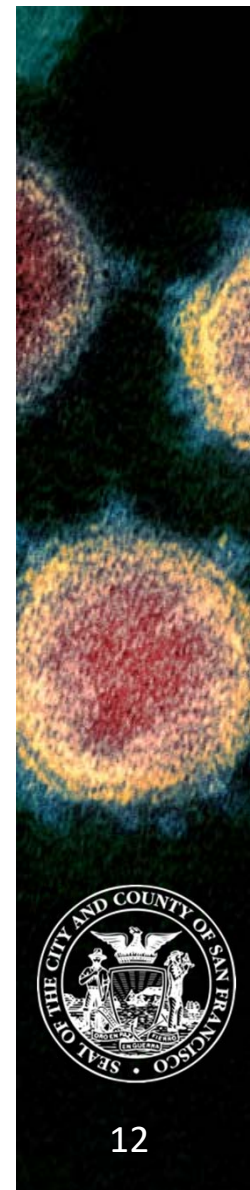
Bay Area health officers issue shelter-in-place order for San Mateo County (Scott Morrow), Marin County (Matt Willis), Santa Clara County (Sara Cody), Alameda County (Erica Pan), San Francisco (Tomás Aragón), City of Berkeley (Lisa Hernandez), and Contra Costa County (Chris Farnitano). [LA Times, April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



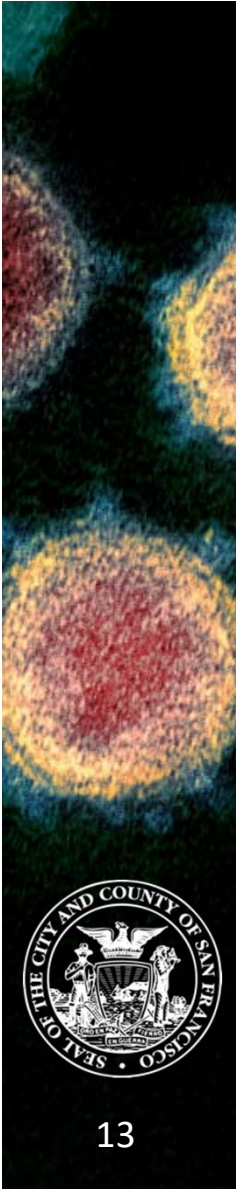
Re number since beginning of pandemic, SF



Source: Dr. Maya Petersen

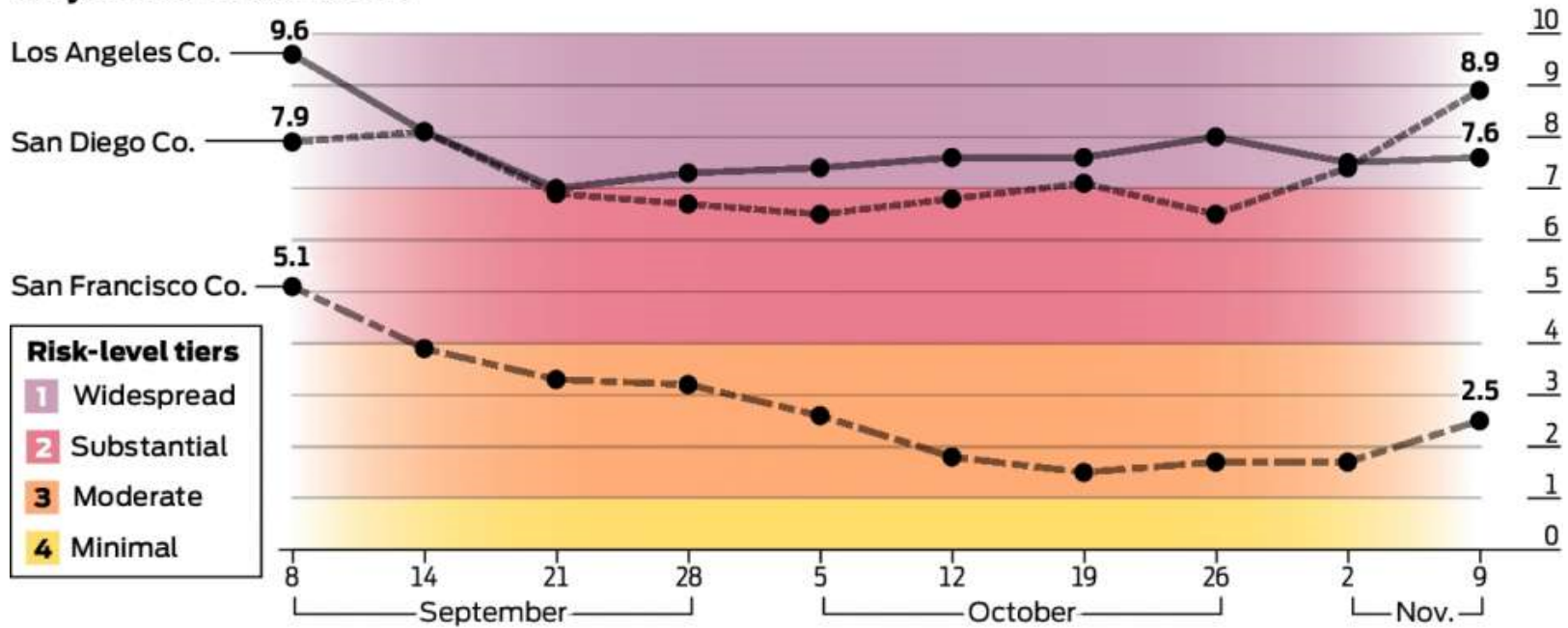


Transmission dynamics



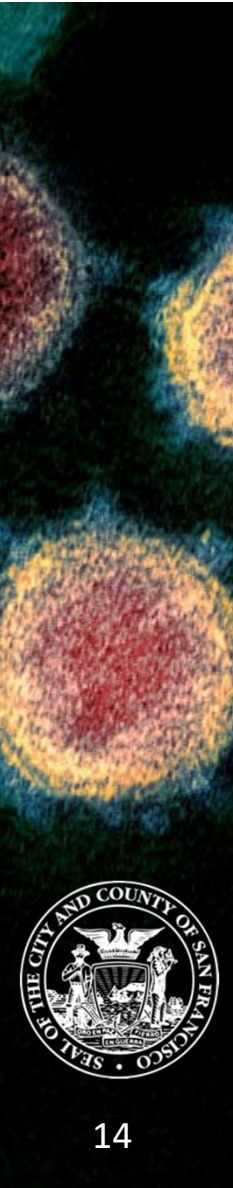
California Blueprint, Tiered Framework

Adjusted case rates

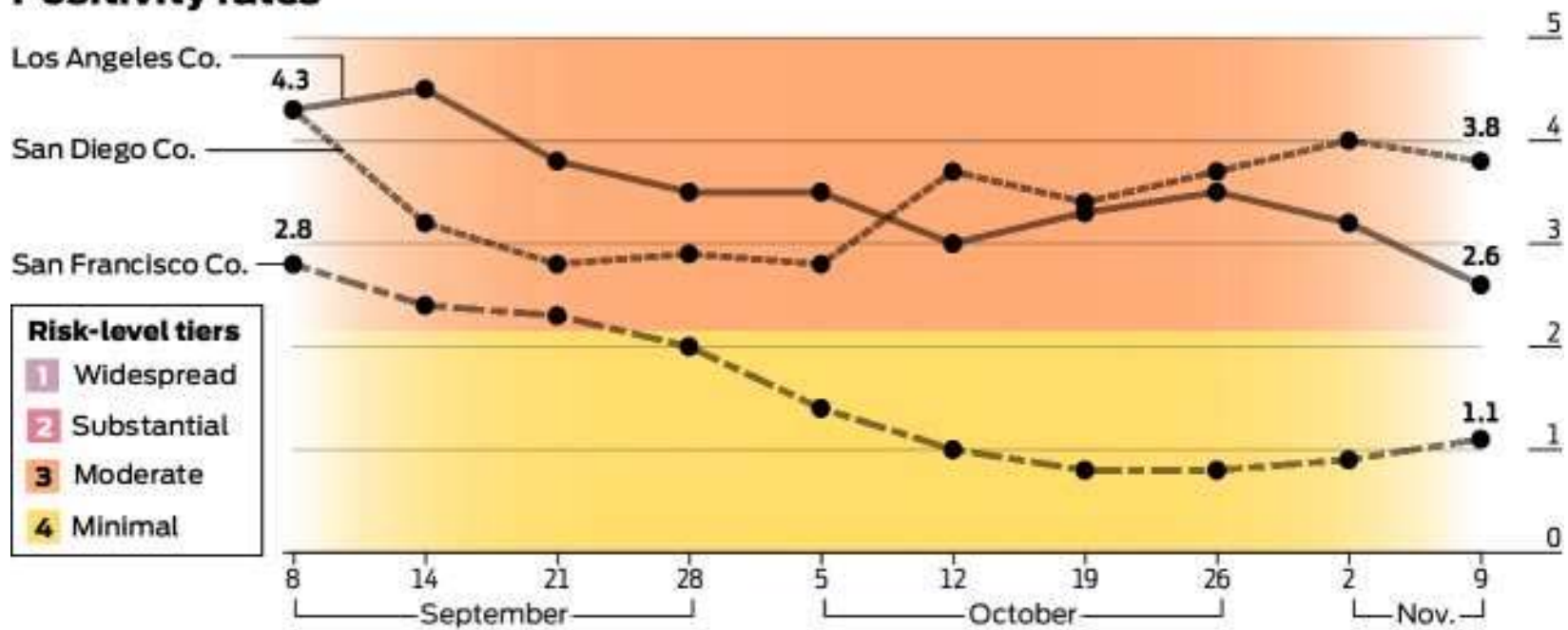


Source: California Department of Public Health

John Blanchard / The Chronicle



Positivity rates

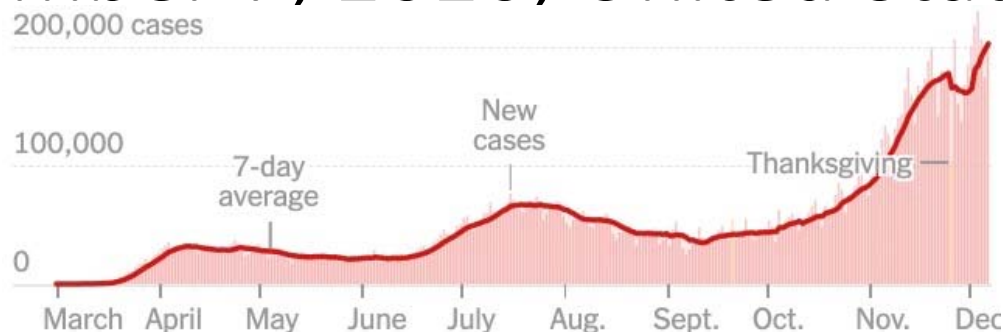


Source: California Department of Public Health

John Blanchard / The Chronicle



COVID-19 cases, deaths, and hospitalizations as of December 7, 2020, United States

