Estimating the Burden of Foodborne Diseases in the Caribbean

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What is a ‘Burden of Illness’ study?

• The burden of foodborne diseases can be defined as the incidence, prevalence of morbidity, disability and mortality associated with acute and chronic manifestations of FBD (WHO 2006)

• A burden of Illness study estimates the true burden of a syndrome (e.g. gastroenteritis) or pathogen e.g. Salmonella) in a community
  – What is the true burden of diarrhea illness in the community?
  – What is the true burden of a specific pathogen e.g. Salmonella) in the community?
Why the need to estimate the global burden of foodborne diseases?
Why do we need BOI studies

- FBD: important global cause of illness and death
- Large variation in capacities to detect, investigate and mitigate FBD – absence of reliable data on burden of FBD
- True burden and real health impact of FBD is not known/well understood, hence not prioritised
- Precise information on BOI is needed to allocate resources for appropriate and most effective FBD control efforts, and developing relevant public health policies
- The WHO through the Global Burden Disease initiative, developed a rigorous approach for BOI estimation
- The underlying concept of this study rests on defining the reporting pyramid for each country
Foodborne Diseases – a Growing Risk

Foodborne diseases encompass a wide spectrum of illnesses and are a growing public health problem worldwide. They are the result of ingesting contaminated foodstuffs, and range from diseases caused by a multitude of microorganisms to those caused by chemical hazards. Recent global developments are increasingly challenging international health security. These developments include the growing industrialization and trade of food production, the rapid urbanization associated with a more frequent food preparation/consumption outside the home and the emergence of new or antibiotic-resistant pathogens.

The most common clinical presentation of foodborne diseases takes the form of gastrointestinal symptoms but such diseases can also lead to chronic, life-threatening symptoms including neurological, gynecological or immunological disorders as well as multiorgan failure, cancer and death.

The global burden of foodborne diseases and its impact on development and trade is currently unknown. Reliable epidemiological data are, however, urgently needed to enable policy-makers as well as other stakeholders to:

- appropriately allocate resources to foodborne disease, prevention and control efforts;
- monitor and evaluate food safety measures;
- develop new food safety standards;
- assess the cost-effectiveness of interventions; and
- quantify the burden in monetary costs.

As a response to the current data gap, the WHO Department of Food Safety, Zoonoses and Foodborne Diseases (FOS) launched a new Initiative to Estimate the Global Burden of Foodborne Disease in collaboration with multiple partners.
Objectives of the Initiative to Estimate the Global Burden of Foodborne Diseases

Objective 1
To provide estimates on the global burden of foodborne diseases according to age, sex and regions for a defined list of causative agents of microbial, parasitic, and chemical origin.

Objective 2
To strengthen the capacity of countries in conducting burden of foodborne disease assessments and to increase the number of countries who have undertaken a burden of foodborne disease study.

Objective 3
To increase awareness and commitment among Member States for the implementation of food safety standards.

Objective 4
To encourage countries to use burden of foodborne disease estimates (e.g. for cost-effective analyses of prevention, intervention and control measures).
Surveillance of Foodborne Disease

What we do know…
(reported cases)

What we need to know!
Known Studies of Burden of Foodborne Illness
Benefits of conducting a ‘BOI’ study

• Obtain estimates of the burden of enteric pathogens and acute gastroenteritis of foodborne origin in the community

• Obtain estimates of the burden caused by specific enteric pathogens commonly transmitted by food in the community

• Gain a better understanding of how your surveillance system and laboratories are working

• Promote cooperation and collaboration among various government sectors

• Advocate for gaining money and affect policy change

• Build capacity and promote intersectoral collaboration

• Determine more appropriate intervention measures for FBD, guide policy
Caribbean Burden of Illness Study
2007-present
Why Caribbean needs a BOI study

• The epidemiology of food and waterborne illnesses at the community level are poorly understood in the Caribbean.

