THE IMPORTANCE OF TESTING IN THE TIME OF COVID-19 (OR ANY PANDEMIC)

Infectious Disease Epidemiology Bootcamp
Session 2
July 14, 2020
Ricky Camplain, PhD
INFECTIOUS DISEASE EPIDEMIOLOGY BOOTCAMPS OBJECTIVES

1. Explain the basics of infectious disease epidemiology, including transmission and conceptual model
2. Evaluate infectious disease measures (e.g., R-naught, case fatality, incidence).
3. Explain the importance of control infectious disease spread
4. Describe the process of testing, case investigation, and contact tracing for infectious diseases
5. Compare sensitivity, specificity, and positive and negative predictive value of diagnostic tests
6. Understand the concepts of database construction and data entry for quality data reporting
7. Interpret data tables and charts related to infectious disease measures
REMEMBER TO JOIN US FOR THE OTHER BOOTCAMPS!

• Tuesday, July 21 at 11:30 AM PDT – Measures of Frequency and Associations
  – Risk and rates
  – How are the calculated?
  – How to interpret them when you encounter them in reports and news stories!

• Tuesday, July 28 at 11:30 AM PDT – Getting the Most Out of Your Data
  – Data interpretation
  – Data visualization
OBJECTIVES

• Types of testing
• Importance of testing for disease prevention  
  – “Box It In”
• Validity and accuracy of diagnostic tests
• When is testing appropriate for disease mitigation?
TYPES OF TESTING
SCREENING

SCREENING TEST

FURTHER TESTS

ADVICE AND SUPPORT

TREATMENT

NO FURTHER ACTION

Source: https://support.pods-online.org.uk/screening-tools
SCREENING

• The best screenings have:
  – Few false positives
  – Few false negatives
• Those with positive screening test may be referred to diagnostic test
SCREENING FOR COVID-19

• Series of questions asked to determine a person’s risk for COVID-19
  – Symptoms being experienced
  – Travel history in recent weeks (less important when community spread is high)
  – Exposure to someone who has been confirmed to have COVID-19

• After screening, a health professional will decide on whether a person should be tested
A viral test can confirm if you have a current infection.

- CURRENT COVID-19 TESTS
  - PCR diagnostic testing
  - Point-of-care RAPID tests
    - Results in 15-30 minutes

- TEST RESULTS CAN VARY FROM 10 MINUTES TO OVER A WEEK
  - Depends on type of test, type of lab, geographical location, availability of lab
ANTIBODY TESTING

• Help determine whether an individual was previously infected – even if that person never showed symptoms
• Can play an important role in understanding the transmission dynamic of the virus in the general population
• Not recommended as the sole basis for diagnosis of acute infection
  – Not authorized by FDA for diagnostic purposes

• HOW LONG DO COVID-19 ANTIBODIES LAST?!
  – Evidence for short-term immunity
  – Antibodies may start to decrease within 2-3 months

MORE RESEARCH NEEDED!
IMPORTANCE OF TESTING FOR DISEASE PREVENTION
TESTING FOR DISEASE MITIGATION

• Testing does not slow the spread of the virus

• Allows you to monitor the outbreak, epidemic, pandemic as it unfolds

• Sets off a chain of events to take action
  – Isolate infected people so the virus stops with them!
  – Contact tracing → quarantine → behavior change
BOX IT IN!

1. Test Widely
2. Isolate All infected people
3. Find Everyone who has been in contact with infected people
4. Quarantine All contacts self-isolate for 14 days

Box It In
To get us all working again

BOX IT IN – CHAIN OF EVENTS

Test Widely

Quarantine Contacts

Identify Contacts

Isolate Quickly
TEST WIDELY AND EFFECTIVELY

• Increase the number of diagnostic tests available
• Increase test processing speed
• Prioritize testing for groups for which testing will make the most difference in improving outcomes
  – Comprehensive testing among vulnerable populations.
• Expand serological testing

• Education!
BOX IT IN – CHAIN OF EVENTS

Test Widely

Isolate Quickly

Quarantine Contacts

Identify Contacts
Test Widely

Isolate Quickly

Quarantine Contacts

Identify Contacts
ISOLATE QUICKLY

• Those who do not require hospitalization to isolate at home

• Make facilities (e.g., hotels) that are safe available for people who cannot safely isolate in their homes

• Rapid and effective isolation of all infected patients in hospitals

• Wide-ranging preventive measures in congregate living settings to prevent introduction of the virus and reduce transmission between vulnerable residents and staff
  – Reducing populations to allow for adequate social distancing
BOX IT IN – CHAIN OF EVENTS

Test Widely ➔ Isolate Quickly

Quarantine Contacts ➔ Identify Contacts
BOX IT IN – CHAIN OF EVENTS

Test Widely → Quarantine Contacts → Identify Contacts → Isolate Quickly
IDENTIFY CONTACTS – CONTACT TRACING

• Massively expand contact tracing capacity at the local, state, and federal levels