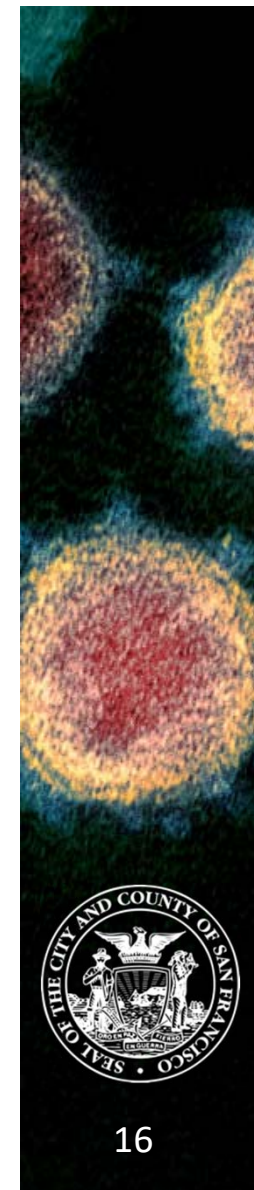


| | TOTAL REPORTED | ON DEC. 7 | 14-DAY CHANGE |
|---------------------|----------------------|----------------|---------------|
| Cases | 15.1 million+ | 202,424 | +17% → |
| Deaths | 285,070 | 1,533 | +47% → |
| Hospitalized | | 102,148 | +23% → |

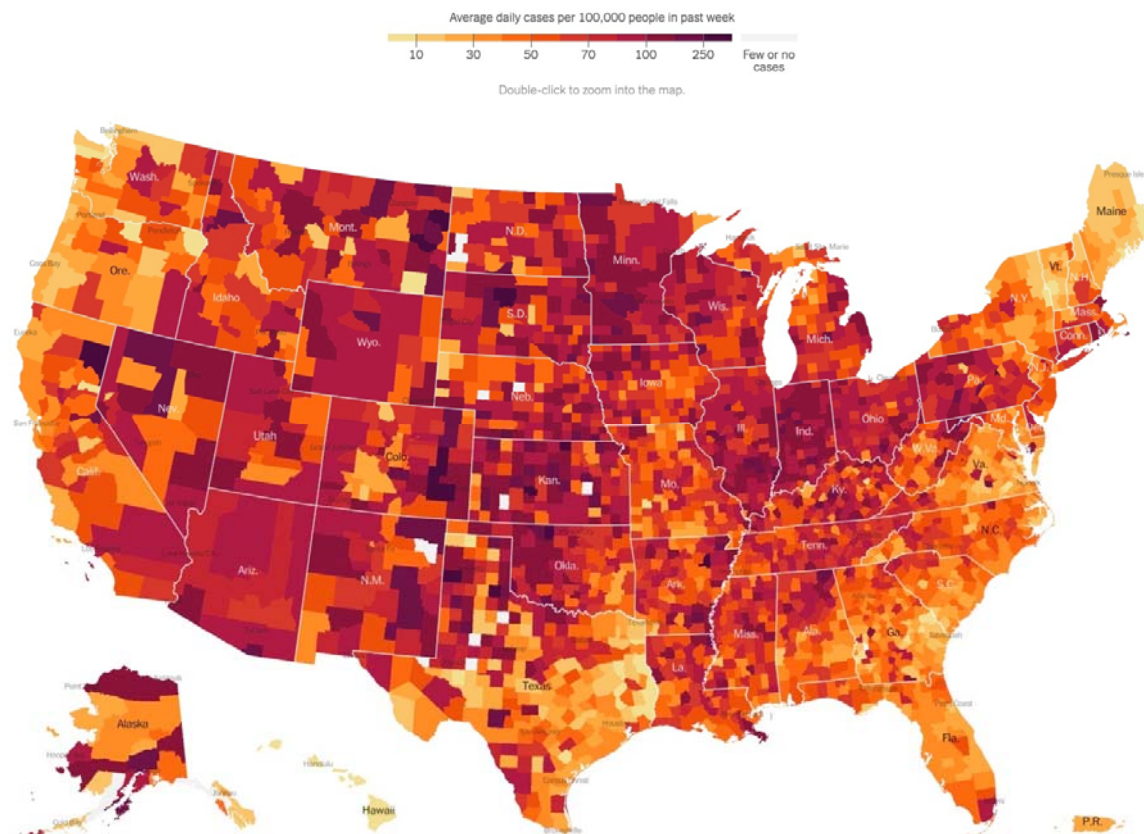
■ Day with data reporting anomaly.

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

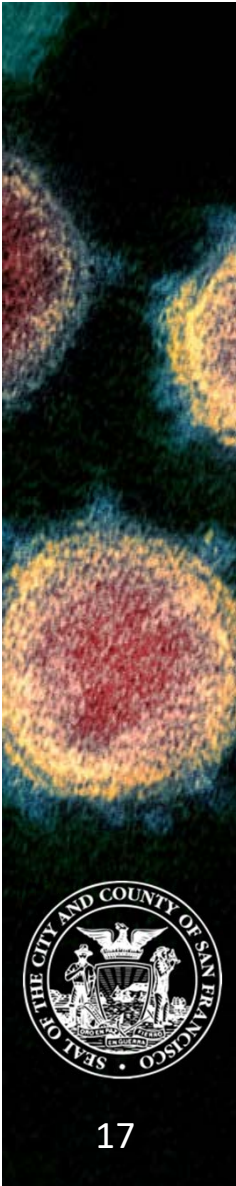
<https://www.nytimes.com/interactive/2020/us/coronavirus-us-cases.html>



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



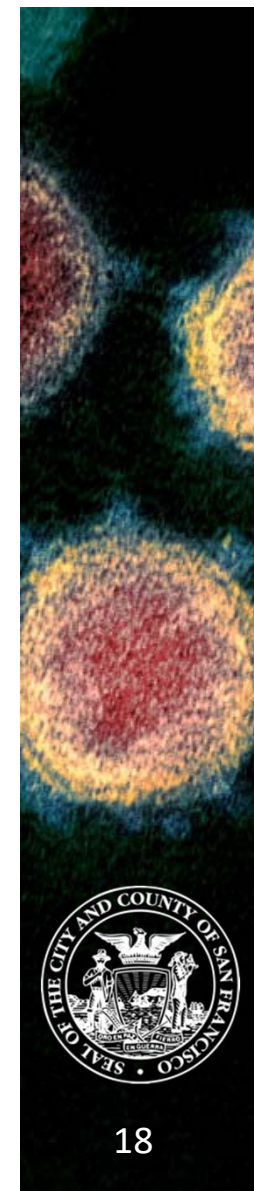
<https://www.nytimes.com/interactive/2020/us/coronavirus-us-cases.html>



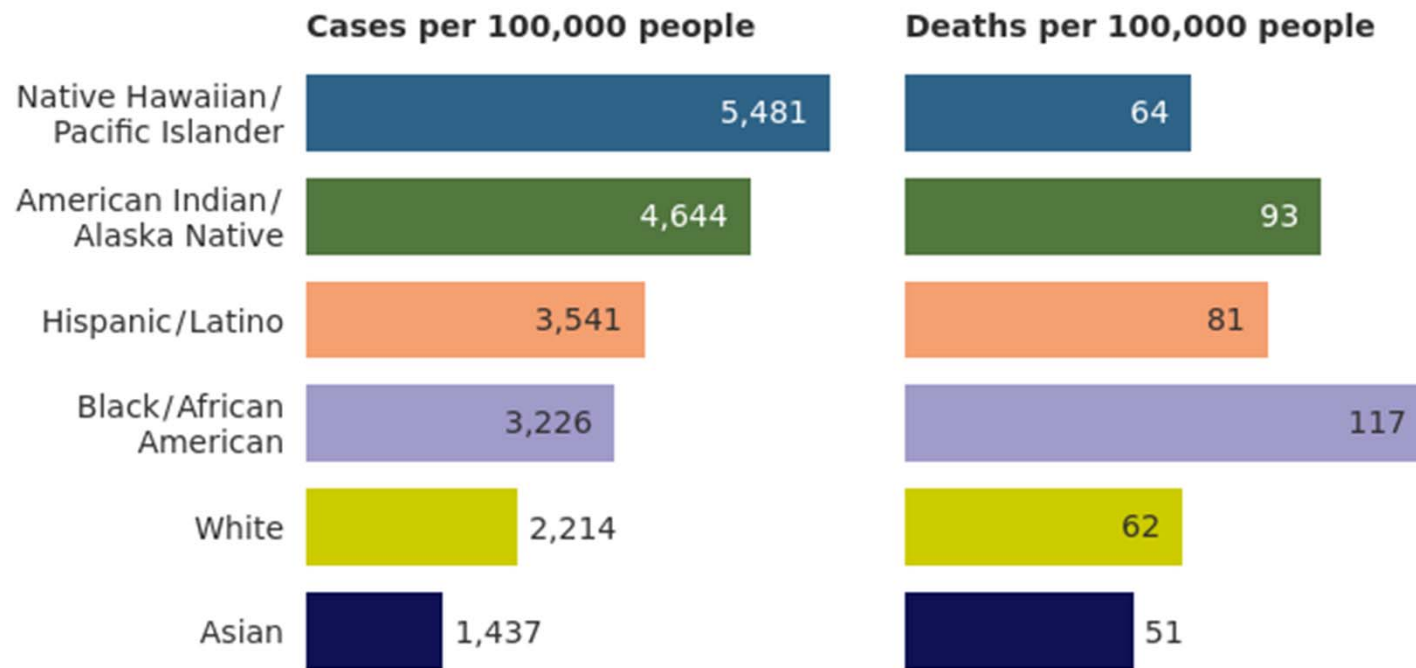
COVID-19 Hospitalization and Death by Race/Ethnicity, United States, November 30, 2020

| Rate ratios compared to White, Non-Hispanic persons | American Indian or Alaska Native, Non-Hispanic persons | Asian, Non-Hispanic persons | Black or African American, Non-Hispanic persons | Hispanic or Latino persons |
|---|--|-----------------------------|---|----------------------------|
| Cases ¹ | 1.8x | 0.6x | 1.4x | 1.7x |
| Hospitalization ² | 4.0x | 1.2x | 3.7x | 4.1x |
| Death ³ | 2.6x | 1.1x | 2.8x | 2.8x |

