National Burden of Foodborne Diseases Studies
- Current Country Protocols

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WHO Consultation
Purpose of presentation

1. Review methods used to estimate the overall burden of foodborne illness
   - United States
   - Compare to methods used in England and Wales and Australia

2. Highlight differences, issues and limitations
Why don’t we know?

• “Tip of the iceberg”
  – Clinical symptoms
  – Medical care seeking behavior
  – Diagnosis
  – Reporting

• Proportion foodborne?

• Unknown pathogens
United States Estimate

• Mead *et al.* (1999) Food-Related Illness and Death in the United States *EID*:5(5); 607-625

• Widely used for cost estimates, risk-assessment, model for other disease estimates

• Most cited EID paper
  • >1,500 citations in peer reviewed journals
Known pathogens

Bacterial
- *Bacillus cereus*
- Botulism, foodborne
- *Brucella* spp.
- *Campylobacter* spp
- *Clostridium perfringens*
- *Escherichia coli* O157:H7
- *E. coli*, non-O157 STEC
- *E. coli*, enterotoxigenic
- *E. coli*, other diarrheogenic
- *Listeria monocytogenes*
- *Salmonella Typhi*<sup>b</sup>
- *Salmonella*, nontyphoidal
- *Shigella* spp.
- Staphylococcus food poisoning
- *Streptococcus*, foodborne
- *Vibrio cholerae*, toxigenic
- *V. vulnificus*
- *Vibrio*, other
- *Yersinia enterocolitica*

Parasitic
- *Cryptosporidium parvum*
- *Cyclospora cayetanensis*
- *Giardia lamblia*
- *Toxoplasma gondii*
- *Trichinella spiralis*

Viral
- Norwalk-like viruses
- Rotavirus
- Astrovirus
- Hepatitis A
Known pathogens

1. Estimate number of reported cases
2. Adjust for underreporting
3. Estimate the foodborne proportion
Number of reported cases

- Active, passive surveillance data
  - Salmonella, Shigella, E. coli O157
- Outbreak surveillance data
  - S. aureus, B. cereus, C. perfringens
  - Adjustment for outbreaks
- Sentinel surveillance data
- Published studies
Adjust for underreporting

- **FoodNet Population Survey**
  - Proportion seeking medical care and submitting a stool sample
- **FoodNet Laboratory Survey**
  - Proportion of labs testing for specific pathogens
- **Multipliers**
  - 38 for *Salmonella*
  - 20 for *E. coli* O157
  - 2 for *Listeria*
Exceptions

• Limited routine surveillance data available
  – Norovirus
    • Estimate derived from studies in England and Wales and the Netherlands
  – Rotavirus
    • Every child has at least one symptomatic infection
  – Toxoplasmosis
    • Sero prevalence surveys
Foodborne proportion

• Method
  – Literature review
  – Outbreak data
  – Expert opinion

• Varies by pathogen
  – 1-100%
  – Overall 36% foodborne
Unknown pathogens

1. Estimate total burden of gastroenteritis
2. Subtract proportion due to known pathogens
3. Estimate the foodborne proportion
Burden of gastroenteritis

• FoodNet Population Survey
  – 12-month, retrospective telephone survey

• Estimate gastroenteritis
  – 0.79 episodes per person/year
Estimate the proportion foodborne

0.79 x 267.7 million (US popn) = 211 million gastro episodes
- 38.3 million (known) = 173 million unexplained
x 36% (known) = 62 million

- 62 million cases of acute gastroenteritis of unknown etiology due to foodborne transmission
Pathogen-based data

Known Pathogens
Illnesses 39,000,000
Hospitalizations 181,000
Deaths 2,700

Symptom-based data

Acute Gastroenteritis
Illnesses 211,000,000
Hospitalizations 937,000
Deaths 6,400

Known Pathogens - Non-gastroenteritis
Illnesses 300,000
Hospitalizations 18,000
Deaths 1,300

Known Pathogens - Acute Gastroenteritis
Illnesses 36,000,000
Hospitalizations 163,000
Deaths 1,400

Unknown Agents - Acute Gastroenteritis
Illnesses 173,000,000
Hospitalizations 774,000
Deaths 5,000

Foodborne Transmission

<table>
<thead>
<tr>
<th>Illnesses</th>
<th>Hospitalizations</th>
<th>Deaths</th>
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<td>120,000</td>
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<td>14,000,000</td>
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<tr>
<th>Illnesses</th>
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<th>Deaths</th>
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<tr>
<td>62,000,000</td>
<td>263,000</td>
<td>3,400</td>
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\[ \text{Total Burden of Foodborne Illness} \]

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<tr>
<th>Illnesses</th>
<th>Hospitalizations</th>
<th>Deaths</th>
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<tr>
<td>76,000,000</td>
<td>323,000</td>
<td>5,200</td>
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* Percentages derived from observed frequency of foodborne transmission of acute gastroenteritis caused by known pathogens.
Finally we have an estimate!

“And it was so typically brilliant of you
to have invited an epidemiologist.”
England and Wales Estimate

INTESTINAL INFECTION

Trends in indigenous foodborne disease and deaths, England and Wales: 1992 to 2000

G K Adak, S M Long, S J O’Brien

Background: Commitment to food safety is evidenced by high profile governmental initiatives around the globe. To measure progress towards targets, policy makers need to know the baseline from which they started.

