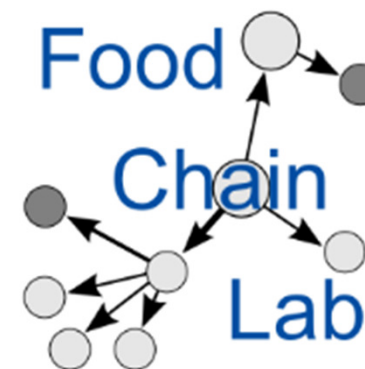
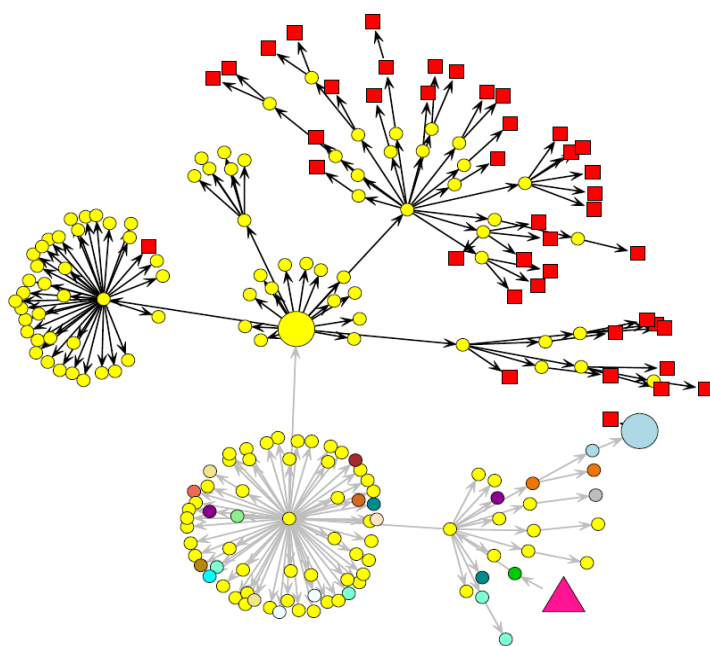
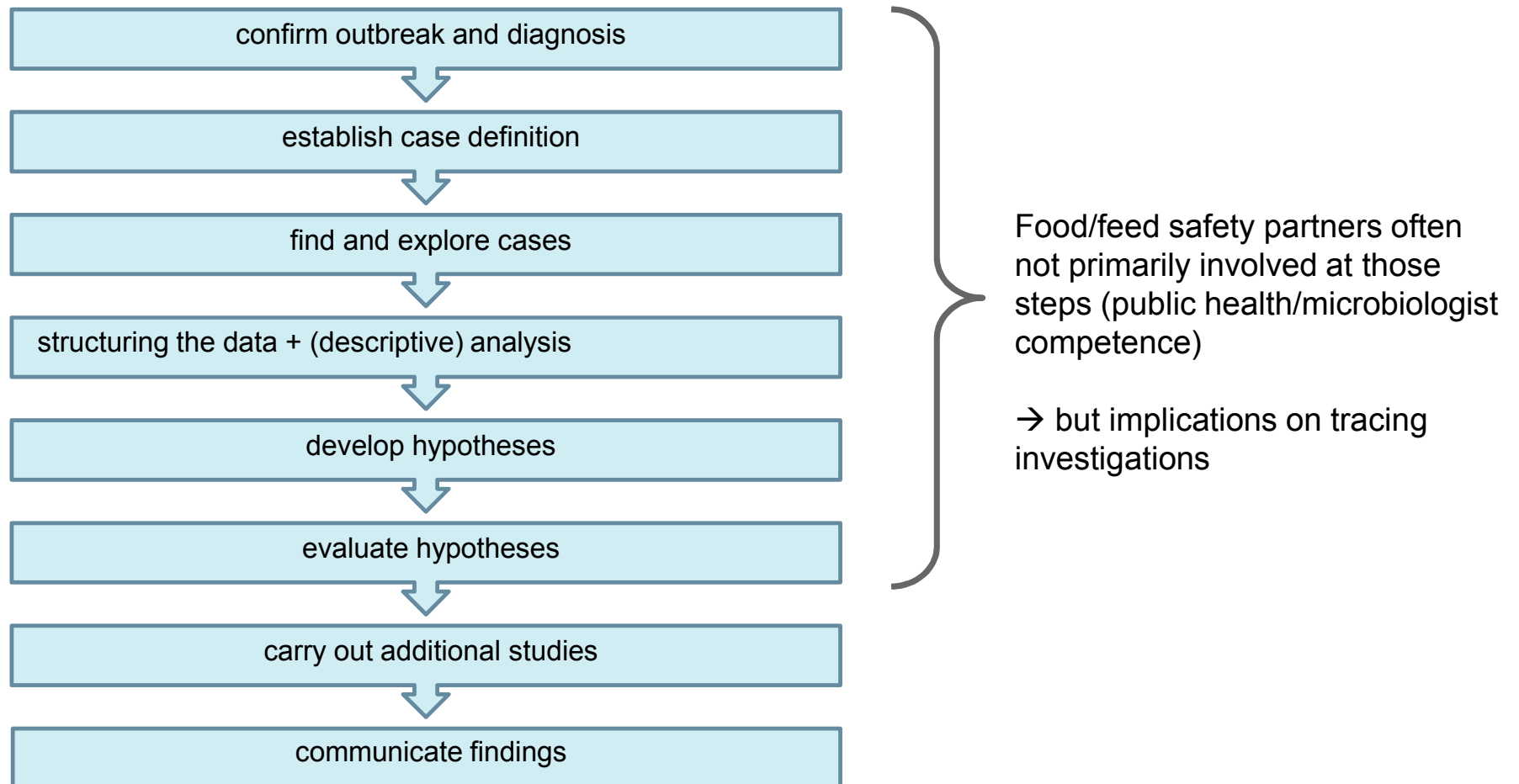


