

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

Myron M. (Mike) Levine, M.D., D.T.P.H.

Simon & Bessie Grollman Distinguished Professor

and

*Associate Dean for Global Health, Vaccinology and
Infectious Diseases*

University of Maryland School of Medicine,

Baltimore, MD, USA

11th Conf. on Invasive Salmonellosis

Hanoi, Vietnam, March 2019



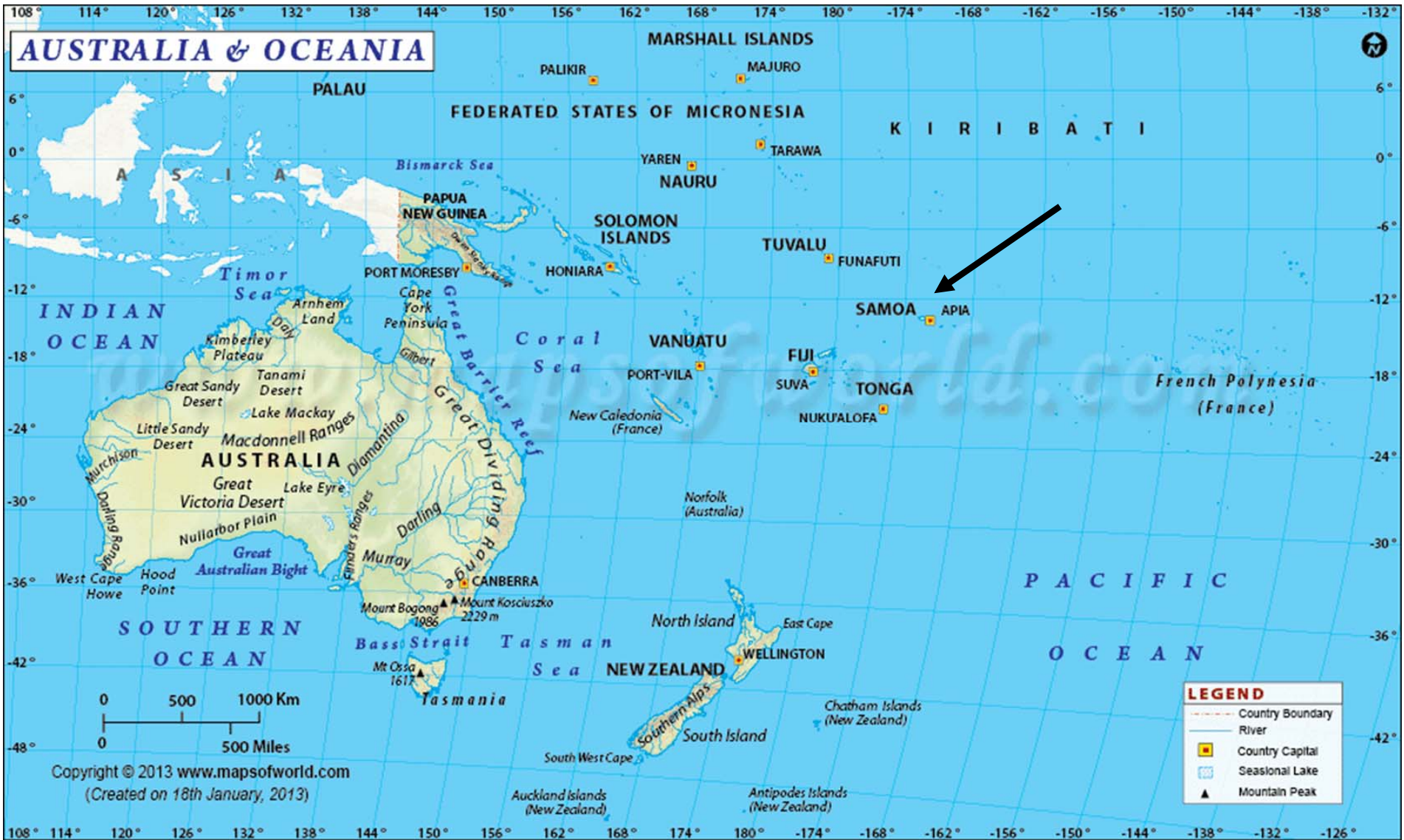
UNIVERSITY of MARYLAND
SCHOOL OF MEDICINE
CENTER FOR VACCINE DEVELOPMENT
AND GLOBAL HEALTH

WHO Typhoid fever update, Wkly Epi Rec, 2018

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. CVJETANOVIĆ,¹ B. GRAB² & K. UEMURA²

