Tenacious endemic typhoid fever in Samoa: is short-cycle (chronic carriers) or long-cycle (water-borne) transmission mainly maintaining endemicity?

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11th Conf. on Invasive Salmonelloses
Hanoi, Vietnam, March 2019
4 key regions of typhoid endemicity

• South Asia - India, Pakistan, Nepal, Bangladesh
• Southeast Asia - Indonesia, Malaysia
• Sub-Saharan Africa - Spotty in E, W, Central
• Oceania - Samoa, Tonga, Fiji, Vanuatu
Epidemiological Model of Typhoid Fever and its Use in the Planning and Evaluation of Antityphoid Immunization and Sanitation Programmes*

B. CVJETANOVIC,¹ B. GRAB,² & K. UEMURA³

*B. CVJETANOVIC,¹ B. GRAB,² & K. UEMURA,³


Used demographic and disease burden data from Samoa (1960s) for the model to predict the impact from use of vaccine and sanitation interventions.
Population ~150,000;
Annual crude typhoid incidence 72/100,000
Predicted that high coverage with an effective vaccine would have a strong impact
2 inhabited islands, Upolu (pop’n ~ 143,418) and Savaii (pop’n ~ 44,402) (2011 census)

In 2012, the Samoan gov’t became concerned about endemic typhoid
  – Samoan typhoid carriers serving as seasonal workers in New Zealand inadvertently contaminated fruit produce leading to destruction of exports with economic loss.
  – Tourism is a major industry
  – Several US visitors to Samoa developed typhoid
  – MML went to Samoa as a WHO Consultant
  – MML’s Samoan counterpart was the Head of Surveillance, MoH, Dr. Take Naseri
TOTAL POPULATION BY REGION, 2016

Samoa: 195,979

- AUA: 37,391
- SAVAI'I: 43,560
- ROU: 45,652
- NWU: 69,376

Savaii Island

SAVAI'I

Apolima Island
Manono Island

Upolu Island

NWU
AUA
ROU

Scale: 1:379,400
Typhoid in Samoa, 2008-2012 --

Occurrence of confirmed cases by time, person and place
Typhoid in Samoa

BLOOD CULTURE ISOLATES OF SALMONELLA TYPHI, BY YEAR, SAMOA 2008-2012

Cyclone Evan, 12/2012
Typhoid in Samoa

BLOOD CULTURE CONFIRMED TYPHOID FEVER 2008-2012

MONTHS

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

CASES

0  10  20  30  40  50  60  70  80

CASES OF TYPHOID FEVER
Typhoid in Samoa

BLOOD CULTURE ISOLATIONS OF SALMONELLA TYPHI, BY MONTH, SAMOA, 2008-2012

NO OF CASES

YEAR/MONTH

2008 2009 2010 2011 2012
Jan Mar May Jul Sep Nov Jan Mar May Jul Sep Nov Jan Mar May Jul Sep Nov Jan Mar May Jul Sep Nov
Typhoid in Samoa, 2008-2012

INCIDENCE OF BLOOD CULTURE-CONFIRMED TYPHOID FEVER PER 10^5 BY AGE GROUP

AGE GROUPS (Years)


INCIDENCE PER 10^5

0  20  40  60  80  100  120
Age-specific incidence of confirmed typhoid in Samoa

INCIDENCE OF BLOOD CULTURE - CONFIRMED TYPHOID FEVER PER 10E5 BY AGE GROUP

INCIDENCE PER 10E5

AGE (Years)

<1
1-4
5-9
Spot map of typhoid cases, Upolu, Samoa, 2008-2012

Total Number of Confirmed Cases Among Persons 0-19 Years of Age, 2008-2012

- 1-3 cases
- 4-6 cases
- 7-9 cases
- 10-12 cases
- 13-15 cases
Cases cluster in the Apia urban area (the capital) and West along the Northern coast of Upolu towards the Northwest tip of the island

Is this because:
• Severe cases seek care at the main hospital?
• This is where the bacteriology lab is located?
• This is Samoa’s highest population density?
• There is an inordinate number of carriers?
• Amplified transmission is occurring there in part due to a reticulated supply delivering inadequately treated water?
Tupua Tamasese Meaole Hospital, Apia
Upolu’s reticulated water supply
Typhoid Fever Surveillance Initiative (TFSI)

Samoa
Dr. Take Naseri, Director, TFSI, Director General, MoH

Dr. Robert Thomsen, Deputy Director, TFSI (Asst. Director, MoH)

CVD Counterparts
Prof Mike Levine
Co-Director, TFSI
(Assoc. Dean, UMSoM)

Dr. Sachin Desai
Head of CVD Typhoid Mission
(Asst. Prof., Pediatrics, CVD)
Samoa Typhoid Fever Surveillance Initiative

