Strategies to support the COVID-19 response in LMICs

A virtual seminar series
Learning Objectives

• Public health economics for pandemic control
  • Funding for the public health practice units we wish we had in Dec 2019
  • Prospects for 2021
• Economics of COVID-19 vaccine discovery and allocation
• Economics of vulnerability
Economics

The study of choices under uncertainty
Health Economics

The study of health choices under uncertainty
## Typology

<table>
<thead>
<tr>
<th></th>
<th>Individuals</th>
<th>Populations</th>
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<tbody>
<tr>
<td>Prevention</td>
<td>Clinical Preventive Medicine</td>
<td>Public Health</td>
</tr>
<tr>
<td>Cure</td>
<td>Clinical Medicine</td>
<td>Health Care Policy</td>
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Public Health Economics

The study of public choices that determine the health of places
Spending on Public Health

US “officially” spends $90 billion on public health
  • $10 Billion by CDC
  • $80 Billion by states and counties

This was all we had to be prepared for COVID-19
  • Health departments starved
  • Distracted by block grants
  • Not doing public health
Local Level Public Health Spending Estimates

Local government per capita community and public health spending (excluding hospital and welfare) in 2012
Does Past Public Health Matter?

**Hypothesis:**
• Being good at public health in the past should help counties bend their COVID-19 curves faster

**Method:**
• Calculate time from 10\textsuperscript{th} case to apex COVID-19 incidence in US counties
• Kaplan Meier curves and Cox regression of time to apex
• Must control for population density, poverty, and tests/100K
Success Indicator=Time to Reach Apex
Effect of PH Spending in County

Multivariate Cox with temperature, density, median income, %Black, %Hispanic, % finished HS, county revenue. Being in top quartile of PH spending hastens time to apex by 7% overall.
## Preliminary Results May 4th

### Hazard ratios for time to apex

Cox regression -- Breslow method for ties

|   | Nitrogen Oxide (NOₓ) | Std. Err. | z  | P>|z| | 95% Conf. Interval  |
|---|----------------------|-----------|----|-----|-------------------|
| 1 | 1.008569             | 0.009064  | 9.49| 0.000| 1.006795 - 1.010347 |
| 2 | 0.9832138            | 0.0323608 | -0.51| 0.607| 0.9217902 - 1.04873  |
| 3 | 1.0181133            | 0.0343849 | 2.45| 0.014| 1.015778 - 1.150651  |
| 4 | 1.031311             | 0.0328294 | 0.97| 0.333| 0.9689328 - 1.097705  |
| Incidence of myocardial infarction (IMI) | 1.002247 | 0.022712 | 0.10| 0.921| 0.9587061 - 1.047765 |
| Incidence of hospitalization (IH) | 0.999411 | 0.0248443 | -0.01| 0.998| 0.952114 - 1.049541 |
| Incidence of hospitalization (IH) | 0.9268052 | 0.0258845 | -2.72| 0.006| 0.8774361 - 0.9789521 |
| Percent of adults with high blood pressure (PABP) | 1.284593 | 0.2737496 | 1.18| 0.240| 0.8460042 - 1.950556 |
| Percent of adults with high blood pressure (PABP) | 0.7810817 | 0.052933 | -3.65| 0.000| 0.6839299 - 0.8920339 |
| Percent of adults with high blood pressure (PABP) | 0.981901 | 0.017902 | -10.02| 0.000| 0.9783984 - 0.9854161 |
| hsCapDum2 | 1.049524 | 0.020583 | 2.53| 0.011| 1.010938 - 1.085984 |
| hsCapDum3 | 1.045699 | 0.0202008 | 2.31| 0.021| 1.006346 - 1.086051 |
| hsCapDum4 | 1.074908 | 0.021427 | 3.36| 0.000| 1.033749 - 1.117706 |
| revCap | 1.000001 | 2.22e-06 | 0.51| 0.609| 0.9999968 - 1.000005 |
Can also study determinants of height of peak incidence

- Adjusting for population density and April temperature
- Poorest quartile of counties had peak COVID-19 prevalence 32% higher than richest quartile
Spending Choices Inside PH Depts

• PH departmental budgets make no sense
• Starving for resources, health commissioners pass the plate to fund vertical programs
Grants Drive Spending

Baltimore City Health Department Recommended Budget 2020 ($Millions). Total $160M.

- HIV treatment for the uninsured
- Emergency Services-Health
- Substance Use Disorder
- Healthy Homes
- Advocacy for Seniors
- MCH
- Clinical Services
- Animal Services
- Direct Care and Support Planning
- School Health
- Health for Seniors
- Environmental Inspection Services
- Senior Centers
- Administration-Health
- Community Services for Seniors
- Chronic Disease Prevention

Total $160M.
Less Than Half is Public Health

- Clinical Care: 6%
- Disability Related: 4%
- Other non-PH: 8%
- Behavioral Health: 4%
- Environmental Protection: 4%
- Public Health: 39%
- Environmental Protection: 8%
- Public Health: 23%
- Other non-PH: 20%
*JHSPH estimate includes added-back federal dollars.
**JHSPH estimate is a range to include margin of error.
Public Health Spending Trends

State governmental spending
by public health activity, 2008-2018

- Public Health (Total)
- Communicable Disease Control
- All Hazards Preparedness and Response

Per capita expenditure (US$ in 2018)
Trends in State Spending

State Spending on Maternal/Child Health

State Spending on Chronic Diseases and Injury

State Spending on Communicable Diseases

State Spending on Environmental Health

State Spending on Foundational Capabilities

State Spending on Foundational Capabilities
Health care spending grew by 52 percent in the past decade, while the budgets of local health departments shrank by as much as 24 percent, according to a 2019 report from the public health nonprofit Trust for America’s Health, and the C.D.C.’s budget remained flat. Today, public health claims just 3 cents of every health dollar spent in the country.
Is US Public Health Exceptional?