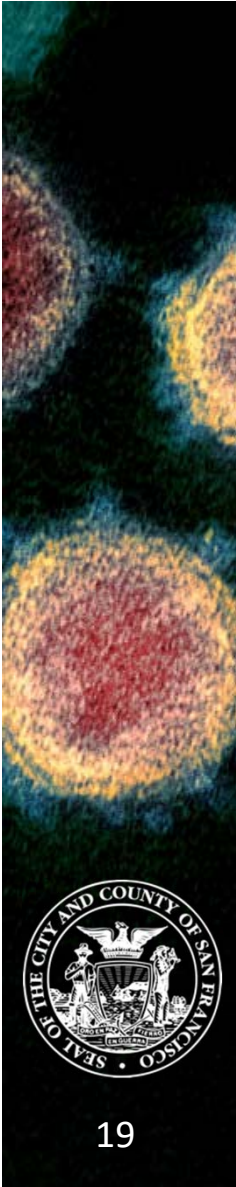
<https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-race-ethnicity.html>



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



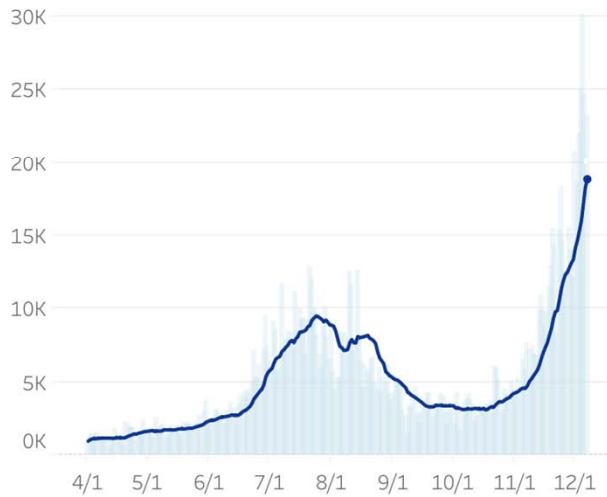
Source: <https://covidtracking.com/race>



Daily cases and deaths, California, 12/08/20

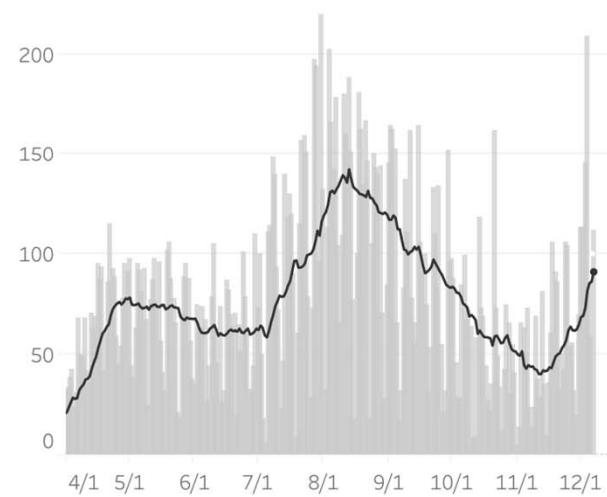
Total cases in California

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

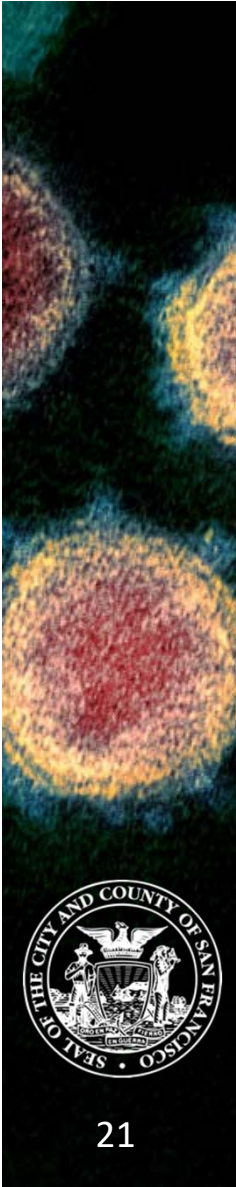
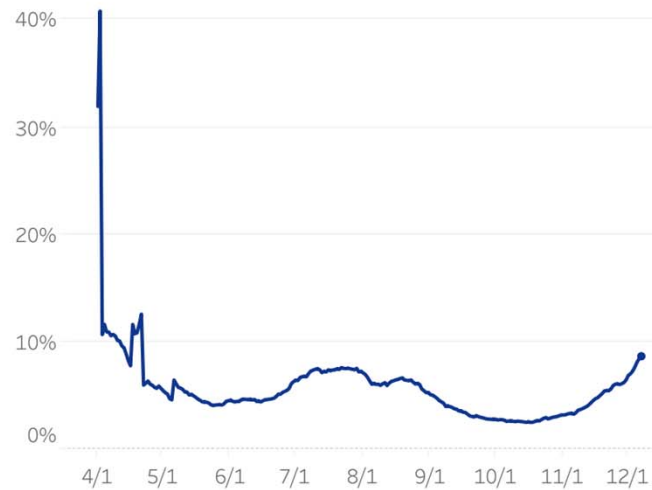
Total tests reported in California