Bull. Org. mond. Santé } 1971, 45, 53-75
Bull. Wld Hlth Org. }

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





Samoa – MML WHO typhoid consultancy 2013

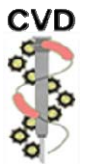
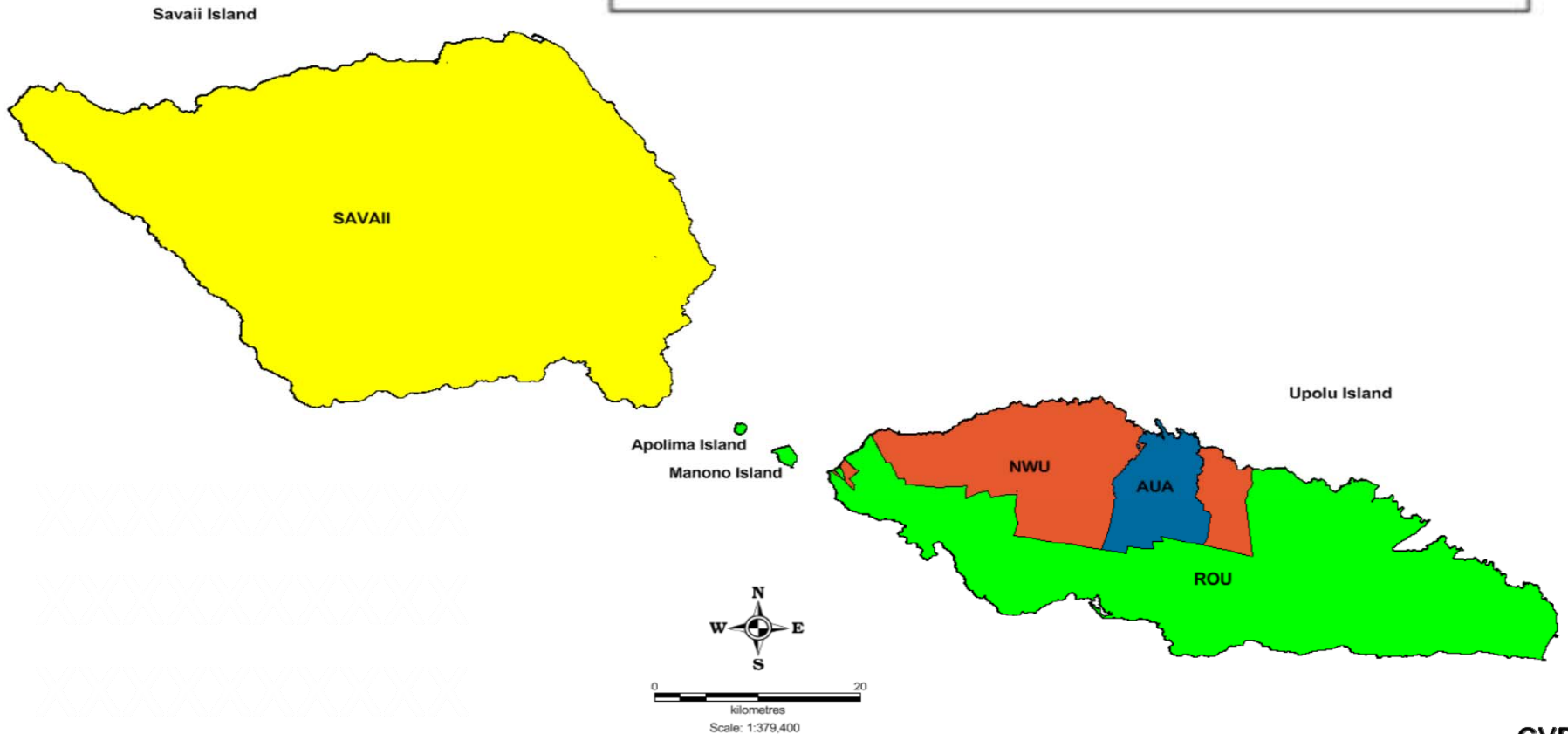
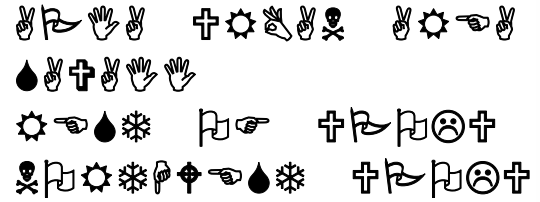
- 2 inhabited islands, Upolu (pop'n ~ 143,418) and Savaii (pop'n ~ 44,402) (2011 census)
- In 2012, the Samoan gov't became concerned about endemic typhoid
 - Samoan typhoid carriers serving as seasonal workers in New Zealand inadvertently contaminated fruit produce leading to destruction of exports 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

