Invasive salmonellosis
Epidemiological data from Africa
Case fatality and association with drug resistance

Lisette Kalonji Mbuyi, Annelies Post, Marie-France Phoba, Jan Verhaegen, Dauly Ngbonda, Jean-Jacques Muyembe, Dadi Falay, Sophie Bertrand, Octavie Lunguya, Jan Jacobs
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Democratic Republic of the Congo

8 months wet, 4 months dry season

North

South

Institute of Tropical Medicine | Clinical Sciences
Democratic Republic of the Congo

Demography

2 345,000 km²

75,508,308 inhabitants

2.5% increase/yr

48.5% < 15 yrs old, 4% > 60 yrs

Human Development Index = 186

HIV

Adults aged 15 to 49

prevalence rate 1.1% [0.9% - 1.3%]

Malnutrition:

Graphique 6 Malnutrition des enfants de moins de cinq ans, MICS-RDC 2010 et EDS-RDC II 2013

Heighth for Age
Chronic malnutrition

Weight for Height
Acute malnutrition/iNTS associated

Weight for Age
Combines acute and chronic
Malaria: *P. falciparum* high endemicity, perennial, not declining

I. Epidemiological profile

<table>
<thead>
<tr>
<th>Category</th>
<th>Population</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>High transmission (≥ 1 case per 1000 population)</td>
<td>65,500,000</td>
<td>97</td>
</tr>
<tr>
<td>Low transmission (0–1 cases per 1000 population)</td>
<td>20,300,000</td>
<td>3</td>
</tr>
<tr>
<td>Malaria-free (0 cases)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>67,530,000</td>
<td></td>
</tr>
</tbody>
</table>

Parasites and vectors:
- Major plasmodium species: *P. falciparum* (90%), *P. vivax* (0%)
- Major anopheline species: *An. gambiae*, *An. funestus*, *An. nili*, *An. moucheti*
- Programme phase: Control
- Reported confirmed cases: 6,715,223
- Reported deaths: 30,918

Malaria admissions and deaths (per 100,000)
Blood culture surveillance network

“Resume Microbiology” in DR Congo
Bloodstream & Meningitis
Antibiotic resistance
Capacity building
Patient care “routine” diagnostics
Epidemic preparedness

Figure. Febrile illness surveillance pyramid.
Blood culture surveillance Methods

Suspected Case

Blood culture

Antibiogram
Shipment and batch testing ITM - Reference lab IPH
Limitations and Strengths

**Limited demographic/clinical data**
- No population-based denominators

**Quality and Logistical issues**
- No GPS coordinates

**Constant performance over time**
- High recovery of isolates
- High(er) reactivity in case of alerts
- Embedded in patient care
- Service-for-free: non economic/urgency bias
Criteria for sampling

In children 28 days and 14 years old

1. Body temperature of $\geq 38^\circ C$ or $\leq 35.5^\circ C$
2. Suspicion of severe localized infection.
   - pneumonia
   - meningitis
   - complicated urinary tract infection
   - osteoarthritis
   - skin and soft tissues infection
   - gynaecological infections
   - peritonitis
3. Clinical suspicion of sepsis
   - typhoid fever and severe malaria
Logistical problems...
Logistical problems...

Salmonella survives for > 2 months in a blood culture vial at room t°

Pneumococcus dies probably after 1 – 2 days
Breakdown of samples

Blood cultures
n = 15.116

0.5 – 4ml in children
2 x 10ml in adults

Septic episodes
n = 14.150

11.734 in children
2.001 in adults

1 septic episode = 14 days

Patients
n = 13.243

777 patients with 2 episodes
91 patients with 3 episodes
32 patients with ≥ 4 episodes

Nr. of CSO n = 2.353 (15,6%)
Clinically significant organisms

Nr. of CON n = 1.713 (11,3%)
Contaminants

Bacillus n = 375
CNS n = 1320
Coagulase negative staphylococcus

Children n = 11,002
Median 2 yrs old (IQR 1 – 4 yrs)
M/F ratio 1.16

Adults n = 1.835
Median 35 yrs old (IQR 25 – 50 yrs)
M/F ration = 1.04
Contamination: Bacillus = gloves