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

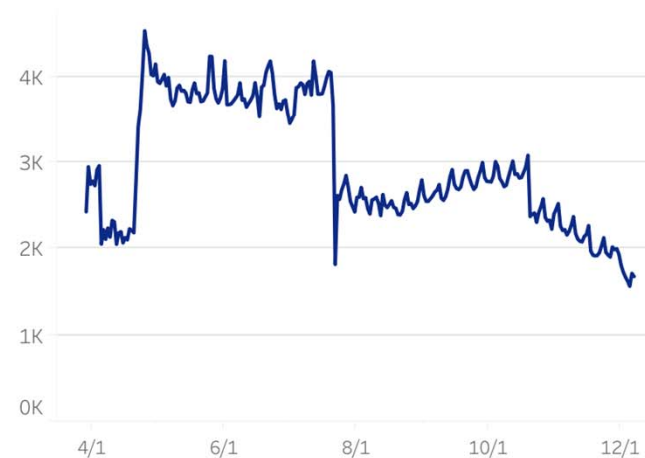
Hospitalized ICU

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

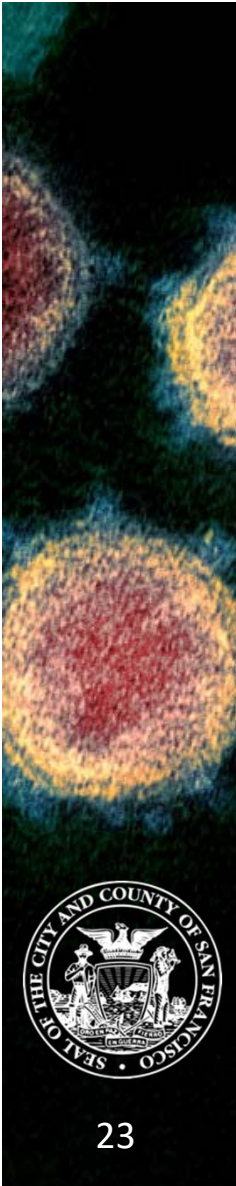
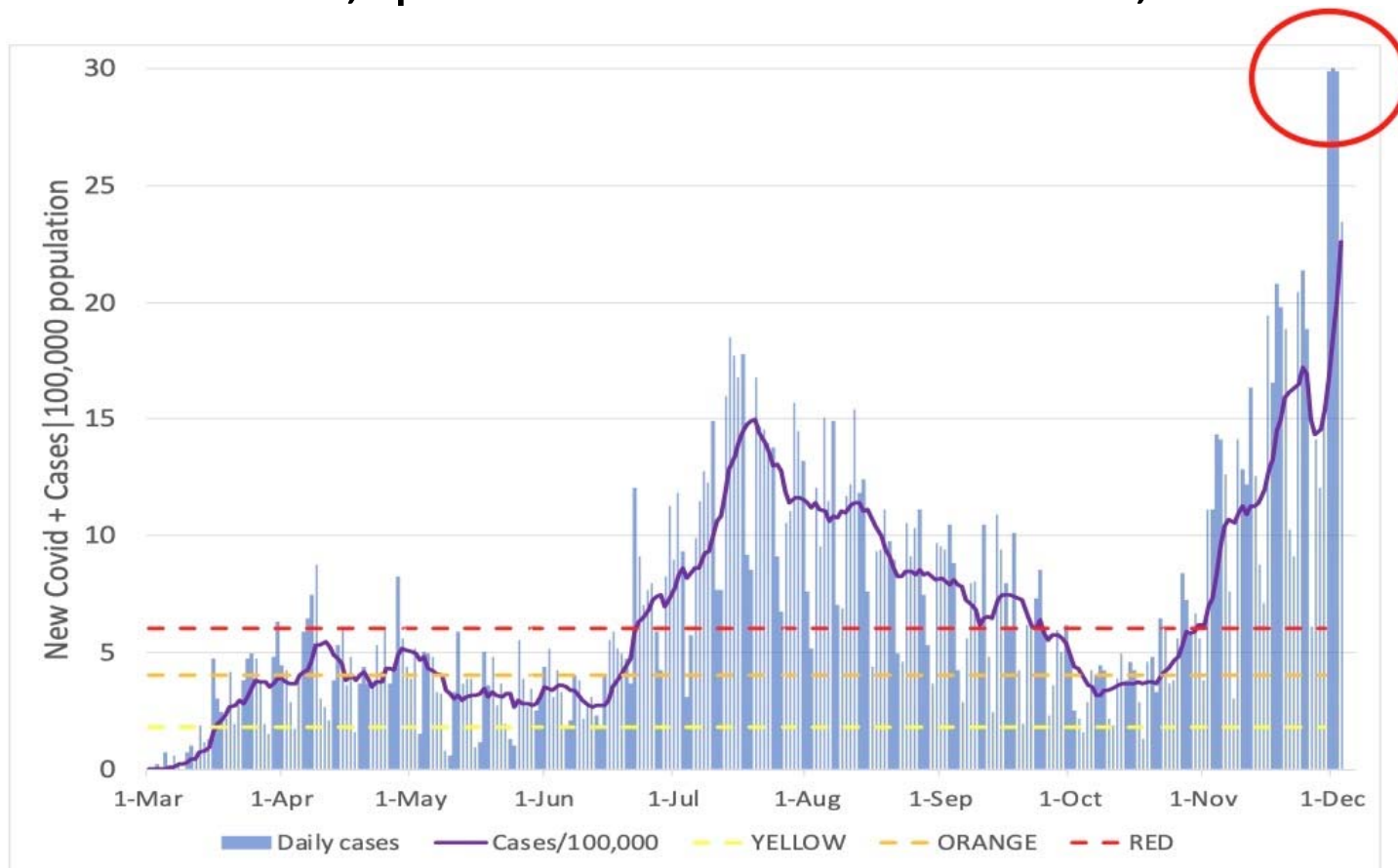


ICU beds in California

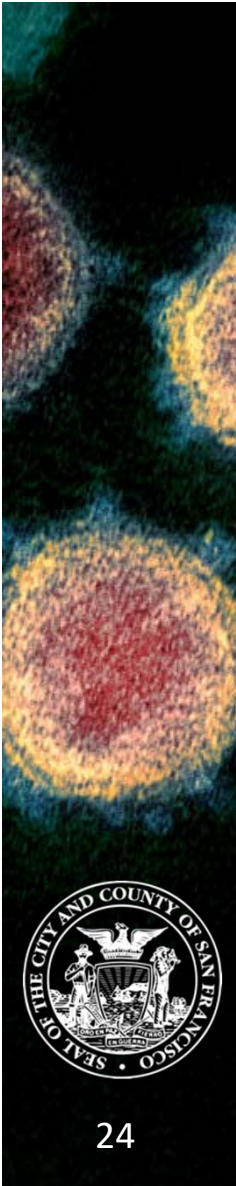
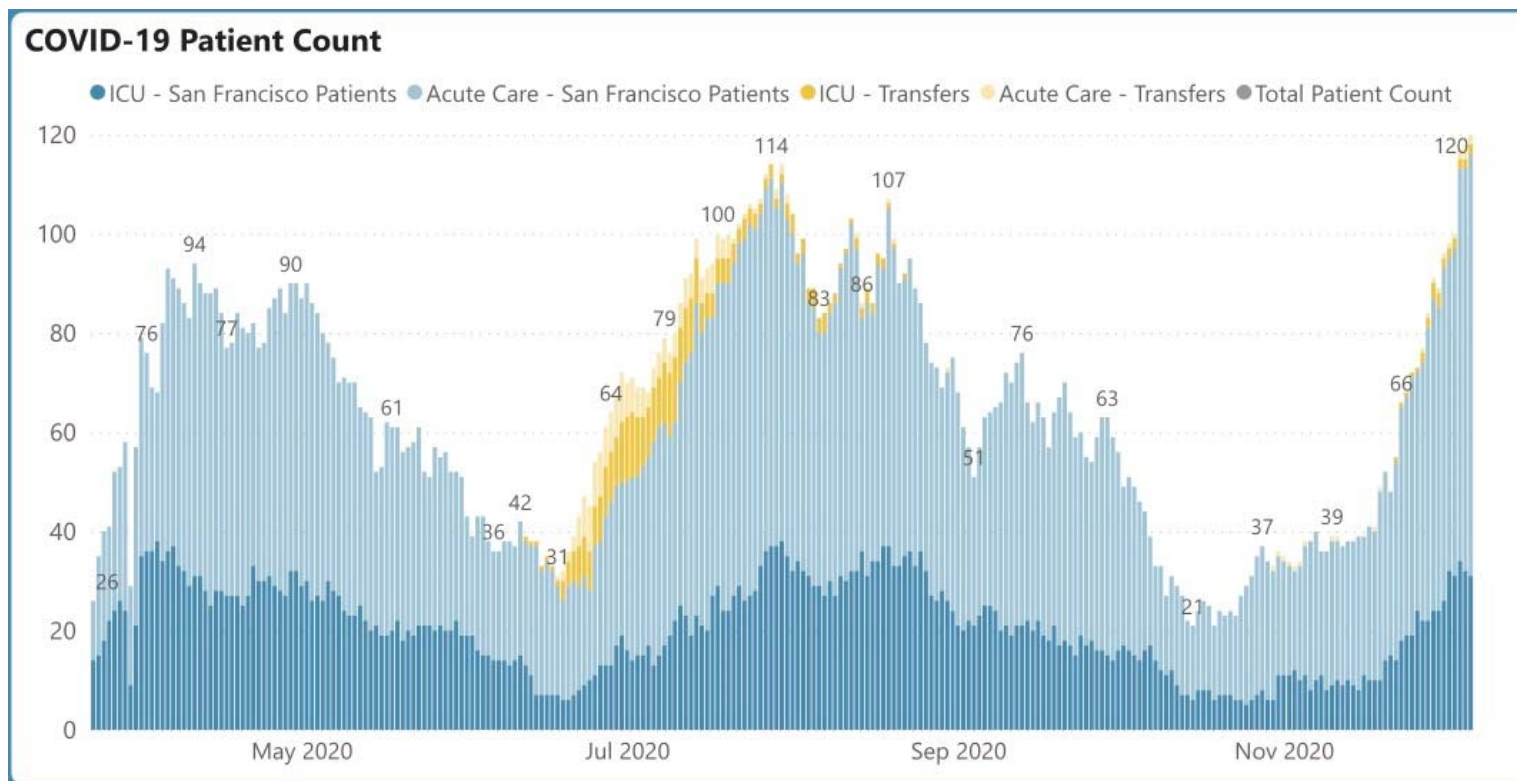
1,679 ICU beds available
35 decrease from prior day



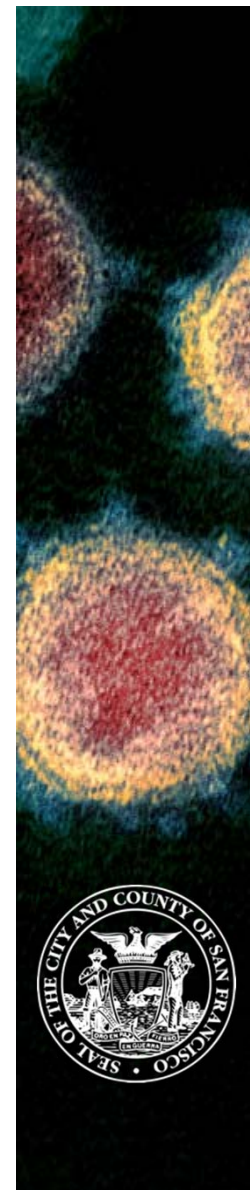
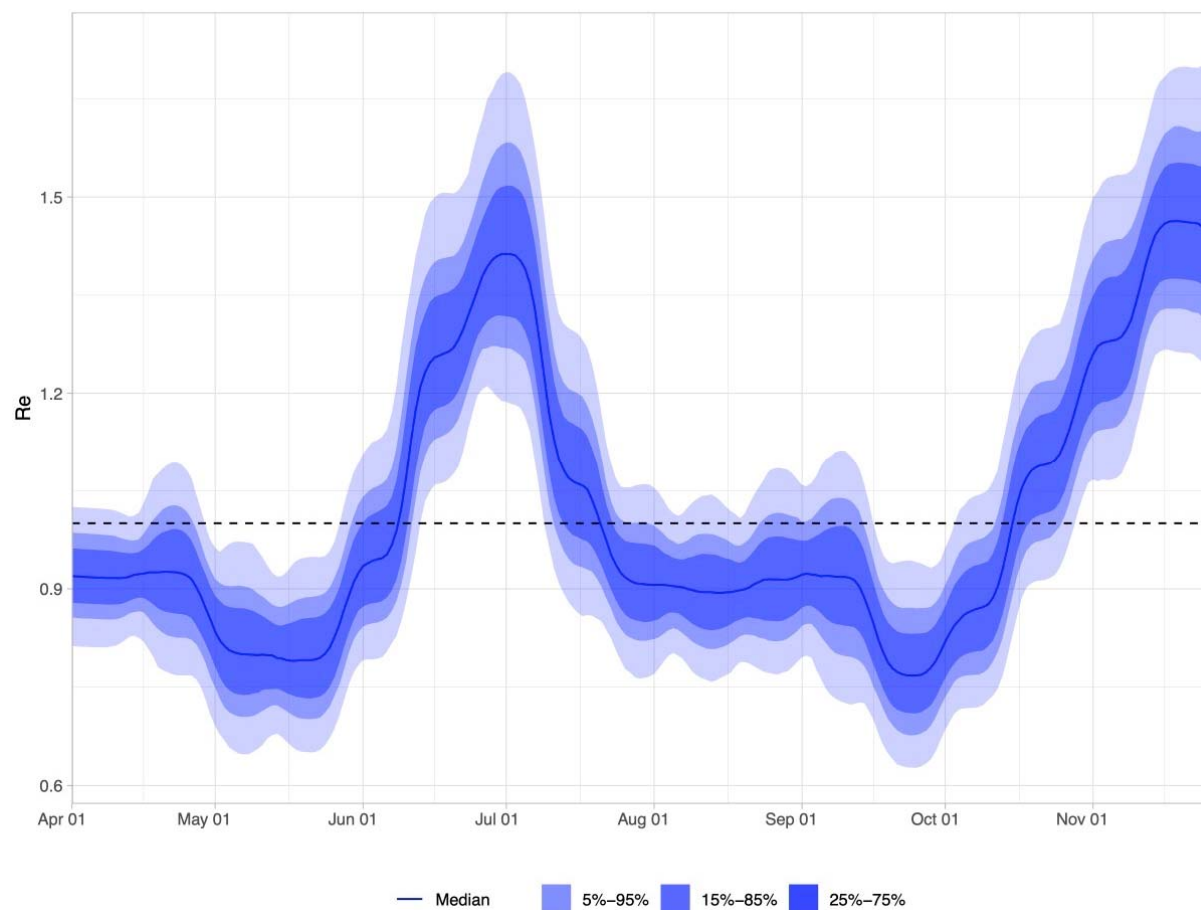
7-day average daily COVID-19 case rates, San Francisco, posted December 7, 2020