	37,391 AUA
	43,560 SAVAII
	45,652 ROU
	69,376 NWU



Typhoid in Samoa, 2008-2012 --

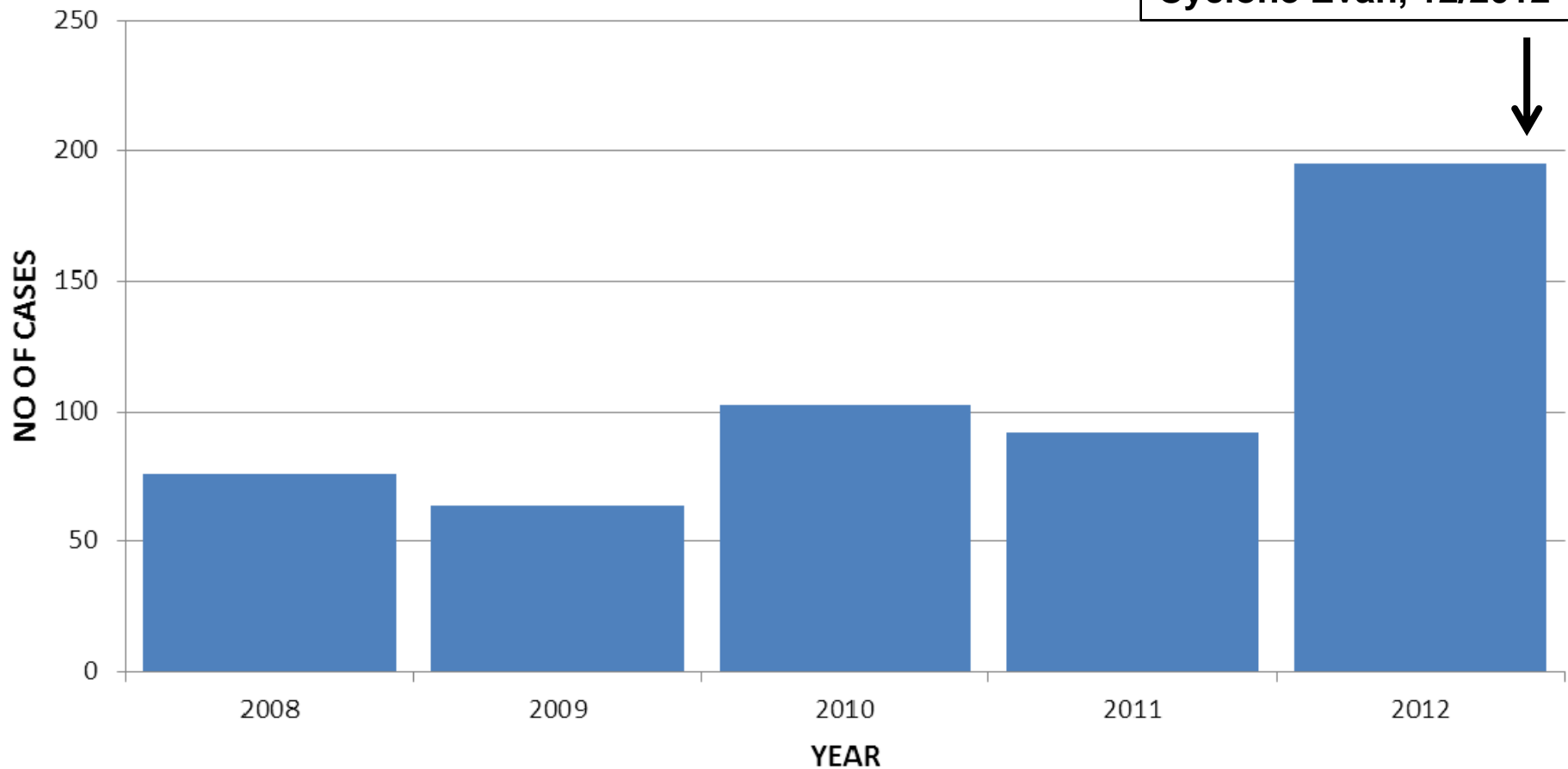
**Occurrence of confirmed cases
by time, person and place**