• Little information on disease burden is available: limiting appropriate prevention measures & allocation of resources

• Large number of marginalized populations with poor access to health are often at high risk to food, waterborne and zoonotic infections – causing considerable morbidity, and largely undetected by routine surveillance systems

• Communicable disease surveillance in the region has primarily been based on syndromic surveillance and there is limited aetiology (based laboratory-confirmed cases) since stools are not routinely collected for lab testing.
Why Caribbean needs a BOI study

- Syndromes are often under-reported. Especially true for GE as many people will self-treat without seeking health care, (doctors do not routinely request stool samples for AGI )
- Limited understanding of which pathogens (etiologies) are responsible for the illnesses manifest in the 3 key syndromes (acute GE, undifferentiated fever, fever and respiratory)
- Even with the enhanced CD system, persons unable/unwilling to go to a health care provider will not be captured leading to a paucity of information about these individuals and the illnesses
- Ltd development of targeted disease reduction interventions.
- Conduct of BOI studies is therefore needed in the Caribbean
<table>
<thead>
<tr>
<th>Symptom</th>
<th># cases 2005</th>
<th># cases 2006</th>
<th># cases 2007</th>
<th># cases 2008</th>
<th># cases 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gastroenteritis (GE) &lt;5 (17-20 CMCS)</strong></td>
<td>25,819</td>
<td>58,772</td>
<td>41,536</td>
<td>57,834</td>
<td>49,564</td>
</tr>
<tr>
<td><strong>Gastroenteritis (GE) &gt;5 (17-20 CMCS)</strong></td>
<td>34,658</td>
<td>57,836</td>
<td>52,316</td>
<td>68,571</td>
<td>71,159</td>
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<tr>
<td><strong>GE/FBD outbreaks</strong></td>
<td>21</td>
<td>21</td>
<td>22</td>
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<tr>
<td><strong>FBD Etiologic agent (Laboratory-confirmed)</strong></td>
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<tr>
<td><em>Campylobacter (3-6CMCS)</em></td>
<td>37</td>
<td>43</td>
<td>37</td>
<td>64</td>
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<tr>
<td><em>Escherichia coli (pathogenic)</em></td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td><em>Norovirus (3-4CMCS)</em></td>
<td>3</td>
<td>7</td>
<td>19</td>
<td>12</td>
<td>11</td>
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<tr>
<td><em>Listeria</em></td>
<td>0</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td><em>Salmonella (13-15CMCS)</em></td>
<td>838</td>
<td>533</td>
<td>528</td>
<td>428</td>
<td>678</td>
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<tr>
<td><em>Shigella (7-11CMCS)</em></td>
<td>183</td>
<td>156</td>
<td>103</td>
<td>74</td>
<td>173</td>
</tr>
<tr>
<td><em>Typhi and Paratyphi</em></td>
<td>0</td>
<td>356</td>
<td>110</td>
<td>6</td>
<td>6</td>
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<tr>
<td><em>Vibri</em></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<tr>
<td><em>Rotavirus</em></td>
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<td><em>(Clinical diagnoses)</em></td>
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<tr>
<td><em>Ciguatera poisoning (4-6CMCS)</em></td>
<td>453</td>
<td>387</td>
<td>263</td>
<td>349</td>
<td>91</td>
</tr>
</tbody>
</table>
Background

• **2007- present**
  – BOI studies: Part of PAHO’s BWP (SO9) on food safety- for promoting & building capacity integrated FBD surveillance in countries (reason for starting)
  – Part of CEHP program

• **2010 to the future**
  – WHO 52\textsuperscript{nd} resolution May 2010
    “Advancing food safety initiatives”
    • URGES Member States to establish or improve the evidence base for food safety through systematic efforts on disease-burden estimation and surveillance……
    • REQUESTS the Director-General: to monitor regularly and report to Member States on the global burden of foodborne and zoonotic diseases from the country, regional and international perspectives;
**Background**

- **Countries (8):**
  - St Lucia, Grenada, Jamaica, Trinidad, Guyana, Dominica
  - Bermuda, Barbados
  - Based on size, capacity, tourism dependence
  - Request and agreements from MoHs
  - representative of the CARICOM countries

- **Coordination:** CAREC with PAHO, PHAC

- **Each country:** responsible for conduct of study
  - Steered by CMO, national epidemiologist & lab director
Objectives of Study

