Environmental Sampling as a Tool for Identification of High Typhoid Risk Settings

Jason Andrews
11th International Conference on Typhoid & Other Invasive Salmonelloses
Hanoi, Vietnam
March 26, 2019
The global burden of typhoid and paratyphoid fevers: a systematic analysis for the Global Burden of Disease Study 2017

GBD 2017 Typhoid and Paratyphoid Collaborators
Generating more typhoid incidence data

- **Surveillance for Enteric Fever in Asia Project (SEAP) Phase II**: Bangladesh, Pakistan, Nepal
- **Severe Typhoid Fever Surveillance in Africa (SETA)**: Burkina Faso, Ghana, Nigeria, DRC, Madagascar, Ethiopia
- **Surveillance of Enteric Fever in India (SEFI)**
- **STRATAA, TyVAC**: Malawi, Nepal, Bangladesh

*Most LMIC countries will need to make decisions about TCV introduction with little if any national, much less subnational, data on typhoid burden*
Accuracy and Cost Trade-offs in Typhoid Burden Estimation

- Hybrid Surveillance (facility + healthcare utilization)
- Facility-based Surveillance
- Geospatial Prediction Models
- Cohort Studies

Accurate Low-cost tools
Why environmental surveillance may enable us to identify high risk settings for typhoid

1. S. Typhi is a human restricted pathogen

2. Municipal water contamination is essential to typhoid transmission

“How can typhoid fever be prevented? ... the reply to the above question may be stated in four words, namely, Stop drinking contaminated water.”

– Henry Baker. 1884
Public water systems are critical to typhoid transmission

Cutler and Miller, *Demography*,

Stanford University
Public water systems are critical to typhoid transmission

Cutler and Miller, *Demography,*

Stanford University
Public water systems are critical to typhoid transmission

Buenos Aires, 1872-1899


Stanford University
Water-borne Typhoid Outbreaks

A Massive Epidemic of Multidrug-Resistant Typhoid Fever in Tajikistan Associated with Consumption of Municipal Water

Jonathan H. Mermin, Rodrigo Villar, Joe Carpenter, Les Roberts, Aliev Samaridze, Larissa Gasanova, Svetlana Lomakina, Cheryl Hoppe, Lori Hutwagner, Paul Mead, Bruce Ross, and Eric D. Mintz

Typhoid Fever: A Massive, Single-Point Source, Multidrug-Resistant Outbreak in Nepal

Michael O. Lewis,1 Oralak Serichantamroj,2 Chittima Pitarangsri,1 Niphon Chuank,1 Carl J. Mason,1 Laxmi R. Roqni,1 Prativa Pandey,1 Ranjan Laskar,1 Chandrika D. Shrestha,1 and Sarala Malla1

1Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand; 2Biharpur Zonal Hospital, 3JWFG Travel Clinic, 4Biharpur College of Medical Sciences, and 5Nepal National Public Health Laboratory, Kathmandu, Nepal

Stanford University
Typhi is detectable in water and sewage and provides actionable data.
Molecular Detection of S. Typhi in Drinking Water
Can Environmental Surveillance for Typhoidal *Salmonella* Distinguish High from Low Typhoid Risk Communities

Sero-Epidemiology and Environmental Surveillance (SEES) study

Navi Mumbai TCV Introduction Evaluation
EES Study: Bangladesh, Nepal, Pakistan

Sampling in catchment of population-based disease surveillance (SEAP)
Leverage incidence heterogeneity
Characterize how *S. Typhi* frequency/abundance in drinking water correlates with incidence of disease
S. Typhi/Paratyphi in urban versus rural Bangladesh

<table>
<thead>
<tr>
<th>Location</th>
<th>DNA detected</th>
<th>Positive (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dhaka (n = 59)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typhi</td>
<td>36 (61)</td>
<td></td>
</tr>
<tr>
<td>Paratyphi A</td>
<td>14 (24)</td>
<td></td>
</tr>
<tr>
<td>Either</td>
<td>39 (66)</td>
<td></td>
</tr>
<tr>
<td>Both</td>
<td>11 (19)</td>
<td></td>
</tr>
<tr>
<td>Mirzapur (n = 33)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typhi</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>Paratyphi A</td>
<td>0 (0)</td>
<td></td>
</tr>
</tbody>
</table>

### Maps

- **Dhaka**: 
  - Only Typhi DNA detected: [Map Section]
  - Only Paratyphi A DNA detected: [Map Section]
  - Both Typhi and Paratyphi A DNA detected: [Map Section]
  - Neither Typhi nor Paratyphi A DNA detected: [Map Section]

- **Mirzapur**: 
  - Only Typhi DNA detected: [Map Section]
  - Only Paratyphi A DNA detected: [Map Section]
  - Both Typhi and Paratyphi A DNA detected: [Map Section]
  - Neither Typhi nor Paratyphi A DNA detected: [Map Section]
Typhi detected in 2% of water samples in Hyderabad, Pakistan.
First-of-its-kind Free Typhoid Conjugate Vaccination Campaign by NMMC

In Navi Mumbai, the first-of-its-kind free Typhoid Conjugate vaccine (TCV) campaign in the world will be undertaken. The initiative will be started from 14th July 2019 under the guidance of Mayor R.R. Raut, Mayor of Navi Mumbai, and Municipal Commissioner Dr. R. Ramawat N. The Typhoid Conjugate Vaccine (Typhovax TCV) will be given to 2 lakh children in the first phase of the campaign, this year. The same number of children will be vaccinated next year in the second phase of the campaign.
Navi Mumbai TCV Introduction

Public sector introduction of Typbar TCV
Step wedge cluster randomized introduction with 11 UHPs vaccinated in 2018, 11 in 2019

**Hypothesis:** UHPs (neighborhoods) who received vaccine will have lower frequency and abundance of S. Typhi in water
S. Paratyphi serves as a negative control outcome
Also will evaluate geographical incidence heterogeneity and Typhi/Paratyphi frequency/abundance
ES for building political will for vaccination and improving water systems

Complacency over fecal contamination of water
‘Coliforms’ don’t motivate politicians and administrators

'Super bacteria' discovered in Rio's waters as Olympics near

By Flora Charner, CNN
© Updated 7:17 PM ET, Tue July 5, 2016
Acknowledgements

SEAP/SEES Nepal
Mista Vaidya
Besh Tamrakar
van Shakya
ony Shrestha
aryn Bern
aac Bogoch
xander Yu
isten Aiemjoy

SEAP/SEES leadership
Denise Garrett
ve Luby
ashmira Date
mir Saha
arah Qamar
aitlin Barkume
essica Seidman
shley Tate
 Bangadesh &Pakistan teams

Navi Mumbai ES Team
ilma Hirani
ily Horng

he Bill and Melinda Gates Foundation for their support and Stanford University