Typhoid in Samoa

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

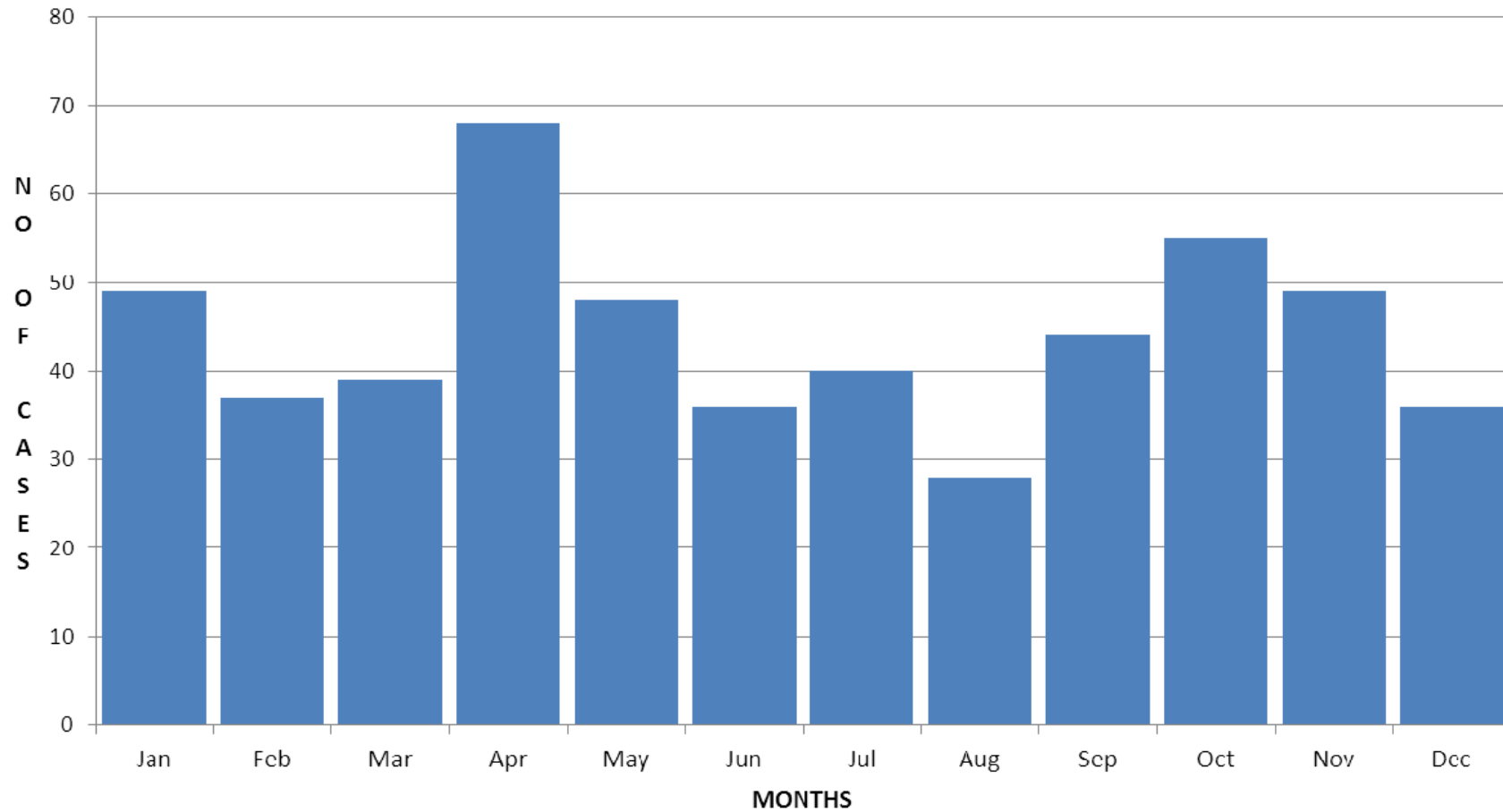
2012

Cyclone Evan, 12/2012



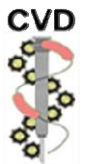
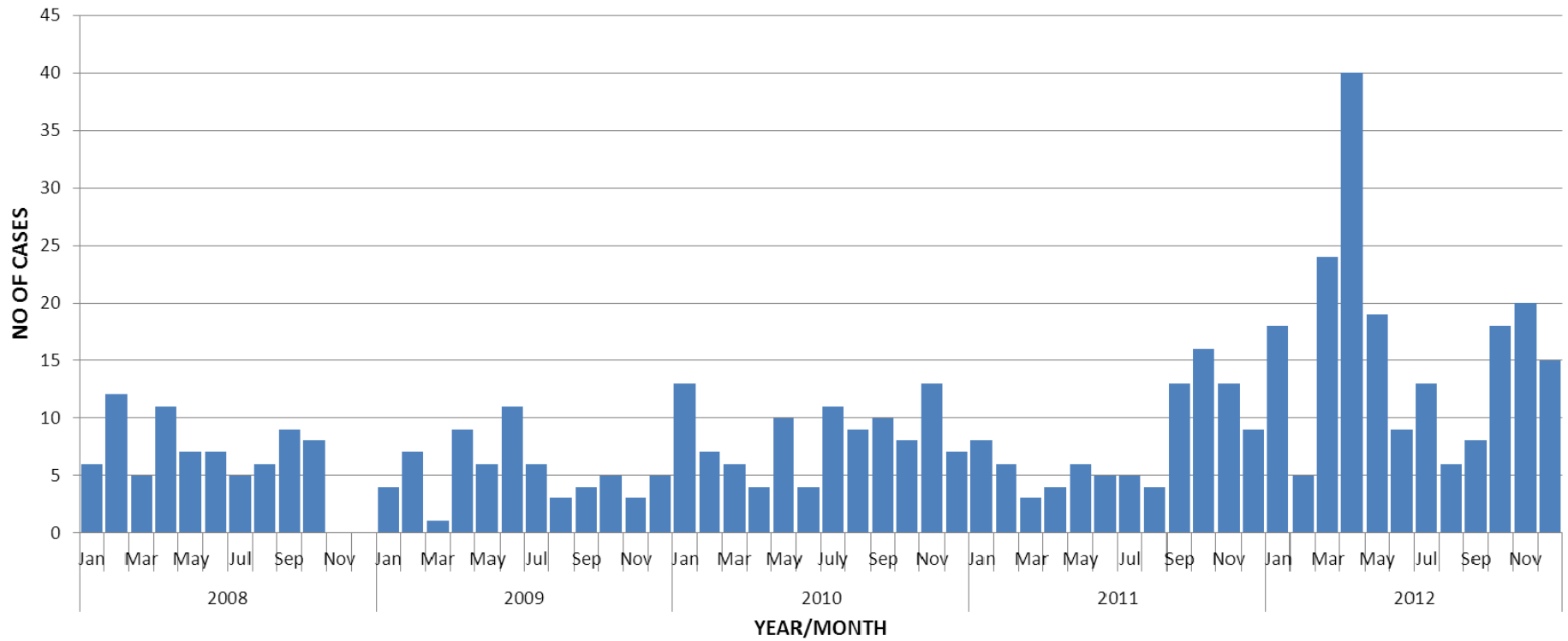
Typhoid in Samoa