Nr. of CSO n = 2.353 (15,6%)  
Clinically significant organisms

Nr. of CON n = 1.713 (11,3%)  
Contaminants

Bacillus n = 375
CNS n = 1320
Coagulase negative staphylococcus
Breakdown of samples

**Septic episodes**

n = 14,150

11,734 in children
CSO: n = 1901
(first isolates)
Clinically significant organisms)

2001 in adults
CSO: n = 300
(first isolates)
Clinically significant organisms)

### Children CSO  n = 1901

1. Salmonella non-Typhi  41.5%
2. Klebsiella spp.  9.0%
3. S. aureus  7.9%
4. Salmonella Typhi  6.5%
5. Enterobacter spp.  6.3%
6. Escherichia coli  5.5%

### Adults  CSO  n = 300

1. Salmonella Typhi  21.3%
2. Escherichia coli  19.7%
3. Salmonella non-Typhi  11.3%
4. S. aureus  10.3%
5. Klebsiella spp.  10.0%
6. Enterobacter  8.7%
### Salmonella single isolates

<table>
<thead>
<tr>
<th>Single isolates (septic episodes)</th>
<th>Numbers</th>
<th>% of CSO (children/adults combined, n = 2201)</th>
<th>% of septic episodes (n = 11,734)</th>
<th>Numbers confirmed and available%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella</td>
<td>1,043</td>
<td>47.4</td>
<td>8.9</td>
<td>952</td>
</tr>
<tr>
<td>Typhi</td>
<td>194</td>
<td>8.8</td>
<td>1.7</td>
<td>163</td>
</tr>
<tr>
<td>Non-Typhi</td>
<td>840</td>
<td>38.2</td>
<td>7.2</td>
<td>789</td>
</tr>
<tr>
<td>Typhimurium</td>
<td>384</td>
<td>17.4</td>
<td>3.3</td>
<td>377</td>
</tr>
<tr>
<td>Enteritidis</td>
<td>398</td>
<td>18.1</td>
<td>3.4</td>
<td>391</td>
</tr>
<tr>
<td>Other</td>
<td>58</td>
<td>2.6</td>
<td>0.5</td>
<td>21</td>
</tr>
</tbody>
</table>
Salmonella

952/1037 (91.8%) first isolates available

1. Serotype distribution

2. Antibiotic resistance

3. Some observations
## Salmonella serotype distribution

<table>
<thead>
<tr>
<th>Single isolates (septic episodes)</th>
<th>Numbers</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella</td>
<td>952</td>
<td>100</td>
</tr>
<tr>
<td>Typhi</td>
<td>163</td>
<td>17.1%</td>
</tr>
<tr>
<td>Non-Typhi</td>
<td>789</td>
<td>82.9%</td>
</tr>
</tbody>
</table>

% of NTS

<table>
<thead>
<tr>
<th></th>
<th>Numbers</th>
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</tr>
</thead>
<tbody>
<tr>
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<td>47.8%</td>
</tr>
<tr>
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<td>391</td>
<td>49.6%</td>
</tr>
<tr>
<td>Other</td>
<td>21</td>
<td>2.7%</td>
</tr>
</tbody>
</table>
Salmonella Typhimurium varietas Copenhagen
35/138 (25.3%) Typhimurium tested
## Antibiotic resistance