COVID-19 hospitalizations, San Francisco, December 6, 2020



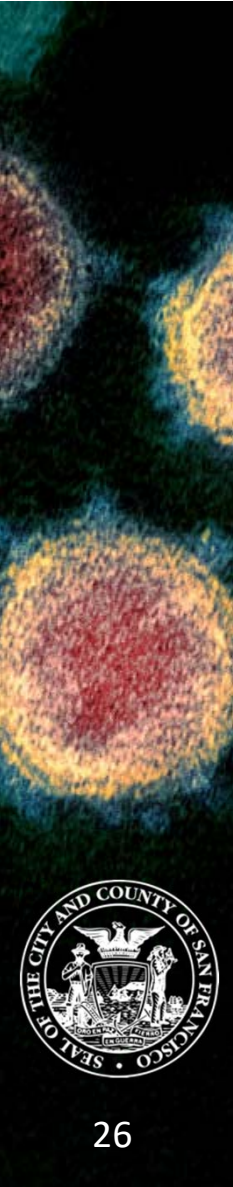
Effective reproductive number, Re , 11/27/20



Effective reproductive numbers for Bay Area counties, December 7, 2020

| County | Effective reproductive number (R_e) |
|---------------|---|
| Alameda | 1.48 |
| Contra Costa | 1.41 |
| Marin | 1.40 |
| San Francisco | 1.43 |
| San Mateo | 1.62 |
| Santa Clara | 1.38 |

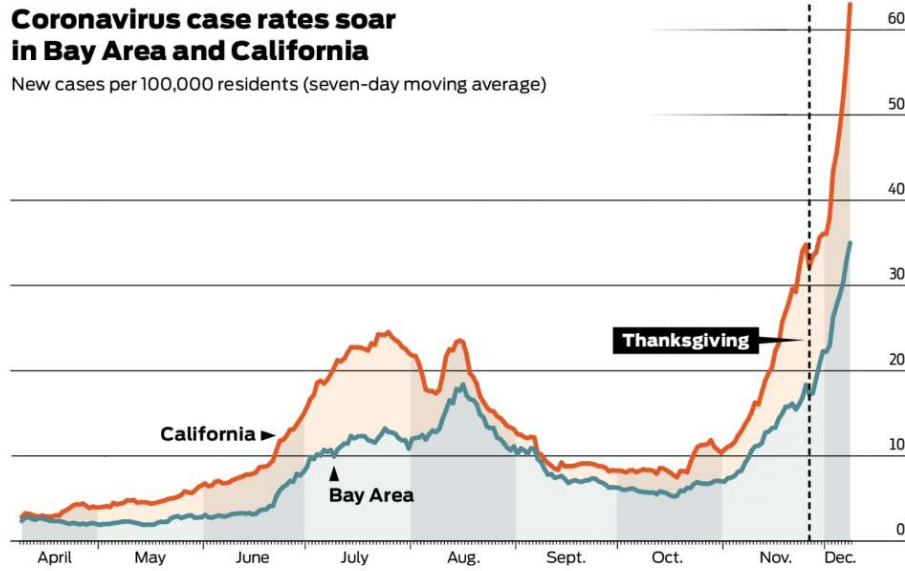
Source: Joshua Schwab, Maya Petersen (<https://github.com/LocalEpi/LEMMA>)



COVID-19 daily case rates, Bay Area, SF Chronicle, December 9, 2020

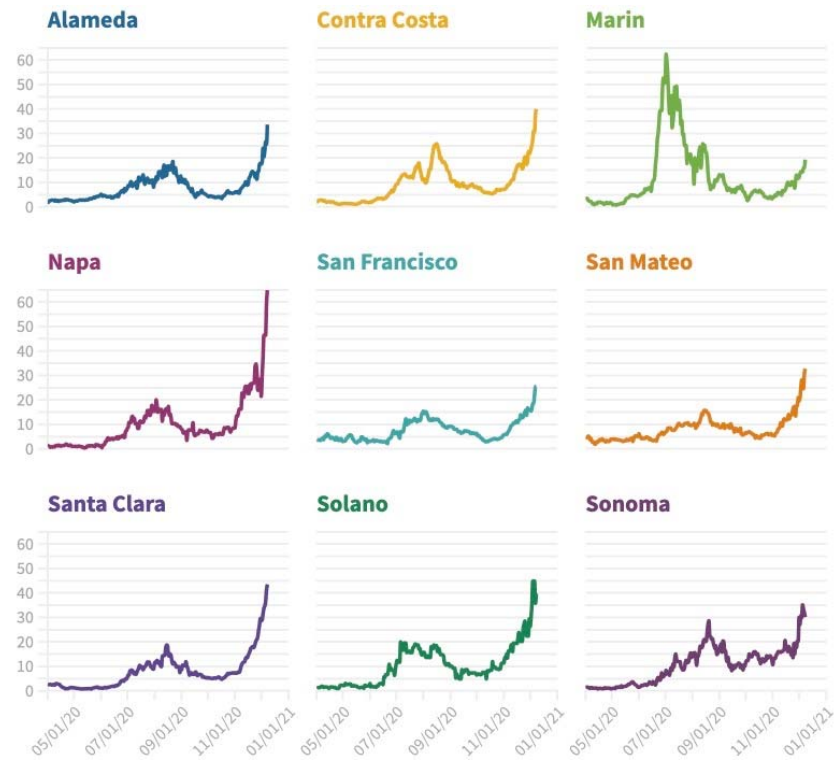
Coronavirus case rates soar in Bay Area and California

New cases per 100,000 residents (seven-day moving average)