BLOOD CULTURE CONFIRMED TYPHOID FEVER 2008-2012

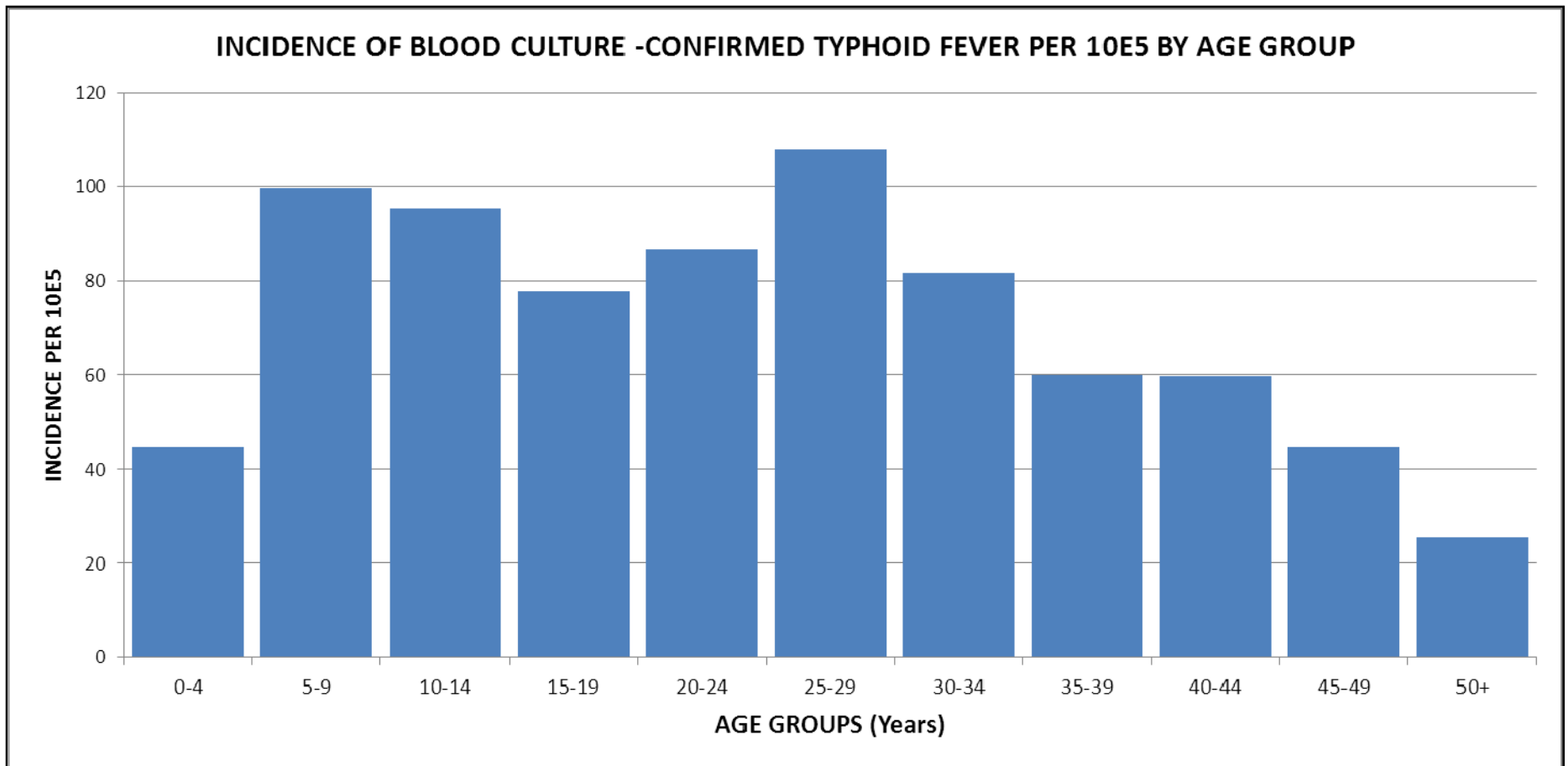


Typhoid in Samoa

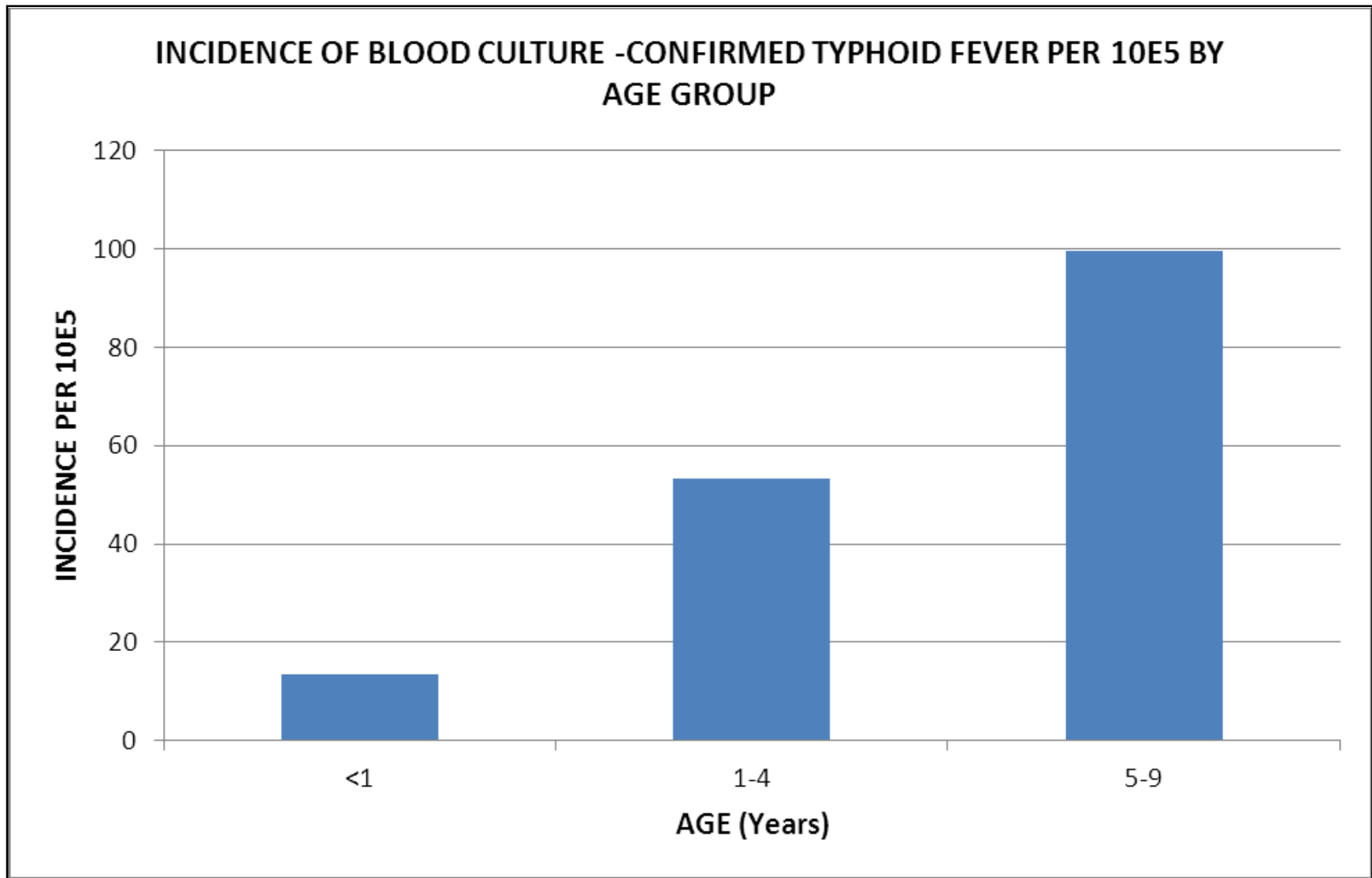
BLOOD CULTURE ISOLATIONS OF SALMONELLA TYPHI, BY MONTH, SAMOA, 2008-2012



