Lessons learned from recent food-borne outbreaks in Germany

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Outline

- food-borne outbreaks in the EU
- experiences with outbreaks
- research activities on food chains and outbreaks
- do we need new tools for investigations?
Outbreaks resulting from contaminations along the food chain

Local foodborne outbreak vs. Diffuse foodborne outbreak

**Source of contamination**
- Local: Food handling at production or processing
- Diffuse: At production or processing

**Contamination dose**
- Local: High
- Diffuse: Low

**Detection**
- Local: Self-reporting, lab follow-up
- Diffuse: Lab-based subtype surveillance

**Investigation**
- Local: Complex multistate
- Diffuse: Local, tracing back
Investigation of foodborne outbreaks along the food chain:
What are the tasks [to do]?

- Assembling an outbreak investigation team
- Exchange of information
- Interviews with patients and unaffected persons (cases & controls)
- Inspection of food establishments
- Tracing foodstuffs
- Collection and analysis of samples
- Interviews with food handlers
- Documentation, assessment and publication of results
Experiences (1)

The majority of German food-borne outbreaks were caused by foods of animal origin.

Nevertheless, significant food-borne outbreaks in Germany were caused by foods of plant origin which have been eaten raw or slightly heated.
Example: *E. coli* O104:H4 outbreak, 2011

Largest outbreak by EHEC infection in Germany so far

**Cases:** 3793 (2353 hospitalized, 53 death)

**Setting:** Disseminated cases (restaurants, hotels, canteens, household)

**Causative food:** Sprouted fenugreek seeds

**Epidemiol. evidence:** Cohort study, trace-back and network analyses (delivery chains of sprouts and seeds)
Comparison of EAEC and German outbreak strain

**EAEC 1995/96**
Entero-Aggregative *E. coli*

**EAHEC 2011**
Entero-Aggregative-Haemorrhagic *E. coli*

Brzuszkiewicz et al. Arch Microbiol 2011 June 29
Example: Norovirus outbreak, 2012

Largest food-borne outbreak in Germany so far

Cases: 10,950 (38 hospitalized)

Setting: Disseminated cases (at least 390 affected facilities, almost exclusively schools and kindergartens)

Causative food: Imported frozen strawberries

Epidemiol. evidence: Case-control studies, trace-back investigations

Microbiol. evidence: Detection of outbreak strains in the suspected lot of frozen strawberries
Norovirus in frozen strawberries

- Detection of norovirus in 7/11 samples derived from the implicated lot
- Detection of 3 different genotypes (GI.9, GII.6, GII.16/II.13) in samples of frozen strawberries and in stool samples of outbreak-cases
- This genotype combination (GII.16/II.13) was previously detected in Asia and had not been reported in Germany so far

Mäde, D. et al., 2013: „Detection and Typing of Norovirus from Frozen Strawberries Involved in a Large-Scale Gastroenteritis Outbreak in Germany. Food Environ Virol 5:162-168
Examples: *Salmonella* Newport outbreaks in 2011

caused by mung bean sprouts from the Netherlands

largest outbreak by S. Newport in Germany with 106 ill persons, further cases in the Netherlands clarified through epidemiological, microbiological, and trace-back investigations

caused by watermelons from South America

outbreak in Germany and UK with 63 cases clarified through epidemiological, microbiological, and trace-back investigations
## Food-borne outbreaks in the EU

<table>
<thead>
<tr>
<th>Year</th>
<th>Outbreaks without identified foodstuff</th>
<th>Outbreaks with identified foodstuff</th>
<th>Source: vegetables and fruits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>3949</td>
<td>1784</td>
<td>18</td>
</tr>
<tr>
<td>2008</td>
<td>4442</td>
<td>890</td>
<td>19</td>
</tr>
<tr>
<td>2009</td>
<td>4537</td>
<td>977</td>
<td>43</td>
</tr>
<tr>
<td>2010</td>
<td>4564</td>
<td>698</td>
<td>70</td>
</tr>
<tr>
<td>2011</td>
<td>4947</td>
<td>701</td>
<td>54</td>
</tr>
</tbody>
</table>

Source: EFSA
Causative agents in strong evidence outbreaks in the EU, 2011

Source: EFSA
Causative agents in strong evidence outbreaks caused by food of non-animal origin in the EU, 2011

Source: EFSA
Experiences (2)

- The foods of plant origin (Fenugreek seeds, frozen strawberries, watermelons) had been imported from Third Countries in great amounts and were widely distributed.