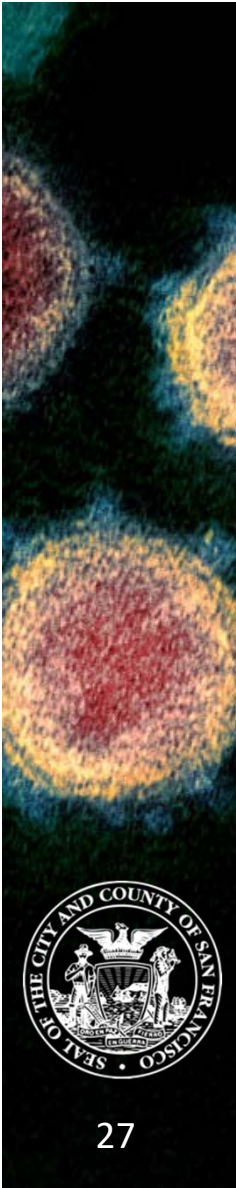


Source: Chronicle/L.A. Times data collaboration

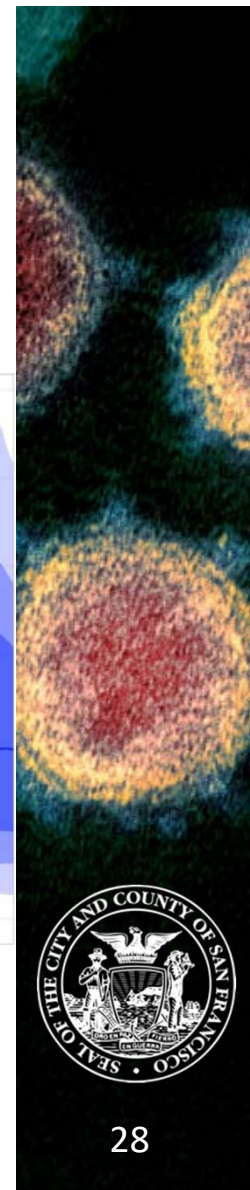
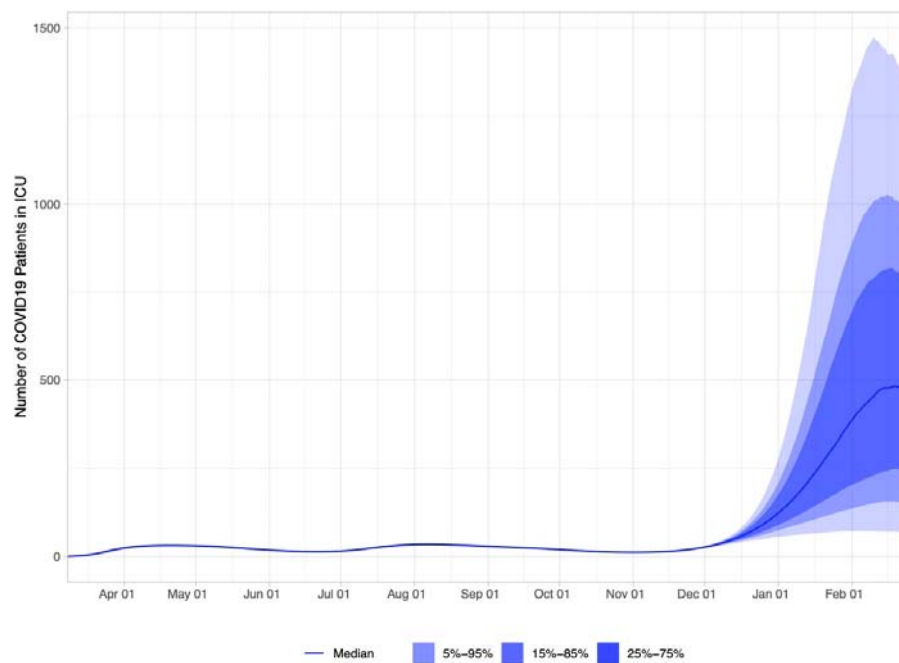
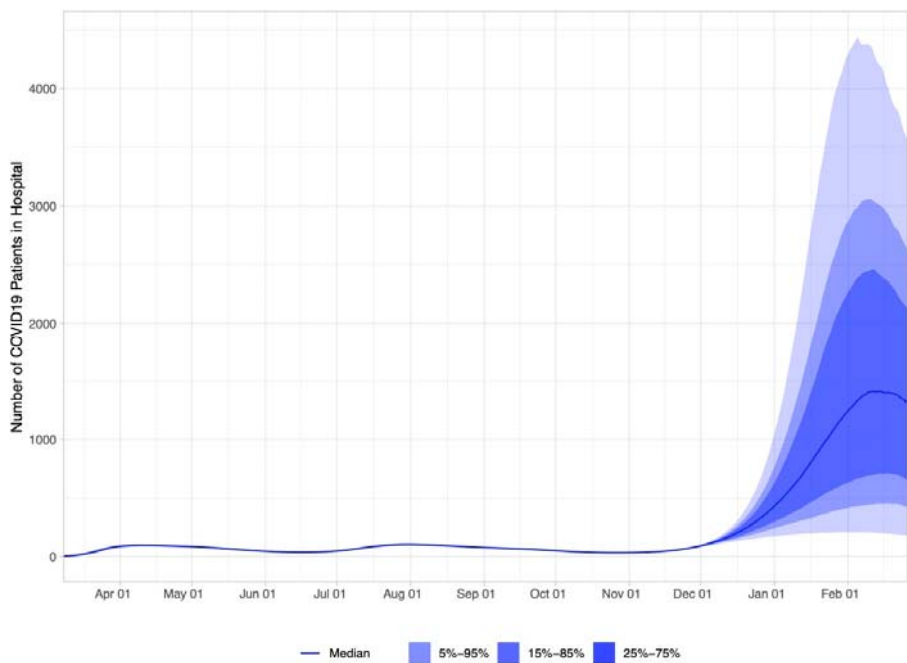
Todd Trumbull / The Chronicle



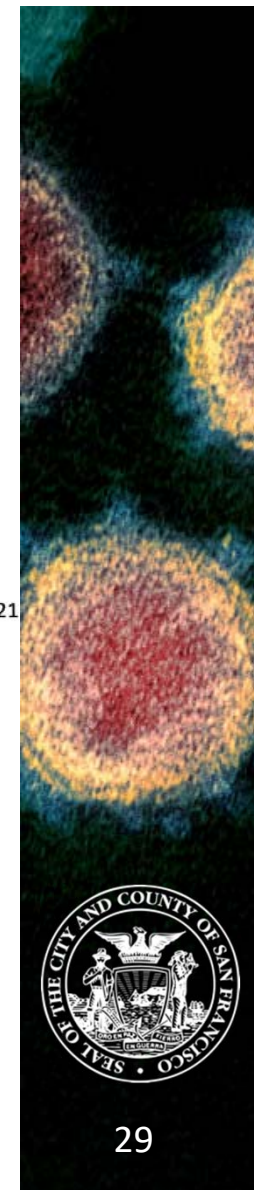
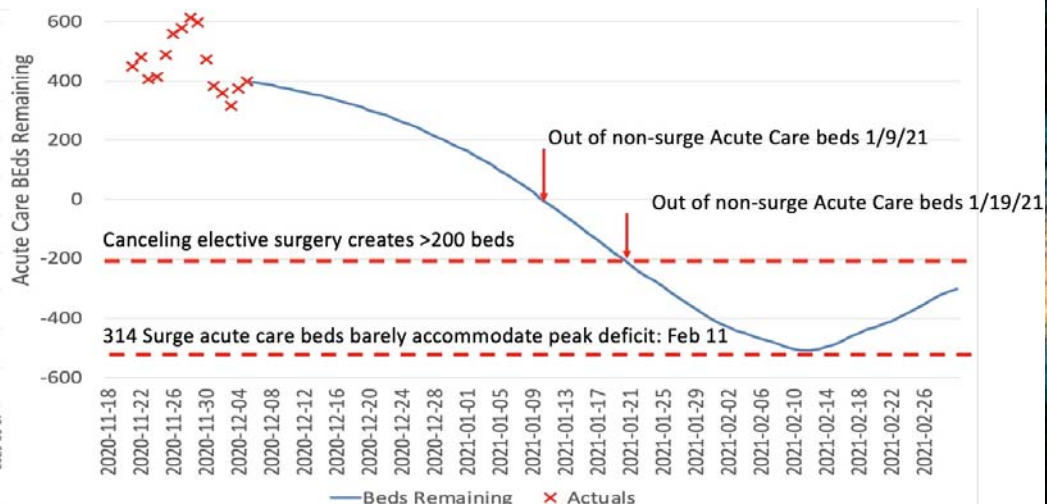
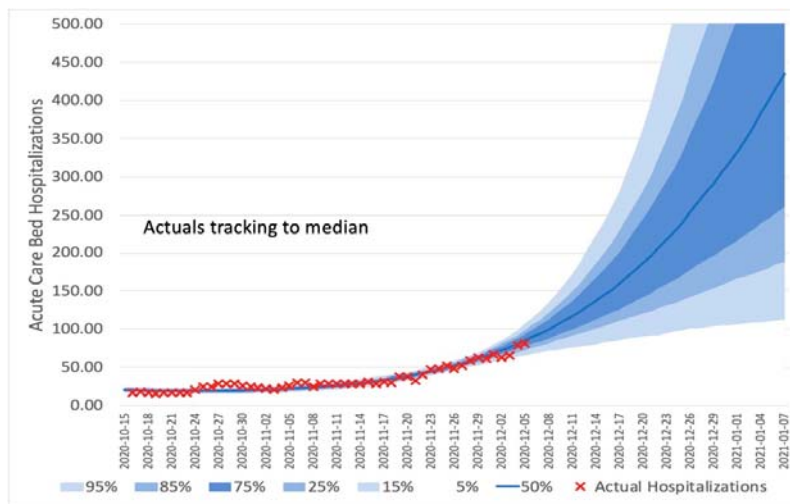
<https://www.sfchronicle.com/bayarea/article/Charts-show-how-bad-the-COVID-surge-has-been-in-15786275.php>



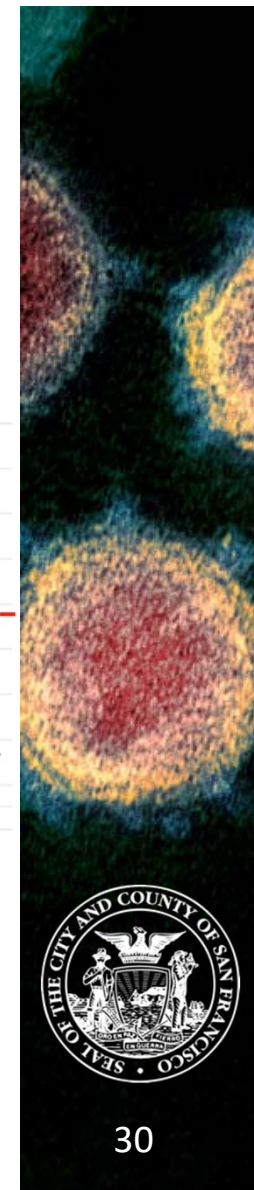
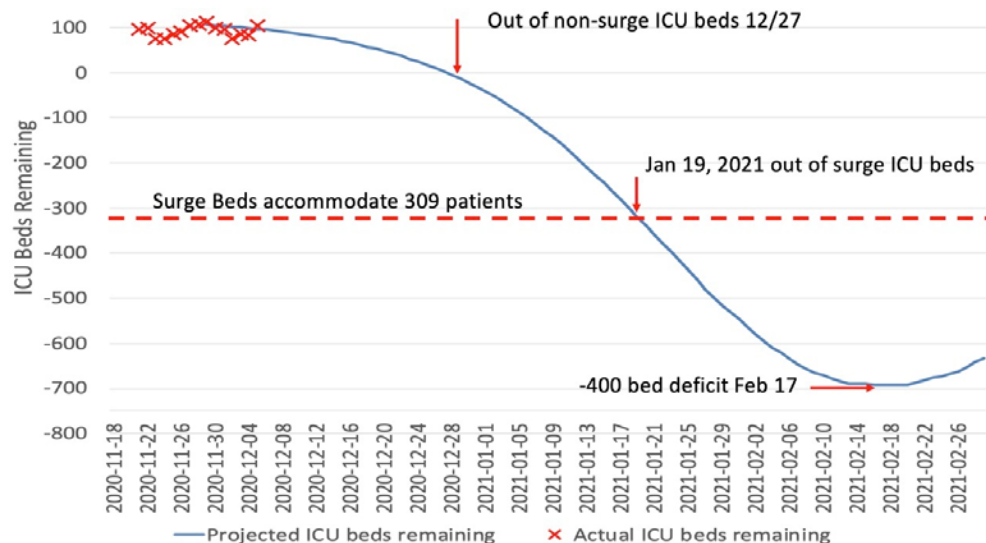
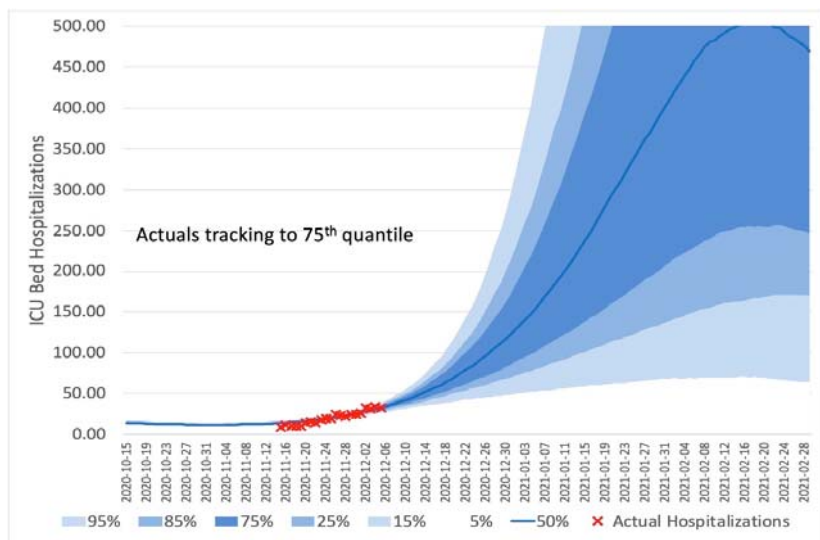
Long term hospitalization and ICU projections, San Francisco, December 6, 2020