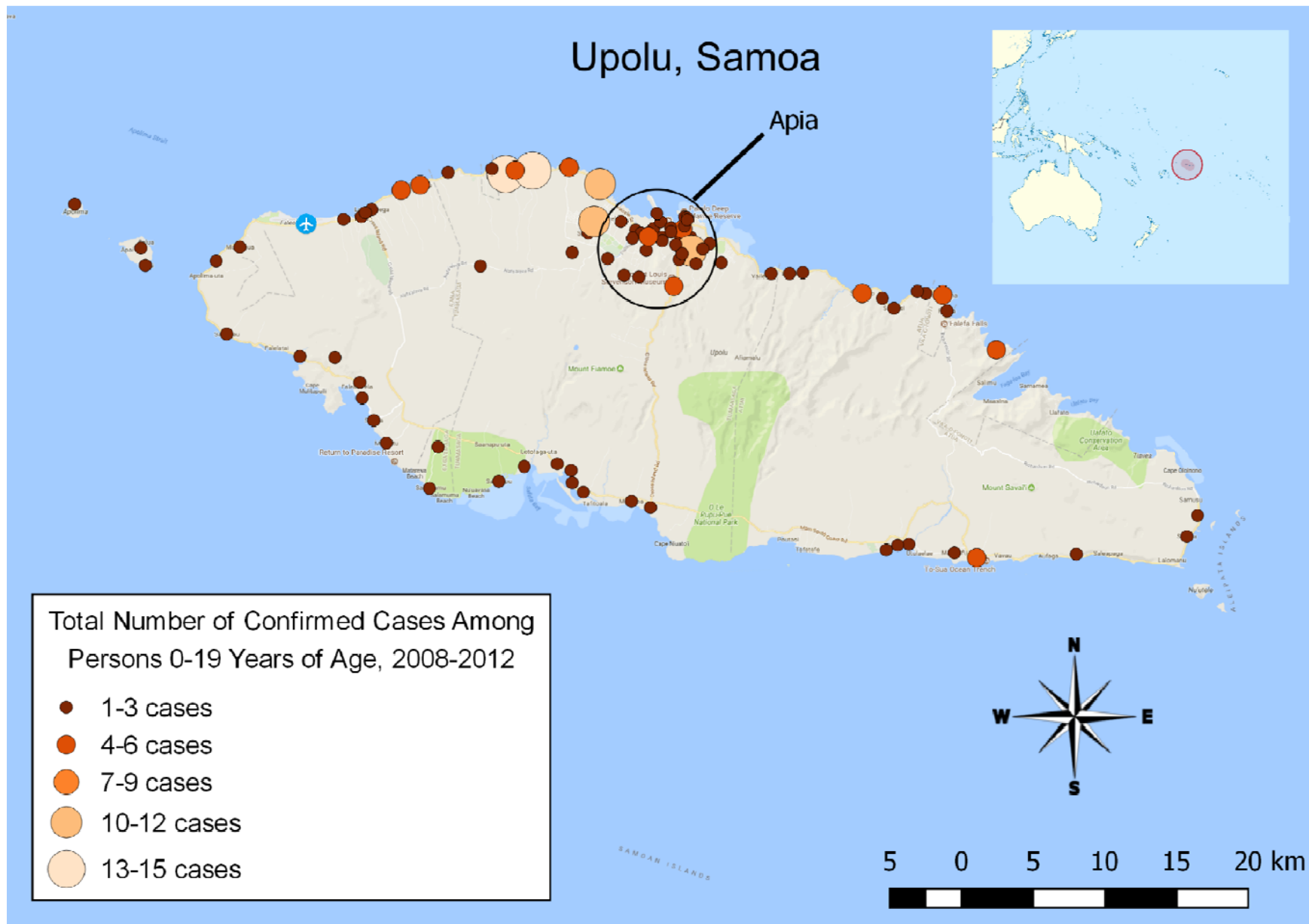
Typhoid in Samoa, 2008-2012



Age-specific incidence of confirmed typhoid in Samoa



Spot map of typhoid cases, Upolu, Samoa, 2008-2012



