Epidemiology and global burden of disease of typhoid fever

John A. Crump, MB ChB, MD, DTM&H
McKinlay Professor of Global Health

WHO SAGE: typhoid vaccines session
17 October 2017
Outline

• Epidemiology
  – Chain of infection
  – Sources and modes of transmission

• Global burden estimates
  – Endemic disease
  – Occurrence by age
  – Geographic and temporal variation
  – Outbreaks
What is the source and predominant mode(s) of transmission?
Mode of transmission locally

- **Waterborne**
  - Municipal water supplies e.g., Kathmandu, Nepal

- **Foodborne**
  - Restaurant-associated outbreaks linked to chronic carriage in food handler in countries where typhoid is rare e.g., Colorado, United States

### Published estimates of typhoid burden, 1995-2016

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Year</th>
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</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
<td>WHO</td>
</tr>
<tr>
<td><strong>Coverage</strong></td>
<td>Global</td>
</tr>
<tr>
<td><strong>Illnesses, millions (95% CI)</strong></td>
<td>16.0 (17.5-24.2)</td>
</tr>
<tr>
<td><strong>DALYs, thousands (95% CI)</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Deaths (95% CI)</strong></td>
<td>600,000 (131,000-344,000)</td>
</tr>
</tbody>
</table>
Global population and typhoid illness estimates 1995-2016

Population (billions)

Global population

Typhoid illnesses

Typhoid illnesses (millions)

Year


Distribution of typhoid fever by age group at various incidence levels, 2000

Typhoid fever DALYs and deaths by age
Global Burden of Disease 2015

Disability Adjusted Life Years

Deaths

EN: early neonatal, LN: late neonatal, PN: post-natal

http://vizhub.healthdata.org/gbd-compare/
Typhoid in infants and young children

- Typhoid <5 years of age
  - Detailed understanding by month of age
  - Especially <2 years of age
  - Severity

- WHO SAGE working group on typhoid vaccines undertook detailed review of unpublished data
Typhoid fever by age <5 years and all ages inpatients
Queen Elizabeth Hospital, Blantyre, Malawi, 1998-2014

Age <5 years by month

All ages

*Age known to year rather than month; age smoothed across all months of year

Summary of results

• Data were received from 15 sources from Africa, Asia, and the Americas

• Available data were of inpatients, outpatients, or both, collected between 1998 and 2017 representing >10 000 blood culture confirmed episodes of typhoid fever

• Among studies of all age groups
  – 27% of typhoid fever occurred in the age group 0-4 years

• In the age group 0-4 years, giving equal weighting to data in these studies
  – 29.7% of typhoid fever episodes occurred at age ≤2 years
  – 9.9% at age ≤1 year
  – 2.9% at age ≤6 months
Summary of typhoid occurrence <5 years of age

- Typhoid fever is uncommon but not absent ≤ 6 months of age
  - Neonatal disease is rare but documented

- Typhoid occurrence increases steeply between 6 and 12 months of age

- Typhoid fever is as common among 1-2 year olds as 2-5 year olds

- Typhoid fever is sufficiently severe among under 5 year olds to require outpatient and inpatient care
Global distribution of typhoid fever, 2000 vs. 2010


Typhoid Surveillance in Africa Programme (TSAP)
Model-predicted age-specific incidence per 100,000 person-years, 2015

The median posterior predicted incidence per 100,000 person-years in each of the age groups (<2 yrs, 2-4 yrs, 5-14 yrs, and ≥15 yrs) is mapped for all low- and middle-income countries (LMICs) with a resolution of 0.1 degrees.
Monthly trends in bloodstream invasive Salmonella diagnosed at Queen Elizabeth Hospital, Blantyre, Malawi, November 2010-October 2014.

Typhoid outbreaks

• Incidence during outbreaks excluded from most estimates of disease burden
  – Typhoid fever is epidemic prone

• The SAGE Working Group reviewed the available data on outbreaks
  – 41 published reports 1990-2017
  – Mean 1,097 cases per outbreak
  – 10 (28.6%) and 8 (22.9%) among 35 distinct outbreaks occurred in the WHO South-East Asia Region and African Region and respectively
  – 14 (40.0%) of 35 outbreaks exceeded 100 days duration
  – Vaccine rarely deployed
Conclusions

• **Typhoid epidemiology**
  – Human reservoir, portal of exit stool
  – Transmission from fecally contaminated water and food

• **Global typhoid cases have plateaued with 11-18 million illnesses and 128,000-190,200 deaths per year**

• **Severe typhoid is common below 2 years of age**

• **Typhoid incidence varies in place and time between and within countries**
  – Heterogeneity is a critical consideration for vaccination strategy

• **Typhoid outbreaks may be large and prolonged**
  – Reactive vaccination seldom timely
Acknowledgements

• TSAP, Africa
  – Florian Marks
  – Gi Deok Pak
• Kamalapur, Bangladesh
  – Firdausi Qadri
  – John Clemens
• SEAP
  – Denise Garrett
  – Samir Saha
  – Farah Qamar
  – Jason Andrews
  – Steve Luby
  – Dipika Sur
• Dhaka, Bangladesh
  – Samir Saha
• STRATAAA
  – Andy Pollard
  – Merryn Voysey
  – James Meiring
• Navi Mumbai
  – Kashmira Date

• SETA
  – Florian Marks
  – Ligia Cruz Espinoza
• Santiago, Chile
  – Mike Levine
  – Rosanna Lagos
• Malawi
  – Melita Gordon
  – Nicolas Feasey
• CVD, Mali
  – Mike Levine
  – Milagritos Tapia
  – Samba Sow
• GERMS-SA, South Africa
  – Karen H. Keddy
• RTS,S
  – Calman MacLennan
• World Health Organization
  – Adwoa Bentsi-Enchill