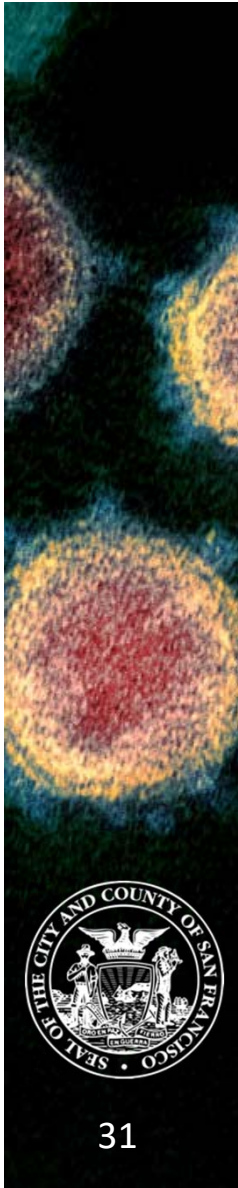
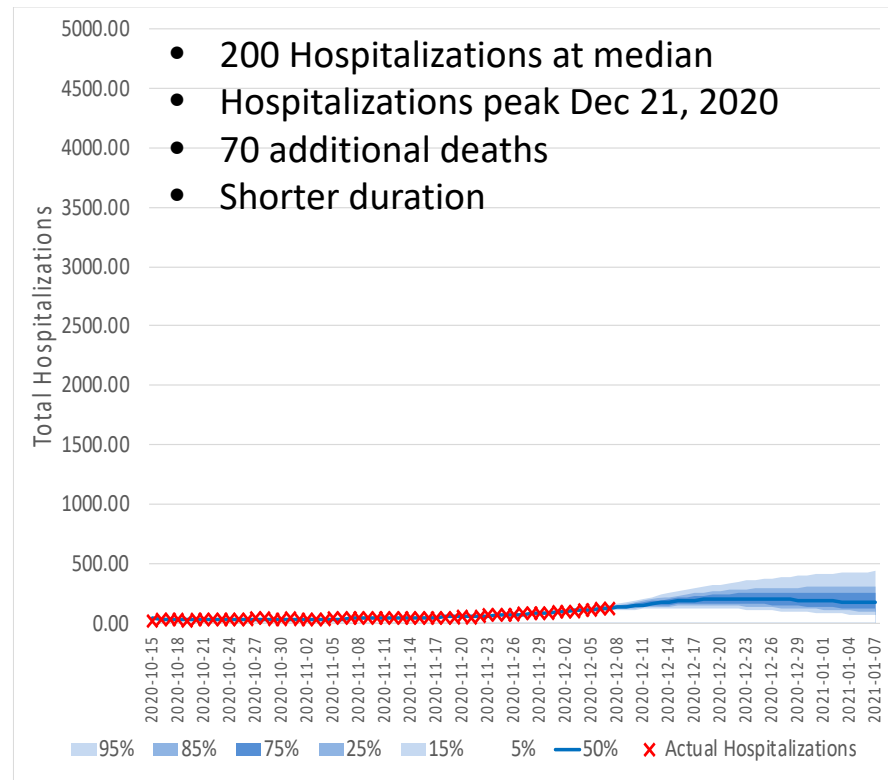
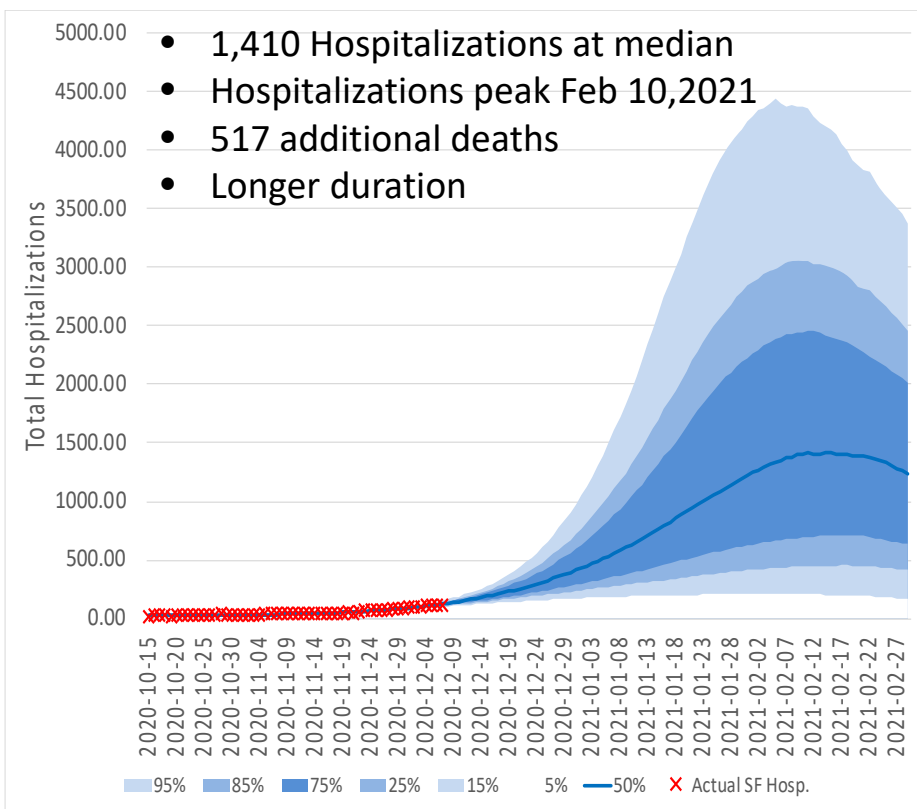
Acute care bed projections and capacity runway based on $Re = 1.45$, San Francisco, Dec 7, 2020



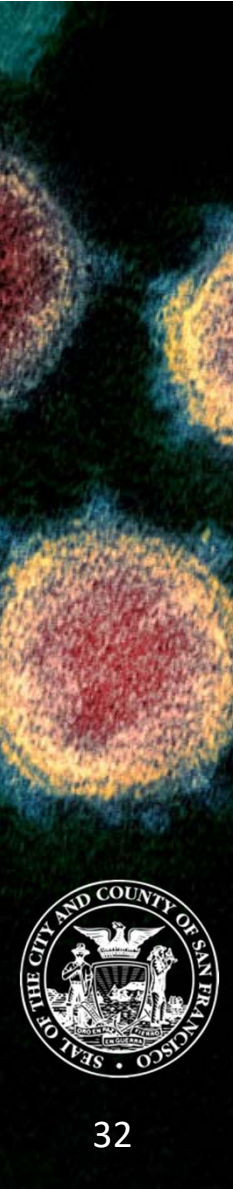
ICU bed projections and capacity runway based on $Re = 1.45$, San Francisco, December 7, 2020