<table>
<thead>
<tr>
<th>Panel of antibiotics:</th>
<th>ECDC 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk diffusion:</td>
<td>CLSI M100-S25</td>
</tr>
<tr>
<td>Ciprofloxacin:</td>
<td>E-test Macromethod (bioMérieux and Oxoid)</td>
</tr>
<tr>
<td>DCS</td>
<td>Decreased ciprofloxacin susceptibility</td>
</tr>
<tr>
<td></td>
<td>DCS if MIC &gt; 0.06(4)mg/l = 0.12</td>
</tr>
<tr>
<td></td>
<td>Resistant if MIC &gt; 1 mg/l</td>
</tr>
<tr>
<td></td>
<td>Pefloxacin (EUCAST), Nalidixic acid (CLSI) disk</td>
</tr>
<tr>
<td>Azithromycin:</td>
<td>EUCAST 2014 v4.0 MIC ≥ 16 mg/l</td>
</tr>
<tr>
<td>MDR:</td>
<td>R to Amoxi/TMP-SMX and Chloramphenicol</td>
</tr>
<tr>
<td>Resistance rates</td>
<td>Typhi n= 162</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>ampicillin</td>
<td>68.7%</td>
</tr>
<tr>
<td>cotrimoxazole</td>
<td>60.7%</td>
</tr>
<tr>
<td>chloramphenicol</td>
<td>54.0%</td>
</tr>
<tr>
<td>MDR</td>
<td>38.0%</td>
</tr>
<tr>
<td>tetracyclin*</td>
<td>46.0%</td>
</tr>
<tr>
<td>gentamicin*</td>
<td>0.6%</td>
</tr>
<tr>
<td>DCS</td>
<td>36.8%</td>
</tr>
<tr>
<td>azithromycin</td>
<td>0.6%</td>
</tr>
<tr>
<td>ESBL</td>
<td>0.0%</td>
</tr>
<tr>
<td>MDR + DCS</td>
<td>17.8%</td>
</tr>
<tr>
<td>MRD + DCS + tetra</td>
<td>8.6%</td>
</tr>
<tr>
<td>MDR + ESBL</td>
<td>0.0%</td>
</tr>
<tr>
<td>MDR + ESBL + azithro</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

* For surveillance purposes only, no resistance to meropenem
### MIC values ciprofloxacin (mg/l)

<table>
<thead>
<tr>
<th>MIC value</th>
<th>&lt;0.01</th>
<th>0.016</th>
<th>0.023</th>
<th>0.038</th>
<th>0.047</th>
<th>0.064</th>
<th>0.125</th>
<th>0.19</th>
<th>0.25</th>
<th>0.38</th>
<th>0.5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typhi</strong></td>
<td>18</td>
<td>66</td>
<td>3</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>1</td>
<td>40</td>
<td>6</td>
<td>4</td>
<td>163</td>
</tr>
<tr>
<td><strong>Typhimurium</strong></td>
<td>110</td>
<td>233</td>
<td>6</td>
<td>12</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>377</td>
</tr>
<tr>
<td><strong>Enteritidis</strong></td>
<td>189</td>
<td>176</td>
<td>7</td>
<td>9</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>391</td>
</tr>
<tr>
<td><strong>Pending</strong></td>
<td>8</td>
<td>9</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>21</td>
</tr>
</tbody>
</table>

**MIC 50 = 0.016 mg/l**

**MIC 90 = 0.038 mg/l**

**DCS in Salmonella Typhi = 38.0%, half of which are MDR**
### MIC values azithromycin (mg/l)

<table>
<thead>
<tr>
<th>MIC value</th>
<th>&lt;2</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>12</th>
<th>15</th>
<th>32</th>
<th>48</th>
<th>64</th>
<th>128</th>
<th>256</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typhi</td>
<td>12</td>
<td>37</td>
<td>40</td>
<td>50</td>
<td>20</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>163</td>
</tr>
<tr>
<td>Typhimurium</td>
<td>28</td>
<td>112</td>
<td>104</td>
<td>66</td>
<td>19</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>21</td>
<td>9</td>
<td>1</td>
<td>1</td>
<td>15</td>
<td>377</td>
</tr>
<tr>
<td>Enteritidis</td>
<td>74</td>
<td>114</td>
<td>133</td>
<td>59</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>391</td>
</tr>
<tr>
<td>Pending</td>
<td>4</td>
<td>8</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>21</td>
</tr>
</tbody>
</table>

**MIC 50 = 3 mg/l  **  
**MIC 90 = 6 mg/l  **

**MIC azithromycin ≥ 16 mg/l : mainly Typhimurium**
- nearly half are high-level resistant
- all but one combined with ESBL
- all but one Bas-Congo, since 03/2013
Azithromycin is a reserve antibiotic but is heavily promoted...
Azithromycin is a reserve antibiotic but is heavily promoted...