• Public Health Departments are neglected in almost all countries
• Globally Less than 5% of Health Spending is for Public Health

• Accreditation of public health departments only occurs in USA
  • 297 out of 3000 health departments accredited
• WHO regions do national PH practice assessments
  • EURO
  • EMRO (Morocco, Qatar only)
  • PAHO (last was 2000)
Section 2

Economics of a COVID-19 Vaccine
Vaccine Discovery Costs ~$1B

Screen 1000s of molecules for bioactivity in vitro or in animals

Human trials for safety, dosing, efficacy

Get FDA approval
Vaccine Development

Old Paradigm

• Prelim bench science  Public

• Clinical trials  Private

• Production

• Financing  Public

• Distribution

COVID-19 Paradigm

• Bench science  Public

• Everything else is joint public and private financing

• Governments are heavy investors in production capacity to prevent future shortages.
Over 100 vaccines in development, building upon several novel and traditional platforms

**AN ARRAY OF VACCINES**

<table>
<thead>
<tr>
<th>Virus Type</th>
<th>Viral vector</th>
<th>Nucleic acid</th>
<th>Protein-based</th>
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<tr>
<td>Inactivated</td>
<td>Replicating</td>
<td>DNA</td>
<td>Protein subunit</td>
</tr>
<tr>
<td>Weakened</td>
<td>Non-replicating</td>
<td>RNA</td>
<td>Virus-like particles</td>
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**PUBLIC AND PRIVATE DEVELOPMENT LANDSCAPE**

- **North America**: Public and non-profit, Academic, Private and industrial
- **China**, **Europe**, **Australia** and other Asia:

* Other efforts include testing whether existing vaccines against poliovirus or tuberculosis could help to fight SARS-CoV-2 by eliciting a general immune response (rather than specific adaptive immunity), or whether certain immune cells could be genetically modified to target the virus.

https://www.nature.com/articles/d41586-020-01221-y
Numerous public-private partnerships

• J&J announced a $1 billion deal with the U.S. government to ...make more than 1 billion doses of a vaccine
  March 30, 2020

The pharmaceutical company Sanofi is retrofitting current manufacturing facilities so they’ll be able to pump out hundreds of millions of COVID-19 vaccine doses. April 24, 2020

Bill Gates says he’ll spend billions on coronavirus vaccine development
April 6, 2020

Pfizer’s (NYSE: PFE) partnership with a German company BioNTech (Nasdaq: BNTX) ... aimed to have 10 to 20 million doses ready by the end of this year.
April 30, 2020

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April 30, 2020

AstraZeneca and the University of Oxford today announced an agreement for the global development and distribution of the University’s potential recombinant adenovirus vaccine aimed at preventing COVID-19 infection from SARS-CoV-2.
April 30, 2020

Moderna and Lonza struck a deal ... that could bring Moderna's capacity up to 1 billion shots per year
May 1, 2020
What might the disease look like when a vaccine is available?

*How many will have been infected? / can people be re-infected?*

<table>
<thead>
<tr>
<th>Duration of immunity</th>
<th>Long</th>
<th>Short</th>
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**How many infected by 2021?**
- Few infected
- Many Infected

**Duration of immunity**
- Short
- Long

Models can be valuable to provide reasonable demand estimates for vaccine manufacturers.
Go/No Go Decision

You are attending the board meeting at your large pharmaceutical company.

Agenda Item: Should we pull our vaccine team off of vaccine pipelines for AIDS, Malaria, TB, and Dengue to make a COVID-19 vaccine candidate to put into phase 1 trials?

What do you want to know to decide this?
You are attending the board meeting at your large pharmaceutical company.

Your firm’s vaccine candidate passed phase 1 trial.

- Synthesis is difficult
- Best case production for 2021 would be 100 million doses
- Cost of labor and ingredients will be $10 per dose

Should you sell the license now or use your firm’s own resources to launch phase 2?
Section 3

Economic Vulnerability
Economic Impact

Social Lockdown Policy Costs and Benefits

Benefits = Lives saved [1]
Costs = Lost economic output

[1] = Which sick people get saved by lockdowns?
Economic Impact

Social Lockdown Policy Costs and Benefits

Benefits = Lives saved
Costs = Lost economic output

Where in the world will the lost economic output be so bad that more people die from lost livelihoods and poverty than who are saved from COVID-19 control?
• Estimate lives lost from a 5% recession—just for under 5s
• Compare to lives saved from COVID-19 control
Context Matters

Net Loss of Life from COVID-19 Control and Ensuing 5% Economic Recession

Lives Lost or Gained

-24,149
-21,549
-16,848
-10,179
-6,988
-2,680
-807

-61,251

-144,451

Nambia
Senegal
Niger
Congo, Rep.
Kenya
Tanzania
Cape Verde
Rwanda
Total

- Under 5 Lives Lost Due to 5% Recession from COVID-19
- Lives Saved by COVID-2 Suppression based on ICL Model
- Net Loss of Life from COVID-19 Suppression
Neo Colonialism

Why is it that what Westerners think and do about health in their health systems is regarded as universally appropriate?
Summary

• Public health economics for pandemic control
  • PH departments have been starving, underfunded
  • Not addressing PH problems as they could
  • Still good evidence that they save lives

• Economics of COVID-19 vaccine discovery and allocation
  • COVID-19 vaccine value is based on things we don’t know

• Economics of vulnerability
  • Eroding livelihoods can be more lethal than COVID in places- PH advice must be contextual
Questions?