- Detect community prevalence of gastroenteritis, fever and acute respiratory illness and undifferentiated fever.
- Quantify the under-reporting of disease syndromes.
- Develop source attribution estimates for GE illnesses.
- Understand the etiology of key pathogens commonly transmitted by food in the Caribbean. *Salmonella, Shigella, Campylobacter, Staphylococcus, pathogenic E coli 0157:H7, Norovirus*
- Provide baseline information on exposure to key zoonoses.
- Improve laboratory capacity to enable timely and sensitive diagnose of infectious diseases.
- Build capacity to analyze surveillance and research data.
- Strengthen national and regional surveillance systems.
- Promote the generation of public policies and interventions for foodborne infections.
What we do know…
(reported cases)

What we need to know!
Sources of Information

1. How many cases are reported to surveillance?
   - Surveillance system

2. How often are laboratory-confirmed cases reported?
   - Laboratory survey

3. How sensitive are the laboratory tests?
   - Laboratory survey

4. How often do laboratories test for a pathogen?
   - Laboratory survey

5. How often are specimens submitted?
   - Population survey

6. How often do ill persons seek medical care?
   - Population survey
Methodology

To estimate the burden of FBD: 2 Components

• A population-based component
  – Population survey based on self reported cases
  – 2 surveys during high and low GI periods

• A laboratory-based component
  – Enhanced lab testing for 1 year
  – Review of lab results before and after

• Information and Policy-based component
1: Population Component

- Population survey based on self-reported cases of AGI
- Administered as a retrospective population based survey
- Use a standardized questionnaire, administered by trained interviewers from randomly selected enumeration districts in each parish

Survey
- Information on acute GE, undifferentiated fever, fever and respiratory symptoms experienced over the past 30 days
- Symptoms, socio-demographics, frequency of health care seeking behaviours, frequency of appropriate laboratory specimen submissions, use of antibiotics and other medications, and perceived cause of illness
Population Survey (based on GI trends)

• **Ist survey: February 21-March 7, 2009** (2 weeks) to capture the high AGI season (*typically during the winter months* (*December-February*))
• **second phase during 14-27 June 2009** (2 weeks)) to capture the low season. (2 weeks)) to capture the low season usually during May – July.
2: Population survey

Outcomes

- estimate of the no of persons in population experiencing these syndromes and proportion of those who sought medical care.
- determine proportion of those seeking care for diarrhea provided a stool for diagnosis, under-reporting factors
- Info to estimate the social and economic cost of AGI

Proportion of gastrointestinal illness (AGI) attributed to food and the specific pathogens, \((\text{Salmonella}, \text{Shigella}, \text{Campylobacter}, \text{pathogenic Staphylococcus aureus, Escherichia coli } 0157: \text{H7}}, \text{Vibrio and Norovirus})\) will then be estimated (in conjunction with other data, including outbreak and laboratory based surveillance data).
2: Laboratory Component

Goal: better understand and improve routine laboratory surveillance at country level & to determine the prevalence of specific aetiologies commonly transmitted by food

The laboratory based component includes

• Lab capacity strengthening initiative
  – Methods and media

• Baseline survey of the national laboratory

• One year enhanced testing

• Survey following one year testing
Outcomes of Lab Study

• estimate the number of specimens received in the laboratories servicing the study sites

• proportion of cases lost to surveillance because of negative findings

• proportion of confirmed cases reported to the surveillance systems in the participating countries.

• Laboratory and population survey- used to estimate the true impact of specific pathogens wrt to diarrheic disease in the populations
Sources of Information

1. How many cases are reported to surveillance?
   - Surveillance system

2. How often are laboratory-confirmed cases reported?
   - Laboratory survey

3. How often do ill persons seek medical care?
   - Population survey

4. How often are specimens submitted?
   - Laboratory survey

5. How often do laboratories test for a pathogen?
   - Laboratory survey

6. How sensitive are the laboratory tests?
   - Laboratory survey

7. How many cases are reported to surveillance?
Example: What is the true burden of *Salmonella* in the community?
To estimate the burden of illness