- The contaminations did most likely happen in the countries of origin

- Unusual or unknown pathogens can be introduced into importing countries via those food vehicles.

Source: World Trade Organisation
Possible sources for pathogen migration in the field

How do we cope with food-borne outbreaks in the context of global food chains?
Are we prepared for risk assessment in global food chains?

The complete International Agro-Food Trade Network in 1998.
Global food chains -

a challenge for risk assessors

- Costumers purchase behaviour is changing massively due to free market economy

- Dissolution from local production and supply

- Highly competitive environment => cheap priced foodstuff

- Differences with respect to regulations: import regulations, border controls, statutory requirements, internet trade

=> Do we have the right information, methods and tools for effective quality management and risk assessment?
Risk Assessment in global trade: easy to do?

Problem formulation

Exposure Assessment
- levels of substance in food and diet
- amounts of food consumed
- intake in individuals (max/min, regularly/occasionally)
- intake in special population groups

Hazard Identification
- identification of adverse health effects (potential and nature)
  - human studies
  - animal-based toxicology studies
  - in vitro toxicology studies
  - structure-activity considerations

Hazard Characterisation
- kinetic and dynamic variability
- mode/mechanism of action
- dose-response for critical effect
- identification of starting point
- selection of critical data set, qualitative/quantitative

Risk Characterisation
Implications of global food supply chains – Increased complexity of risk / exposure assessments

Matopoulos et al. (2007) Supply Chain Management: Vol. 12 Iss: 3, pp.177 - 186
Our Vision and Invitation:
Join the development of food safety community tools + community databases

animal disease models
Food processing and distribution
human disease models

Environmental factors
Processing parameters
BfR solutions -
Integrated tools for risk / exposure assessment

PMM-Lab

Predictive Microbiology

Data Analysis and Visualization

Spatio-Temporal Modeling

Food Process Simulation

DB

Food Chain Lab

Powered by BfR

Prof. Bernd Appel, BfR & NIFDS/MFDS Symposium, 14th - 15th November 2013, Berlin
Example: *E. coli* O104:H4 outbreak, 2011

Distribution of fenugreek seeds from Egypt (Batch 48088, 15 t)

Epidemiological survey

Distribution of sprouts from the horticultural farm in lower saxony

HUS incidences by residence (per 100,000 inhabitants)
Robert Koch-Institute (data 13 July 11)
Epidemiological survey

Example: network graph for all collected data on seed supply chains

Another style of visualization:
• the boxes include anonymized names of the companies and represent a distributor/producer/consumer (colored: foreign)
• the delivery quantity varies between 50g packets and 15 tons
Example: Norovirus outbreak, 2012
Distribution of frozen strawberries from China (Batch 00EB007378, 44 t)

May 2012

July 2012

September 11th 2012

>136 other clients

Importer

Caterer A

Caterer B

Caterer C

Main Caterer

04.10.2012

02.10.2012


~ 25.09.2012

123 cases

184 cases

52 cases

>10,400 cases

September 11th 2012

44 t

July 2012

May 2012

Importer
Example -
Data structure for successful back- and forward tracing
Example: Norovirus outbreak, 2012
Distribution of frozen strawberries from China (Batch 00EB007378, 44 t)
Example - Location Visualizer

Get Coordinates with Google Geocoding:
Example - Region To Region”/”Location To Location” Visualizer
Example – Tools to support outbreak investigations II

Product / Product Group / Retail Store Distribution

Human Cases Distribution

Statistical Test on Similarity of Distributions

Spatial Distribution Test against a user-defined Reference Distribution for each product in commodity group
Thank you for your attention

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