Jan, do not forget to reveal the need for treatment guidelines!
<table>
<thead>
<tr>
<th>Antibiotics</th>
<th>CSO (% of total)</th>
<th>Typhi (% of total)</th>
<th>NTS (% of total)</th>
<th>No growth of CSO</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>550 14.0%</td>
<td>55 0.15%</td>
<td>201 6.0%</td>
<td>2433 73.3%</td>
<td>3376</td>
</tr>
<tr>
<td>No</td>
<td>693 14.0%</td>
<td>73 1.5%</td>
<td>238 4.8%</td>
<td>3603 73.0%</td>
<td>4933</td>
</tr>
<tr>
<td>Total</td>
<td>1243</td>
<td>128</td>
<td>439</td>
<td>6036</td>
<td>8085</td>
</tr>
</tbody>
</table>

41.7% of patients were on antibiotics ≤ 48h before sampling

Proportion of growth similar in both groups
Demographics/Clinical presentation – some epidemiological data

1. Age/Gender
2. Outbreaks
3. Symptoms
4. Outcome
## Age and gender distribution

<table>
<thead>
<tr>
<th></th>
<th>Typhi</th>
<th>Non-typhi</th>
<th>Typhimurium</th>
<th>Enteritidis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total numbers</td>
<td>163</td>
<td>789</td>
<td>377</td>
<td>391</td>
</tr>
<tr>
<td>Mean age ± SD</td>
<td>16.1 ± 15.4</td>
<td>3.5 ± 8.4</td>
<td>3.2 ± 7.9</td>
<td>3.8 ± 8.7</td>
</tr>
<tr>
<td>Median age (range)</td>
<td>10 (0 – 75)</td>
<td>1 (0 – 76)</td>
<td>1 (0 – 64)</td>
<td>1 (0 – 76)</td>
</tr>
<tr>
<td>M:F ratio</td>
<td>1.22</td>
<td>1.28</td>
<td>1.22</td>
<td>1.34</td>
</tr>
<tr>
<td>% below 15 yrs</td>
<td>63.7%</td>
<td>95.7%</td>
<td>97.0%</td>
<td>94.8%</td>
</tr>
<tr>
<td>% below 5 yrs</td>
<td>21.0%</td>
<td>85.4%</td>
<td>88.3%</td>
<td>82.9%</td>
</tr>
<tr>
<td>% below 2 yrs</td>
<td>4.9%</td>
<td>52.3%</td>
<td>52.8%</td>
<td>51.4%</td>
</tr>
</tbody>
</table>
Age and gender distribution children

[Bar chart showing the distribution of children by age and gender, categorized by different strains of bacteria.]
No clusters of healthcare-based infections
No “second peak” of NTS in adults
# Economy at the household level: 5 day hospital admission

<table>
<thead>
<tr>
<th>Description</th>
<th>Francs congolais</th>
<th>US $</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Child 10kgs private structure, 5 days Hospital Admission</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Transport</strong> (child+ care-taker to and back from hospital, median 13.5km; range 1 - 130km)</td>
<td>4000</td>
<td>4.3</td>
</tr>
<tr>
<td><strong>Registration</strong></td>
<td>5000</td>
<td>5.3</td>
</tr>
<tr>
<td><strong>Antibiotics/5.6 days</strong> (Ceftriaxone ou cefotaxime (spécialité) 38000 FC, Gentamicin 800FC, Solvant)</td>
<td>38000</td>
<td>40.4</td>
</tr>
<tr>
<td><strong>Antipyretics</strong> (Dipyrone ou Paracetamol 1000FC)</td>
<td>1000</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>Antimalaials</strong> (Quinine 750FC, Artemether/Luméfantrine 1500FC)</td>
<td>1500</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>IV-Perfusions</strong> (Sérum glucosé 5% ou Physiologique 1500FC)</td>
<td>1500</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>Food and meals</strong> (child and caretaker)</td>
<td>5000</td>
<td>5.3</td>
</tr>
<tr>
<td><strong>Hospital Stay</strong></td>
<td>5000</td>
<td>5.3</td>
</tr>
<tr>
<td><strong>Nursing</strong></td>
<td>5000</td>
<td>5.3</td>
</tr>
<tr>
<td><strong>Blood Transfusion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Laboratory analysis</strong> (Hb 700FC, TBF 1000FC, WBC 1500FC, Differential count 1500FC ESR 1000FC)</td>
<td>6500</td>
<td>6.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>72500</td>
<td>77.1</td>
</tr>
</tbody>
</table>
Economy at the household level: 5 day hospital admission