Step 1: Collect and analyze data

- (I) Review of current surveillance system:
- (II) Conduct a laboratory-based component
  - One year enhanced lab testing & survey
- (iii) Conduct a population-based survey
  - Two surveys based on AGI trends

Step 2: Calculate Multipliers

Step 3: Calculate Burden of Illness
Step 2: Calculate multipliers

• What is a multiplier?
  – A multiplier is the inverse of a proportion calculated to account for the underreporting between two steps in a surveillance pyramid
    ▪ 10% = 100/10 = Multiplier of 10
    ▪ 20% = 100/20 = Multiplier of 5
    ▪ 15% = 100/15 = Multiplier of 6.7
Step 2: Calculate Multipliers

How many cases are reported to surveillance?
18,012

How often are laboratory-confirmed cases reported?
100% = 100/100 = 1.0

How sensitive are laboratory tests?
70% = 100/70 = 1.4

How often do laboratories test for a pathogen?
100% = 100/100 = 1.0

How often are specimens submitted?
18% = 100/18 = 5.6

How often do ill persons seek medical care?
12% = 100/12 = 8.3
Step 3: Calculate Burden of Illness

Cases Reported = 18,012

Laboratory-confirmed cases = 18,012

Specimens Examined = 25,217

Persons submitting specimens = 25,217

Lab Tests

Persons seeking medical care = 141,214

Specimens Obtained

Medical Care

Persons Ill = 1,172,077
## Burden of Illness Calculator

**Salmonella**

<table>
<thead>
<tr>
<th>A</th>
<th>How many cases of disease are reported?</th>
<th>2</th>
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<tbody>
<tr>
<td>B</td>
<td>How often does the parish report to NND</td>
<td>100</td>
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<tr>
<td>B</td>
<td>How often are laboratory confirmed cases reported to local health authority?</td>
<td>100</td>
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<tr>
<td>C</td>
<td>How sensitive are the laboratory tests for pathogen?</td>
<td>75</td>
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<tr>
<td>D</td>
<td>How often do laboratories test for pathogen?</td>
<td>88</td>
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<tr>
<td>E</td>
<td>How often are specimens submitted?</td>
<td>100</td>
</tr>
<tr>
<td>E</td>
<td>How often are requests for stool samples made?</td>
<td>35</td>
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<td>F</td>
<td>How often do persons with a diarrheal illness seek care?</td>
<td>17.2</td>
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</tbody>
</table>

**Final Multiplier**

| 25.169 |

**Overall**

| 50.34 |
Step 3: Calculate Burden of Illness

Persons Ill = 1,172,077

There are approximately 1.2 million cases of \textit{Salmonella} in the community
In country BOI Activities

• Provide technical assistance for overall coordination
• Finalization of protocols, questionnaire, timelines, budget, logistics, id of BOI coordinator
• Conduct lab training
• Develop Sampling frame with statistical unit
• Sensitization advocacy and Launch Meetings
• Survey Administration training workshops
• Advocacy for stool collection
• Monthly/Bimonthly Conference Calls/ Meetings
## Status of in country BOI studies

