Who should you be talking to?
3 lessons in interdisciplinary problem-solving

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3 lessons

1) Your area isn’t the only one with unsolved questions

2) Find an expert in the right subsubdiscipline:
   - Good experts direct you to still more relevant experts
   - Bad experts propagate misconceptions instead

3) Math can be a common language
Contact tracing

41% of SARS-CoV-2 transmission is *before* symptoms appear (Ferretti et al. medRxiv 2020.09.04.20188516)

– Isolating the symptomatic isn’t enough
– Find and quarantine contacts before they transmit to anyone else
For SARS-CoV-2, contact tracing must be fast

- Infected individuals could have transmitted long before the contact tracers find them
- Apps promise instant notification
Design spec for exposure notification

Get the right people to quarantine in time, and let everyone else go back to living more normally
Design spec for exposure notification

Get the right people to quarantine in time, and let everyone else go back to living more normally
  – 6 feet 15 minutes from someone -2 to +9 days relative to symptom onset
  – Infected

1) Your area isn’t the only one with unsolved questions
Proximity in public transit

RESEARCH ARTICLE
Measurement-based evaluation of Google/Apple Exposure Notification API for proximity detection in a light-rail tram

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Abstract
We report on the results of a Covid-19 contact tracing app measurement study carried out on a standard design of European commuter tram. Our measurements indicate that in the tram there is little correlation between Bluetooth received signal strength and distance between handsets. We applied the detection rules used by the Italian, Swiss and German apps to our measurement data and also characterised the impact on performance of changes in the parameters used in these detection rules. We find that the Swiss and German detection rules trigger no exposure notifications on our data, while the Italian detection rule generates a true positive rate of 50% and a false positive rate of 50%. Our analysis indicates that the performance of such detection rules is similar to that of triggering notifications by randomly selecting from the participants in our experiments, regardless of proximity.
What’s up with the 6 foot rule then?

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../public health/exposure science/aerosols/viral aerosols
Not ../public health/epidemiology
Particles come in a range of sizes
Where did 15 minutes come from?

• Murky: some early case study of smallpox?
• Dose scales linearly over time, of course
• Another propagated misconception is the **minimum infectious dose**
  – Makes testable prediction that dose-response curves will curve
  – They don’t
Targeting notifications to the infected

1. Infectiousness of primary case
   - 10-fold variation depending on timing relative to symptom onset

2. Duration of exposure
   - Proportional (no magic about 15 minutes)

3. Distance/BlueTooth signal
   - Limited information about infection, even for known distance

3) Math can be a common language re importance of each factor

Wilson et al. (2021) “Quantifying SARS-CoV-2 infection risk within the Google/Apple exposure notification framework to inform quarantine recommendations” accepted at Risk Analysis, medrxiv 2020.07.17.20156539
Distance is informative because of human behavior, not physics

- Natural distance when talking
- Correlation between being close and face to face interaction

Wilson et al. (2021) “Quantifying SARS-CoV-2 infection risk within the Google/Apple exposure notification framework to inform quarantine recommendations” accepted at *Risk Analysis*, medrxiv 2020.07.17.20156539
BlueTooth weights don’t matter in the real world. Threshold does.

- Beta test of daily life in real workplace
- Ground truth from QR code scans
3. Math can be a common language

- Not everyone in public health / biomedical science speaks it
- Often argue for “conservative” intermediate assumptions
  = treating risk inconsistently
- Final risk threshold sets conservative vs permissive
What risk should trigger quarantine?

• This is an economics question (with lots of math)
• Hard to compare lives vs. livelihoods
• Exploit fact that R(t) tends to average to 1 in the long run
• R(t) reduction achieved either by
  – selective quarantine/isolation
  – indiscriminate social distancing
  – same units: reduction in social contact per person per day

What risk should trigger quarantine?

• Optimal is to quarantine anyone who, on that day, has higher Expected(transmissions) than those not in quarantine
  – Will lead to larger number of mostly shorter quarantines
• More information on E(transmissions) means less staying home to achieve same R(t)
  – good assessment of infection risk
  – negative test results

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1. infectiousness of primary case
   – 10-fold variation depending on timing relative to symptom onset
   – superspreader status (20% cases → 80% infections)
2. duration of exposure
   – proportional (no magic about 15 minutes)
3. distance/BlueTooth signal
   – limited information about infection, even for known distance

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Broadcast-only beacons (GAEN compatible) that contact tracers can use to mark superspreader sites
Targeting notifications to the infected

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   - 10-fold variation depending on timing relative to symptom onset
   - Superspreader status (20% cases → 80% infections)

2. Duration of exposure
   - Proportional (no magic about 15 minutes)

3. Distance/BlueTooth signal
   - Limited information about infection, even for known distance
   - indoors vs outdoors (estimated 20-fold risk difference)

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Tradeoffs

Epidemiological effectiveness vs. Privacy/security

- Enough metadata with TEK to quantify infectiousness
- Ability to do backward contact tracing from superspreader events
- Actual threat
- Perception required to promote uptake

What is the relevant discipline to consult?
Not everyone agrees with choice

Covid-19 Apps Are Terrible—They Didn’t Have to Be

Jane Bambauer & Brian Ray

November 2020

Covid-19 apps in the United States have been ineffective as public health tools because they are designed primarily to protect privacy. Poor design choices, effectively mandated by Google and Apple, were driven by ongoing consumer privacy and national security debates that shortsightedly rejected tracking technologies.

How (Not) to Fight Covid-19

Sep 3, 2020 | Peter Singer, Joanna Masel

Public-health experts who adhere to rigid rules for containing the pandemic are standing in the way of new technologies that can help us develop a more flexible approach. By focusing on those with the highest risk of spreading the virus, we can inflict less harm and contain the pandemic more effectively.

Melbourne/Tucson – When Covid-19 first appeared, strict quarantine requirements and short, tight lockdowns would have been a small price to pay to keep it at bay. Now that the pandemic has infected over 26 million people in 213 countries and territories, we need to find new ways to control it that are not just effective, but also efficient.

To avoid inflicting more pain than necessary, we should target stay-at-home orders as precisely as possible to those who are most likely to pose a risk to others. This requires not just tracing the contacts of those who are infected, but also distinguishing which of their contacts are most likely to have been infected.

Here, technology can help. We should combine new apps that notify people when they have been exposed to a risk of infection with new testing methods that are fast, easy, and as readily available as pregnancy tests. Contact tracing...
What helps fight Covid?

- Target notifications to the infected

Design spec:
Get **the right people** to quarantine in time, and let everyone else go back to living more normally
What helps fight Covid?

- Target notifications to the infected
- Notify them faster

Design spec:
Get the right people to quarantine in time, and let everyone else go back to living more normally
What helps fight Covid?

- Target notifications to the infected
- Notify them faster
- Solicit behavior change (quarantine/testing)

Design spec:
Get the right people to quarantine in time, and let everyone else go back to living more normally.
The final mile

- Messaging effectiveness
- ENX does not permit embedding of date
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Let’s talk, to fight this pandemic

Am I missing a discipline I need to know about?

Can you point me to a good expert?

Do you need help finding the right person to talk to?
Thank you!

Amanda Wilson  
James Petrie  
Sameer Halai

Too many others to list, at the University of Arizona, WeHealth, and elsewhere