Private sector: 77.1 $
Public sector: 44.6 $

74% use private sector

71.3% lives with < $/day (PNAM)

5 days IV treatment is (too?) short
Outbreaks: “flambées de fièvre”

Minus 5 years old
Fever + Severe anemia
Non-response to antimalarials
Microscopy or RDT* malaria positive
Increase in Hospital Admissions
Increase in Case fatality rates
Increase in Transfusions

* RDT = malaria rapid diagnostic test
## Outcome during outbreaks of iNTS

<table>
<thead>
<tr>
<th>Location</th>
<th>Onset</th>
<th>Culture-proven</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kisantu</td>
<td>2/3 of admissions</td>
<td>23.2%</td>
</tr>
<tr>
<td>Sept 2010 – May 2011</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bwamanda</td>
<td>15.4%</td>
<td>11.1%</td>
</tr>
<tr>
<td>Nov 2011 – May 2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pawa 2012</td>
<td>14.0%, 70% on day 1</td>
<td>10.0%</td>
</tr>
</tbody>
</table>

### Graph

- **Months**: January to December
- **Legend**:
  - **2008**: Blue line
  - **2009**: Red line
  - **2010**: Green line
  - **2011**: Purple line

### Map

- Locations: Kisantu, Bwamanda, Pawa
- Regions: Kinshasa, Bandundu, Haut-Uélé, Kasai Oriental, Katanga
- Country: Democratic Republic of the Congo

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**Institute of Tropical Medicine | Clinical Sciences**
# Outcome during outbreaks of iNTS

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<td></td>
</tr>
<tr>
<td>Pawa 2012</td>
<td>14.0%</td>
<td>10.0%</td>
</tr>
<tr>
<td></td>
<td>70% on day 1</td>
<td></td>
</tr>
</tbody>
</table>

Early installed treatment seems to improve outcome!?

Need health utilization survey: how many die at home/on the road?
Outbreak in Pawa, Isiro, Poko & Wamba

2/3 of iNTS: need for transfusion

Increase in Admissions/Transfusion = alert
### iNTS Oriental Province, DRC 2009 - 2014

<table>
<thead>
<tr>
<th>Condition</th>
<th>Typhi (n=13)</th>
<th>Non-Typhi (n=75)</th>
<th>Typhimurium (n=39)</th>
<th>Enteritidis (n=34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low weight-for-age</td>
<td>0 (0)</td>
<td>14 (20.3)</td>
<td>8 (21.6)</td>
<td>6 (19.4)</td>
</tr>
<tr>
<td>Very Low WfA</td>
<td>0 (0)</td>
<td>11 (15.9)</td>
<td>6 (16.2)</td>
<td>5 (16.1)</td>
</tr>
<tr>
<td>Malaria</td>
<td>4 (30.8)</td>
<td>52 (69.3)</td>
<td>24 (61.5)</td>
<td>28 (82.4)</td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td>9.4 (4.0 – 11.8)</td>
<td>6.0 (3.0 – 12.0)</td>
<td>6.3 (4.0 – 12.0)</td>
<td>5.0 (3.0 – 9.8)</td>
</tr>
<tr>
<td>Anemia (Hb &lt; 11 g/dl)</td>
<td>10 (76.9)</td>
<td>73 (98.6)</td>
<td>37 (97.4)</td>
<td>34 (100)</td>
</tr>
<tr>
<td>Severe anemia (Hb &lt; 5 g/dl)</td>
<td>1 (7.7)</td>
<td>22 (29.7)</td>
<td>10 (26.3)</td>
<td>12 (35.3)</td>
</tr>
<tr>
<td>Blood transfusion</td>
<td>4 (30.8)</td>
<td>49 (65.3)</td>
<td>24 (61.5)</td>
<td>25 (73.5)</td>
</tr>
<tr>
<td>Died in hospital</td>
<td>1 (7.7)</td>
<td>10 (13.3)</td>
<td>7 (17.9)</td>
<td>3 (8.8)</td>
</tr>
</tbody>
</table>
Comparison with previous findings
## Comparison with findings 2007 – 2010 Salmonella Typhi