<table>
<thead>
<tr>
<th>Time period</th>
<th>Country</th>
<th>Pop Survey Administration[1]</th>
<th>Laboratory testing (year)</th>
<th>Current Status and outstanding activities</th>
</tr>
</thead>
<tbody>
<tr>
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<td>? Request for assistance to prepare country report</td>
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<td>? Country report received in May 2010 being reviewed by CAREC</td>
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<td>? Abstract presented at ICEID 2010</td>
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<td>? Request by country for data to be disseminated in country</td>
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<td>? Paper being written for journal</td>
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<td>? Country report just received for review by CAREC</td>
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<td>? Abstract to be presented at IUFOST 2010</td>
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<td>? Paper being written for CHRC 2010</td>
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<td>? Waiting CAREC comments for data dissemination</td>
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<tr>
<td>Year 1</td>
<td>Country</td>
<td>Period</td>
<td>Final Study Period</td>
<td>Status</td>
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<td>Survey Mid August 2009</td>
<td>Survey: Mid Nov2009</td>
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<td>Low: wk 30-31 (Jul 26-Aug 08)</td>
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<tr>
<td>AGE population and laboratory surveys data</td>
<td>Range * (from 6 countries)</td>
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<td>-------------------------------------------</td>
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<tr>
<td>Survey Respondent /cooperation rate</td>
<td>65.8%- 99.95%</td>
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<tr>
<td>Monthly Prevalence of AGE</td>
<td>4.03%- 10.7%</td>
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<tr>
<td>Incidence/ episodes of diarrheal per person year.</td>
<td>0.52 -1.4 episodes /year</td>
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<tr>
<td>Duration of Diarrhea</td>
<td>1-20 days</td>
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<tr>
<td>Mean duration of diarrhea</td>
<td>2.1-3.8 days</td>
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<tr>
<td>Loss of productive days due to illness</td>
<td>1-20 days</td>
<td></td>
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<tr>
<td>Mean Loss of productive days</td>
<td>1.5-4 days</td>
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<tr>
<td>AGE population and laboratory surveys data</td>
<td>Range * (from 6 countries)</td>
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<tr>
<td>Ill persons sought seek medical care</td>
<td>15.4%-36%</td>
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<tr>
<td>Hospitalizations</td>
<td>0-14%</td>
<td></td>
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<tr>
<td>Stool specimens requested <em>from ill person</em></td>
<td>12.5%-23%</td>
<td></td>
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<tr>
<td>Stools specimens Submitted for testing</td>
<td>1%-43%</td>
<td></td>
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<tr>
<td>Laboratory tested for AGI stool specimen</td>
<td>25%-95%</td>
<td></td>
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<tr>
<td>Proportion of Laboratory positive AGE specimen</td>
<td>8.5%-47%</td>
<td></td>
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<tr>
<td>Laboratory confirmed AGE reported to surveillance unit</td>
<td>11.8%-76.4%</td>
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<tr>
<td>Treatment of AGE with ORS</td>
<td>4.3%-65%</td>
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<tr>
<td>Treatment of AGE with antibiotics</td>
<td>2.0%-41%</td>
<td></td>
<td></td>
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<tr>
<td>Hand washing before and after toilet use</td>
<td>21%-58%</td>
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<tr>
<td>Using soap to wash hands.</td>
<td>28-68%</td>
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</tbody>
</table>
Critical success factors

1. **Advocacy/sensitization msgs for stool collection**
2. **To doctors, health care workers** for enhanced stool collection from cases with diarrhea
   - **To public**: to bring/request/give stool samples

1. **Timeliness of Stool collection & transport to lab**
2. **Enhanced Laboratory testing**
   - Media and supplies
   - Proper info on forms (onset, symptoms, age)
   - Standardized methods

3. **Survey administration**
   - Follow protocol
   - Avoid bias (convenient sample)
   - Visit homes when entire household is present
Capacity building

• Created/strengthened the capacity in the design of country protocols,
• Strengthened laboratory diagnosis and identification of FBD pathogens;
• BOI data analysis workshop Improved specimen collection and transport,
• Data analysis and assessment of the evidence
• Intersectoral collaboration,
• Strengthening the health surveillance system in the countries.
Impact

- Promotion of Interdisciplinary team work, communication and data sharing between lab, epi, env health and vet
- Gaps in surveillance system identified
  - Improvement in FBD surveillance (timeliness of reporting, coordination, response)
- Increase in lab capacity and better lab data
  - More etiologies, more labs, more accurate data
  - Computerized data collection and analyses
- Data on burden of AGI and economic costs
  - Evidence of the importance of FBD
- Data on risk factors for infection
  - Improve food safety measures
- Definition of new research lines
  - Attribution to the source of origin
  - Burden of disease (Dalys calculation)
Future actions

• Complete on-going studies

• Data dissemination
  – Country reports
  – Peer reviewed papers: regional and country data.
    • Workshop at Guelph (PHAC-U of Guelph)
    • Journal articles (Infection journal)

• Knowledge translation
  – Workshop for social network mapping
    • PVS tool
  – Follow-up the workshop as part of PAHO BWP in 2011 and in the BWP12-13 for the Caribbean led by CAREC.
Thank you