• Broad objectives

• Strengthen microbiology infrastructure
  • FX40 automated blood culture for Savaii
  • Training of Samoan bacteriology technicians
  • Establish a Samoa MoH Typhoid Laboratory
    – Measure IgG anti-Vi titers in serum (screen for carriers)
    – Stool culture surveys
    – Environmental bacteriology (Moore swabs cultures from septic tanks & streams)

• Build epidemiologic investigation capacity
  – Samoa Typhoid SWAT Team
  – Systematic enhanced surveillance at sentinel health facilities
Samoa Typhoid Surveillance Initiative Partners

- Ministry of Health, Samoa (Dr Take Naseri, Robert Thomsen)
- CVD of the University of Maryland School of Medicine (Sachin Desai, Jane Han, Michael Sikorski, Marcela Pasetti, Mardi Reymann, Sharon Tennant, Rafi Simon, Faye Mayo, Andrew Lees, Seth Hoffman, Nicole Eddington, Deb Ingram) (Ellen Higginson)
- University of Otago, NZ (Prof John Crump)
- Microbiological Diagnostic Unit, U of Melbourne, Australia (Profs. Ben Howden, Roy Robins-Browne, Dr. Susan, Ballard) (Ms Savitra Rambocus)
- Univ. of Cambridge, UK (Prof Gordon Dougan, Ellen Higginson)
- Institute of Disease Modeling, Bellevue, WA (Jillian Gauld, Daniel Klein)
- World Health Organization
- Bill & Melinda Gates Foundation
Building containing the School of Nursing, WHO office, and the Samoa Typhoid Fever Surveillance Initiative Public Health Laboratory

Ministry of Health of Samoa, Apia, Upolu
Typhoid SWAT Team activities

Expeditiously visit household (or school or workplace) of every confirmed typhoid case
- Epidemiologic investigation (questionnaire)
- **3 stool cultures** from all contacts cases
- Serum from all adult contacts for **Vi serology**
- **RUQ ultrasound of adult contacts** to find gallstones using hand-held POC US device
- **Determine water source & sanitation facility**
- Place **Moore swabs in septic tank** (or latrines)
- **Moore swabs in intake of untreated piped river water**
- Enterotest to collect bile-containing duodenal fluid (if there is a suspect chronic carrier)
- **MDU does whole genome sequencing of S. Typhi isolates within 3 weeks**
The Samoan Typhoid Fever SWAT team is finding chronic carriers among household contacts of acute typhoid fever cases

A very large gallstone in radiology unit ultrasound exam of the gallbladder of a 73 YO woman who prepared meals in the household of a case of typhoid fever. This afebrile woman’s stool cultures grew S. Typhi.

Gallbladder of a 66 YO woman visualized using hand-held POC ultrasound device in the field
Most Samoan houses are served by septic tanks

Water supplies for Samoan households

- Samoa Water Authority (SWA) provides treated water through a reticulated distribution system
- Independent Water Schemes Association (IWSA) provides untreated water to villages and households
- Bore holes
Cumulative percent of all cases of typhoid in Samoa, 2015-2018, by certain ages

<table>
<thead>
<tr>
<th>Years of surveillance</th>
<th>Cases with known age*</th>
<th>Age group (yrs)</th>
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<tbody>
<tr>
<td>2015-2018</td>
<td>318</td>
<td>&lt; 30</td>
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<td></td>
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<td>&lt; 40</td>
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<td></td>
<td></td>
<td>&lt; 50</td>
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<tr>
<td></td>
<td></td>
<td>≥ 50</td>
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<tr>
<td>Mean annual pop’n</td>
<td>Total: 196,473</td>
<td>123,337</td>
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<td>145,873</td>
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<td>165,982</td>
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<tr>
<td></td>
<td></td>
<td>30,491</td>
</tr>
<tr>
<td>Cumulative % of all cases</td>
<td>67%</td>
<td>84%</td>
</tr>
<tr>
<td></td>
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<td>94%</td>
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<td>6%</td>
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* Of 338 total cases
3 Phases of the Samoa Typhoid Fever Control Program

• The Preparatory Phase (known as the Samoa Typhoid Surveillance Initiative) (2 years)

• Attack Phase (~ 4 years)
  – Mass vaccination of Samoans < 50 yrs with Typbar-TCV
  – Routine toddler vaccination (Typbar-TCV, age 12 mos)
  – Ty21a live oral vaccine for persons ≥ 50 years of age
  – Identify and treat chronic carriers
  – Epidemiologic investigation of all typhoid cases

• The Consolidation Phase (3-5 yrs)
  – Intensive searches for cases and chronic carriers
  – Rx of chronic carriers
A Samoan sunset — stay tuned
Samoa Typhoid Surveillance Initiative Partners

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