Cases cluster in the Apia urban area (the capital) and West along the Northern coast of Upolu towards the Northwest tip of the island

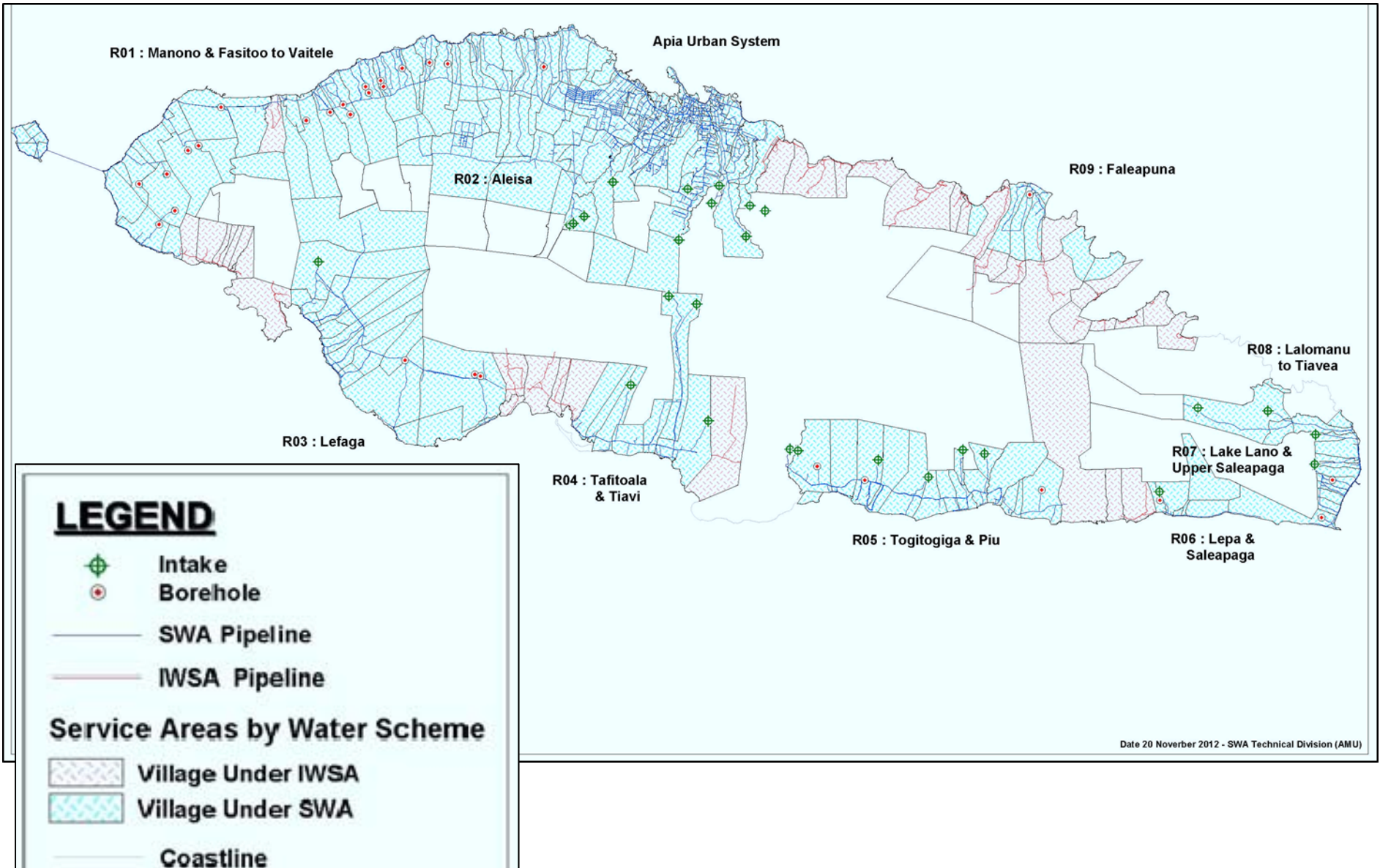
Is this because:

- 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

Expeditionally visit household (or school or workplace) of every confirmed typhoid case

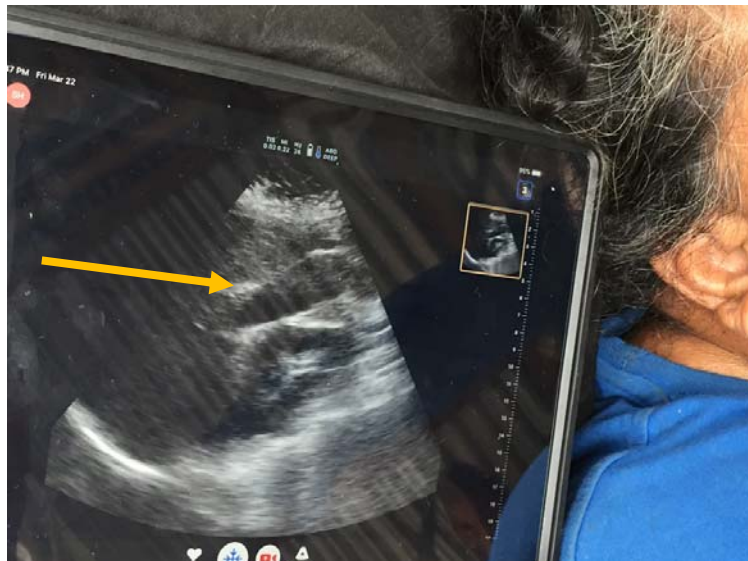
- Epidemiologic investigation (questionnaire)
- **3 stool cultures** from all contacts cases
- Serum from all adult contacts for **Vi serology**
- **RUQ ultrasound of adult contacts** to find gallstones using hand-held POC US device
- **Determine water source & sanitation facility**
- Place **Moore swabs** 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

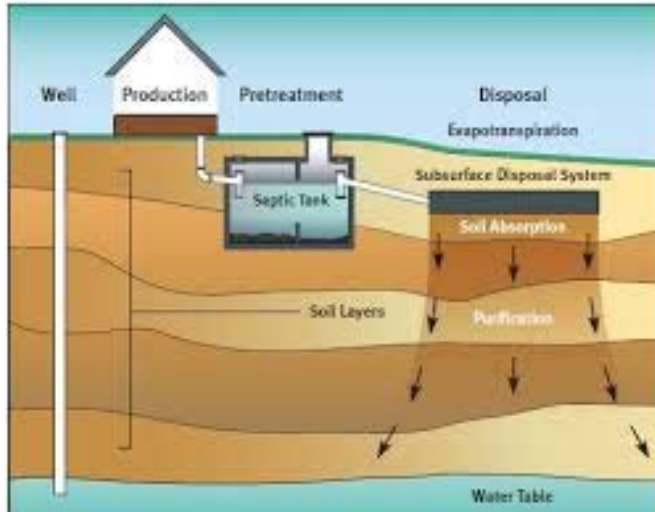


A very large gallstone in radiology unit ultrasound exam of the gallbladder of a 73 YO woman who prepared meals in the household of a case of typhoid fever. This afebrile woman's stool cultures grew *S. Typhi*.



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

Years of surveillance	Cases with known age*	Age group (yrs)			
		< 30	< 40	< 50	≥ 50
2015-2018	318				
Mean annual pop'n	Total: 196,473	123,337	145,873	165,982	30,491
Cumulative % of all cases		67%	84%	94%	6%
* 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 \geq 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

- **Ministry of Health, Samoa** (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, Ifayet 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**