<table>
<thead>
<tr>
<th></th>
<th>2007 - 2010 (n = 201)</th>
<th>2011 – 2014 (n = 194)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.3% of clinically significant organisms</td>
<td></td>
<td>8.8% (more children, higher % CSO)</td>
</tr>
<tr>
<td>2.1% of blood cultures</td>
<td></td>
<td>1.7%</td>
</tr>
<tr>
<td>MDR 30.3% DCS 15.4% AZI 1.0%</td>
<td></td>
<td>MDR 38.0% DCS 36.8%, half of which are MDR, AZI 0.6%</td>
</tr>
<tr>
<td>Median age 15 yrs, IQR 8 -25 yr, 33% in first and 60% in second decade</td>
<td></td>
<td>Median age 16 yrs, range 0 - 75 yr), nearly two-thirds below 15 years old</td>
</tr>
</tbody>
</table>
## Comparison with findings 2007 - 2010, non-Typhi Salmonella

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Typhimurium</strong></td>
<td>79% Enteritidis 18%</td>
<td>Typhimurium 47.8% Enteritidis 49.9%</td>
</tr>
<tr>
<td><strong>23.0% of clinically significant organisms</strong></td>
<td></td>
<td>38.2% of clinically significant organisms</td>
</tr>
<tr>
<td><strong>2.4% of blood cultures</strong></td>
<td></td>
<td>7.9% of blood cultures</td>
</tr>
<tr>
<td><strong>MDR 80.7% DCS 4.3% AZI 3.0% ESBL 1.3%</strong></td>
<td></td>
<td>MDR &gt; 80% DCS 2% combined AZI-R and ESBL in 10.7% of Typhimurium</td>
</tr>
<tr>
<td><strong>M/F 1.24, Median age 2 yrs, IQR 1 – 11 yr</strong></td>
<td></td>
<td>M/F 1.22 – 1.34, Median age 1 yr, IQR 0 – 75 yr</td>
</tr>
<tr>
<td><strong>Rainy season</strong></td>
<td></td>
<td>Outbreaks, transfusion needs, particularly with Enteritidis</td>
</tr>
</tbody>
</table>
On-going & Future projects

Ethical clearance for study of demographic and clinical data
Molecular typing/resistance
Salmonella carrier study
Salmonella Schistosoma association study

Diagnosis: proteomics  Stijn Deborggraeve
Sara Saleh
Sandra Van Puyvelde
Saskia Decuypere

metabolomics

Public Health: Koen Peeters

Burkina Faso guest: Guiraud Issa

Clinical Microbiology
Laura Kuijpers
Annelies Post
Barbara Barbé
Collaborators, acknowledgements, funders

INRB, DRC
Lisette Kalonji Mbuyi
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Octavie Lunguya

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Dadi Falay
Dauly Ngbonda
Brigitte Mapendo

ITM Belgium
Annelies Post
Barbara Barbé
Marleen Verlinden
Kim van Bambost

KU Leuven
Jan Verhaegen
Hugo Devlieger
Chris Van Geet

ISP Belgium
Sophie Bertrand

Belgian Development Cooperation
Thank you for your attention!