Aim: To describe the burden (mortality, morbidity, new presentations to general practice, hospital admissions, and hospital occupancy) and trends of indigenous foodborne disease (IFD) in England and Wales between 1992 and 2000.

Methods: Routinely available surveillance data, special survey data, and hospital episode statistics were collated and arithmetic employed to estimate the burden and trends of IFD in England and Wales. Adjustments were made for underascertainment of disease through national surveillance and for foreign travel. The final estimates were compared with those from the USA.

Results: In 1995 there were an estimated 2,365,909 cases, 21,138 hospital admissions, and 718 deaths in England and Wales due to IFD. By 2000 this had fallen to 1,338,772 cases, 20,759 hospit-
Australian Estimate

Estimating Foodborne Gastroenteritis, Australia

Gillian Hall,* Martyn D. Kirk,† Niels Becker,* Joy E. Gregory,‡ Leanne Unicomb,§ Geoffrey Millard,¶ Russell Stafford,# Karin Lalor,‡ and the OzFoodNet Working Group

We estimated for Australia the number of cases, hospitalizations, and deaths due to foodborne gastroenteritis in a typical year, circa 2000. The total amount of infectious gastroenteritis was measured by using a national telephone survey. The foodborne proportion was estimated (3). In particular, we are now faced with the emergence of antimicrobial drug–resistant bacteria and a number of viruses not previously recognized (4,5).

Foodborne disease is a public health concern in all parts
Estimating burden of illness

• Three components required to comprehensively assess burden of all enteric foodborne illness:

• Estimate of:

  1. Incidence of gastroenteritis in the community
  2. Number of cases due to known pathogens
  3. Proportion cases due to contaminated food for both known and unknown pathogens
Incidence of gastroenteritis

- United States and Australia used 12-month cross-sectional telephone survey
  - Respondents asked retrospectively about gastrointestinal symptoms in the past month
- England and Wales used prospective cohort study component
  - Participants returned weekly postcards for 6 months declaring the absence of intestinal illness
# Pros and cons of study design

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<thead>
<tr>
<th>Study Design</th>
<th>Pros</th>
<th>Cons</th>
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<tr>
<td><strong>Cohort Study</strong></td>
<td>√ More reliable data</td>
<td>× Expensive</td>
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<td>× Complex</td>
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<td>× Long time to conduct</td>
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<td>× Harder to standardise</td>
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<td></td>
<td></td>
<td>× Possible study fatigue</td>
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<tr>
<td><strong>Cross-Sectional</strong></td>
<td>√ Cheaper</td>
<td>× Possibility telescoping</td>
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<td><strong>Survey</strong></td>
<td>√ Quicker</td>
<td>× Higher likelihood of bias</td>
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<tr>
<td></td>
<td>√ Assess over wide geographic area</td>
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<tr>
<td></td>
<td>√ Easily standardised</td>
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Differences in results

- Cohort studies generally report lower incidence
  - United States 0.76 per person-year
  - Australia 0.95 per person-year
  - England and Wales 0.19 per person-year

- How much difference is due to study design?
  - Answer!?!?
  - 2nd Infectious Intestinal Disease Study (IIDII) to estimate incidence using prospective cohort and cross-sectional telephone survey design
Estimating burden of illness

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Known pathogens

- Cross-sectional studies did not allow for determination of pathogens causing illness
- Data on proportion of different pathogens obtained from other sources
  - Active, passive and outbreak surveillance
- Adjusted for underreporting
Known pathogens

- England and Wales cohort study
  - Prospective collection of faecal specimens
    - Person reporting symptoms of gastroenteritis asked to submit stool specimen for testing
    - Specimens tested to determine pathogens causing illness
‘Multipliers’

- Number of cases in community for each case in national surveillance data
  - Variation by country
- For *Salmonella* reported to surveillance
  - United States estimated a multiplier of 38
  - Australia estimated a multiplier of 15
  - England and Wales estimated a multiplier of 3
Estimating burden of illness

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• Estimate of:

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Proportion foodborne

• Foodborne proportion each disease
  – Literature review
  – Outbreak data
  – Expert opinion

• Estimates
  – United States (36%)
  – England and Wales (25%)
  – Australia (32%)
Proportion foodborne

• Limited information available
• Weakest link in estimation!
• Norovirus!!!

• Proportion foodborne for unknown pathogens
  – Based on overall proportion foodborne for known pathogens
Conclusions

• Burden of foodborne illness estimates useful
  – Build capacity for foodborne surveillance
  – Specific areas for disease prevention

• Currently revising estimates
  – Australia, United States, England and Wales
Things to consider

• Inherent uncertainty in the data
  – Australia modelled potential variation
  – Distribution of plausible values with 95% credible intervals

• Future studies should account for uncertainty
Things to consider

• Why are they so different?
  – Estimates of gastroenteritis
    • IIDII Cohort and Cross-sectional telephone survey
    • Pathogens specific multipliers
      • Continual version of multipliers necessary

• Estimate of proportion foodborne?
  – Estimating the burden of viral foodborne illness