• Support person-to-person contact tracing to make it more efficient and effective

• Address concerns about confidentiality and privacy

• Embrace technology
Test Widely

Quarantine Contacts

Isolate Quickly

Identify Contacts
BOX IT IN – CHAIN OF EVENTS

Test Widely

Quarantine Contacts

Isolate Quickly

Identify Contacts
QUARANTINE CONTACTS

- Provide services and support to people so they can quarantine as comfortably as possible

- Provide ready access to telehealth services and care when needed
BOX IT IN – CHAIN OF EVENTS

Test Widely → Isolate Quickly

Quarantine Contacts → Identify Contacts
• Testing and “Box It In” is not our only mitigation strategy
  – Especially in the current stage of the pandemic

• In tandem with:
  – Stay at home orders
  – Public health messaging
  – Going out for essential things only
  – Social distancing
  – Wearing masks
  – Washing hands
VALIDITY AND ACCURACY OF DIAGNOSTIC TESTS
### How to Measure Test Validity and Accuracy

<table>
<thead>
<tr>
<th>Test Result</th>
<th>Disease Status</th>
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<tbody>
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<td>TP</td>
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- **TP** = True positive
- **FP** = False positive
- **TN** = True negative
- **FN** = False negative
- **D+** = Disease positive
- **D-** = Disease negative
- **T+** = Test positive for disease
- **T-** = Test negative for disease
TERMS YOU MAY HAVE HEARD

- Sensitivity
- Specificity
- Positive Predictive Value
- Negative Predictive Value
**SENSITIVITY**

**Sensitivity** = probability of a positive test among persons with a disease

How good is a test for identifying people with disease?
## SENSITIVITY

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### Sensitivity

\[
\text{Sensitivity} = \frac{TP}{TP + FN} = \frac{TP}{D+}
\]
Specificity = probability of a negative test among persons without disease

How good is a test for identifying people without disease?
### SPECIFICITY

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**Specificity** = \( \frac{TN}{TN + FP} = \frac{TN}{D-} \)
WHAT ABOUT THESE OTHER QUESTIONS

• If I obtain a positive test result, what is the probability that I actually have the disease?

• If I obtain a negative test result, what is the probability that I do not have the disease?
POSITIVE PREDICTIVE VALUE (PPV)

**PPV** = probability that a person has the disease given that a positive test has been obtained

If I obtain a positive test result, PPV is the probability that I actually have the disease.
**POSITIVE PREDICTIVE VALUE (PPV)**

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</tbody>
</table>

\[
\text{PPV} = \frac{TP}{TP + FP} = \frac{TP}{T+}
\]
NEGATIVE PREDICTIVE VALUE (NPV)

NPV = probability that a person does not have the disease given that a negative test has been obtained.

If I obtain a negative test result, NPV is the probability that I actually do NOT have the disease.
## NEGATIVE PREDICTIVE VALUE (NPV)

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<td>T-</td>
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<tr>
<td>D+</td>
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</tbody>
</table>

\[
\text{NPV} = \frac{\text{TN}}{\text{TN} + \text{FN}} = \frac{\text{TN}}{\text{T-}}
\]
• **Sensitivity** = How good a test is for identifying people with disease

• **Specificity** = How good a test is for identifying people without disease

• **Positive Predictive Value** = How likely it is for someone who tests positive to actually have the disease

• **Negative Predictive Value** = How likely it is for someone who tests negative to not have the disease
ACCURACY OF COVID-19 TESTS MAY DEPEND ON TIME!

Source: https://www.medrxiv.org/content/10.1101/2020.05.15.20103275v1.full.pdf
WHEN IS TESTING APPROPRIATE FOR DISEASE MITIGATION?
COVID-19 RISK LEVEL IN THE UNITED STATES

Source: https://globalepidemics.org/key-metrics-for-covid-suppression/?fbclid=IwAR0mvYgzE_GsbVRE-2BF_XciztZp5w_JFZjJnFcypSRbSXJFhkKr85mPICo
COVID-19 RISK LEVEL – HARVARD GLOBAL HEALTH INSTITUTE

COVID RISK LEVEL: GREEN

LESS THAN ONE CASE PER 100,000 PEOPLE
ON TRACK FOR CONTAINMENT
MONITOR WITH VIRAL TESTING AND CONTACT TRACING PROGRAM

COVID RISK LEVEL: YELLOW

1-9 CASES PER 100,000 PEOPLE
COMMUNITY SPREAD
RIGOROUS TEST AND TRACE PROGRAMS ADVISED

COVID RISK LEVEL: ORANGE

10-24 CASES PER 100,000 PEOPLE
ACCELERATED SPREAD
STAY-AT-HOME ORDERS AND/OR RIGOROUS TEST AND TRACE PROGRAMS ADVISED

COVID RISK LEVEL: RED

20+ CASES PER 100,000 PEOPLE
TIPPING POINT
STAY-AT-HOME ORDERS NECESSARY

Source: https://globalepidemics.org/key-metrics-for-covid-suppression/?fbclid=IwAR0mvYgzE_GsbVRE-2BF_XciZlZp5w_JFZjJnFcygSRbSXJFhkKr85mPICo
COVID-19 RISK LEVEL IN THE UNITED STATES – BY COUNTY