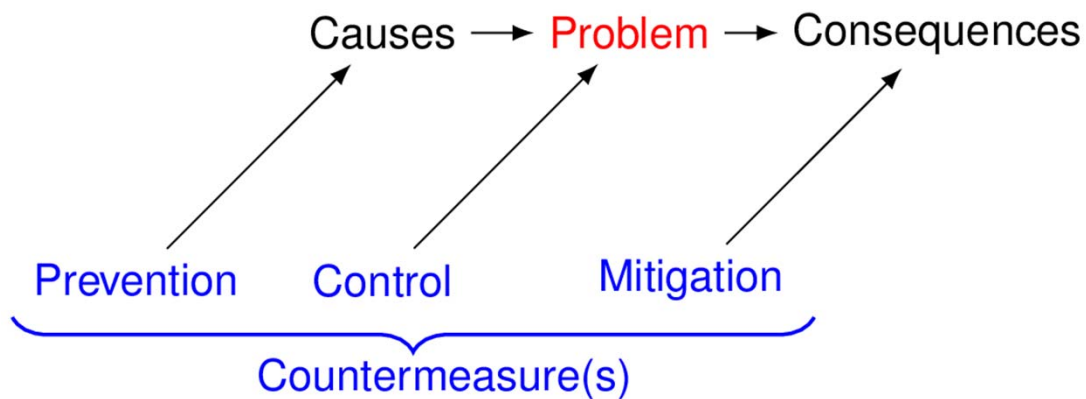
Two possible futures, San Francisco, CA



Transmission containment



PDSA problem-solving with causal thinking



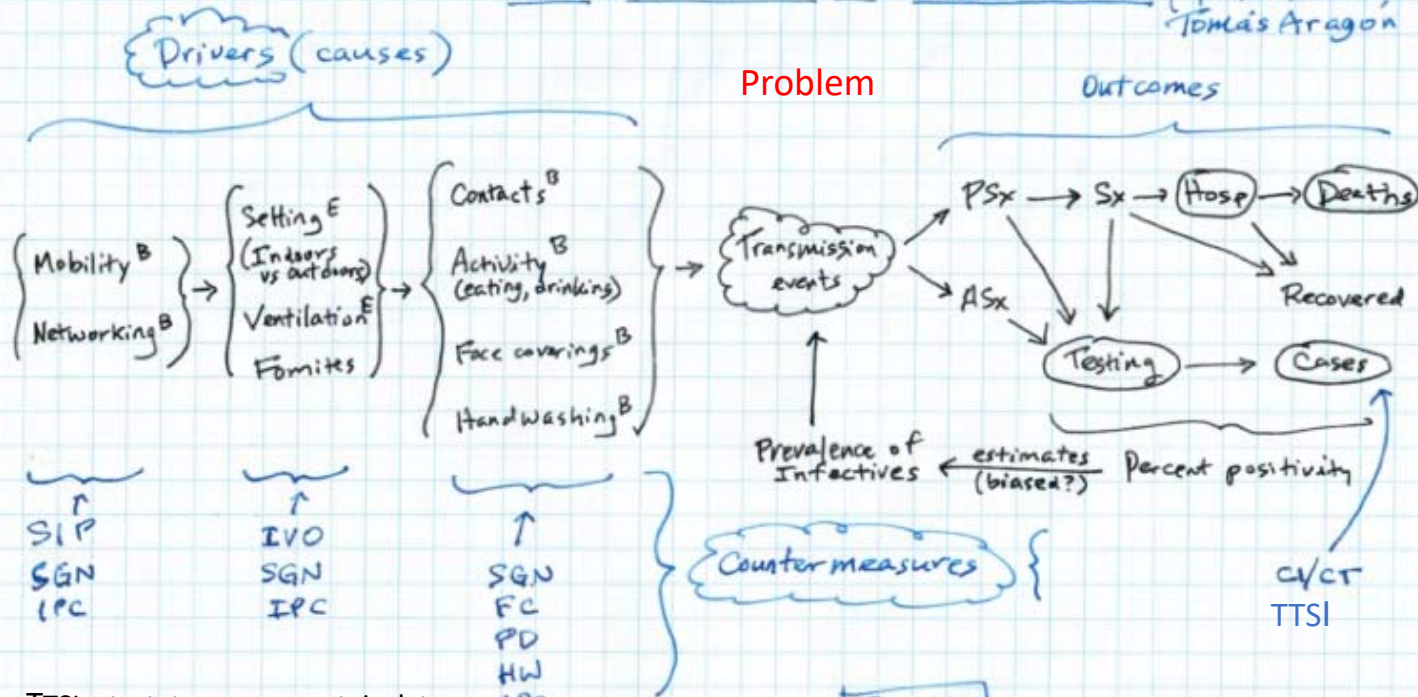
- 1. Plan:**
 - Problem definition
 - Root cause analysis
 - Consequence (risk) analysis
 - Countermeasure selection
- 2. Do:**
 - Countermeasure execution
- 3. Study:**
 - Countermeasure evaluation (causal analysis)
- 4. Act:**
 - Act on what you learn to improve.

Aragón TJ, et al. Crisis decision-making at the speed of COVID-19: Field report on issuing the first regional shelter-in-place orders in the United States. *J Public Health Management and Practice*. 2020.

https://journals.lww.com/jphmp/Fulltext/2021/01001/Crisis_Decision_Making_at_the_Speed_of_COVID_19_.aspx



CAUSAL FRAMEWORK FOR PROBLEM-SOLVING (8/22/20)
Tomás Aragón



TTSI = test, trace, support, isolate

Contacts = 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

○ = outcome measures

IPC = infection prevention & control

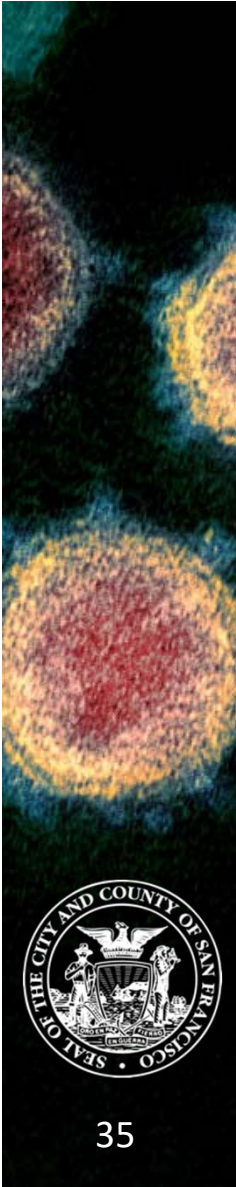
Insights

- 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

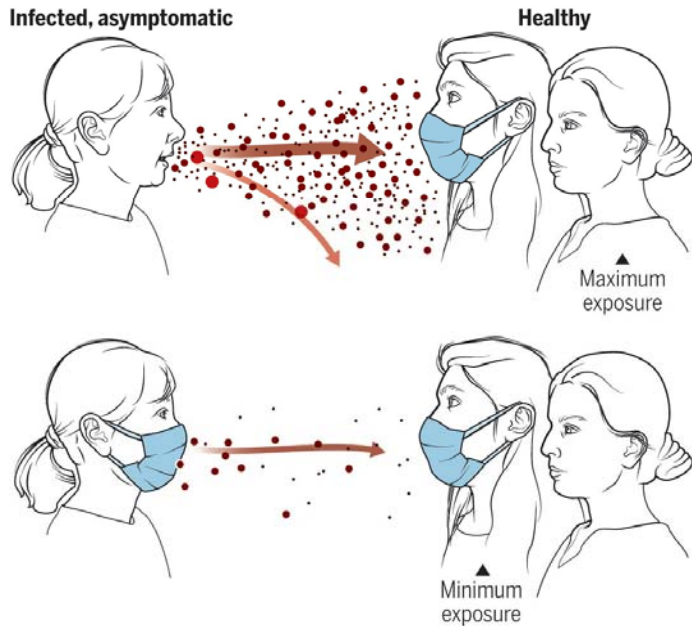
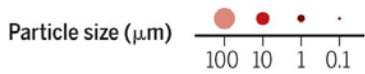
| No. | Risk category | subcategory | Comment |
|-----|----------------------|-------------------------|---|
| 1 | Mobility | | Leaving household |
| 2 | Gatherings | | Mixing with persons outside your household |
| 3 | Aerosol transmission | Respiratory protection | Protect self; also achieves source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



Risk-based criteria

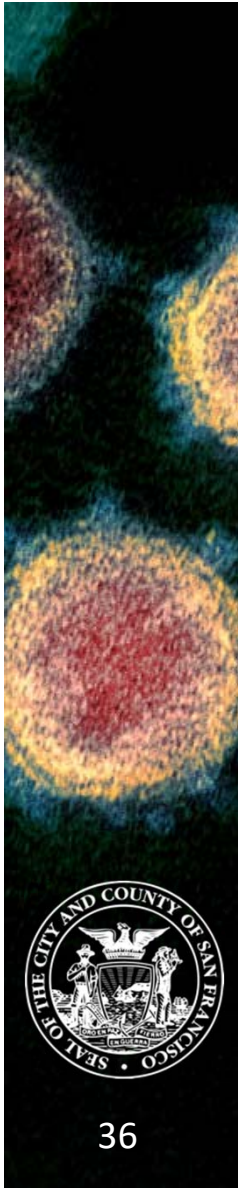
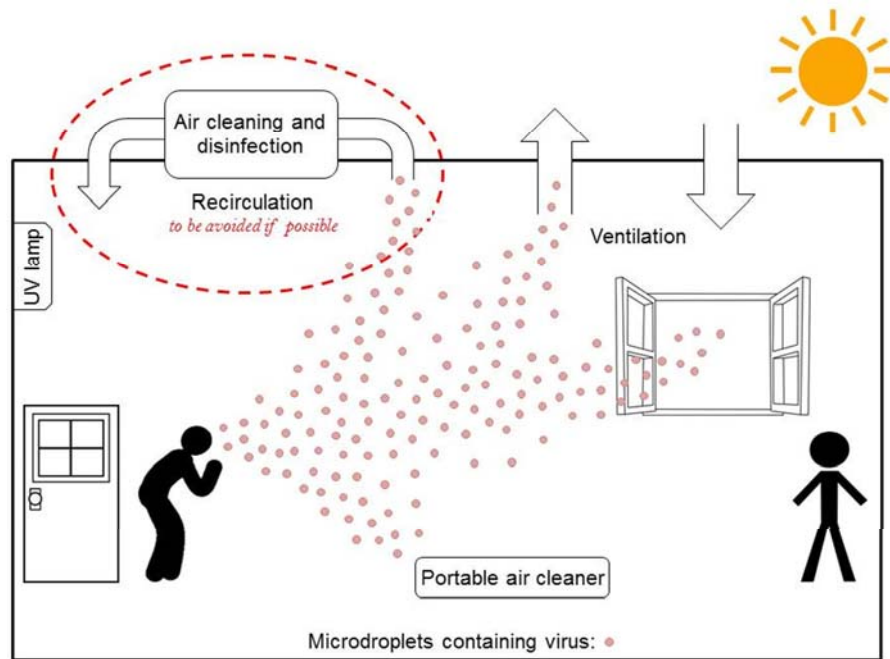
Masks reduce airborne transmission

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.



GRAPHIC: V. ALTOUNIAN/SCIENCE

- 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>



Questions?