Source: https://globalepidemics.org/key-metrics-for-covid-suppression/?fbclid=IwAR0mvYgzE_GsbVRE-2BF_XcizlZp5w_JFZjJnFcyptSRbSXJFhkk85mPICo
## COVID-19 Risk Level by State

<table>
<thead>
<tr>
<th>State/County</th>
<th>Daily new cases per 100k people (7d moving avg.)</th>
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<tbody>
<tr>
<td>Arizona</td>
<td>49.1</td>
</tr>
<tr>
<td>Florida</td>
<td>43.6</td>
</tr>
<tr>
<td>Louisiana</td>
<td>34.9</td>
</tr>
<tr>
<td>South Carolina</td>
<td>30.1</td>
</tr>
<tr>
<td>Georgia</td>
<td>28.5</td>
</tr>
<tr>
<td>Texas</td>
<td>27.9</td>
</tr>
<tr>
<td>Alabama</td>
<td>25.2</td>
</tr>
<tr>
<td>Nevada</td>
<td>24.1</td>
</tr>
<tr>
<td>Mississippi</td>
<td>23.7</td>
</tr>
<tr>
<td>Idaho</td>
<td>23.5</td>
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<tr>
<td>Tennessee</td>
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</tr>
<tr>
<td>California</td>
<td>21.9</td>
</tr>
<tr>
<td>Arkansas</td>
<td>19.8</td>
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<tr>
<td>Utah</td>
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<tr>
<td>Kansas</td>
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<tr>
<td>Iowa</td>
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<tr>
<td>North Carolina</td>
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<tr>
<td>Oklahoma</td>
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<tr>
<td>New Mexico</td>
<td>12.1</td>
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<tr>
<td>Wisconsin</td>
<td>10.9</td>
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<tr>
<td>Delaware</td>
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<tr>
<td>Ohio</td>
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<tr>
<td>Virginia</td>
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<tr>
<td>Washington</td>
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<tr>
<td>Nebraska</td>
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<td>North Dakota</td>
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<tr>
<td>Minnesota</td>
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<tr>
<td>District of Columbia</td>
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</tr>
<tr>
<td>Kentucky</td>
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<tr>
<td>West Virginia</td>
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<tr>
<td>Indiana</td>
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<tr>
<td>Maryland</td>
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<td>South Dakota</td>
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<tr>
<td>Illinois</td>
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<td>Colorado</td>
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<td>Hawaii</td>
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<tr>
<td>New Hampshire</td>
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<tr>
<td>Maine</td>
<td>1.1</td>
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<tr>
<td>Vermont</td>
<td>0.9</td>
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COVID-19 RISK LEVEL BY COUNTY

Source: https://globalepidemics.org/key-metrics-for-covid-suppression/?fbclid=IwAR0mvYgzE_GsbVRE-2BF_XciztZp5w_JFZjJnFcypSRbSXJFhkKr85mPICo
SARS-COV-1 – BOX IT IN SUCCESS

• SARS-CoV-2 (virus that causes COVID-19)
  – 13,000,000 cases
  – 571,000 deaths

• SARS-CoV-1
  – 8,000 cases
  – 700 deaths
  – More aggressive than SARS-CoV-2
SARS-COV-1 – BOX IT IN SUCCESS

- SARS-CoV-1
  - Easier to identify cases
  - Easier to track down contacts

- EVERYONE HAD SEVERE SYMPTOMS IN TWO TO THREE DAYS
REFLECTION

- Types of testing
- Importance of testing for disease prevention
  - “Box It In”
- Validity and accuracy of diagnostic tests
- When is testing appropriate for disease mitigation?
ACKNOWLEDGMENTS

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• Kate Compton-Gore
• Dr. Samantha Sabo
• Dr. Julie Baldwin
• The Southwest Health Equity Research Collaborative (SHERC)
  – nau.edu/sherc
THANK YOU!

QUESTIONS?

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REFERENCES

   - [https://www.nature.com/articles/s41591-020-0965-6](https://www.nature.com/articles/s41591-020-0965-6)

2. Resolve to Save Lives. “Box It In: Rapid Public Health Action can Box in COVID-19 and Reopen Society”.

   - [https://globalepidemics.org/key-metrics-for-covid-suppression/?fbclid=IwAR0mvYgzE_GsbVRE-2BF_XciztZp5w_JFZjJnFcypSRbSXJFhkKr85mPICo](https://globalepidemics.org/key-metrics-for-covid-suppression/?fbclid=IwAR0mvYgzE_GsbVRE-2BF_XciztZp5w_JFZjJnFcypSRbSXJFhkKr85mPICo)

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