Steps of outbreak investigations Focussing on Tracing

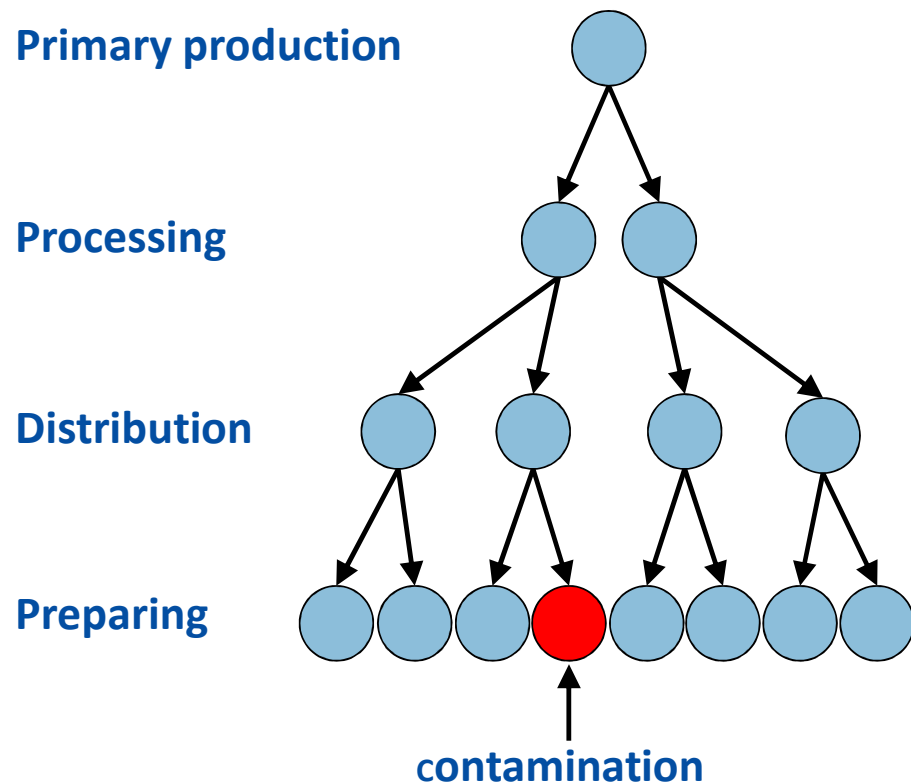


**Armin Weiser, Marion Gottschald, Alexander Falenski,
Marco Rügen, Christian Thöns, Bernd Appel, Annemarie
Käsbohrer**

Steps of an outbreak investigation



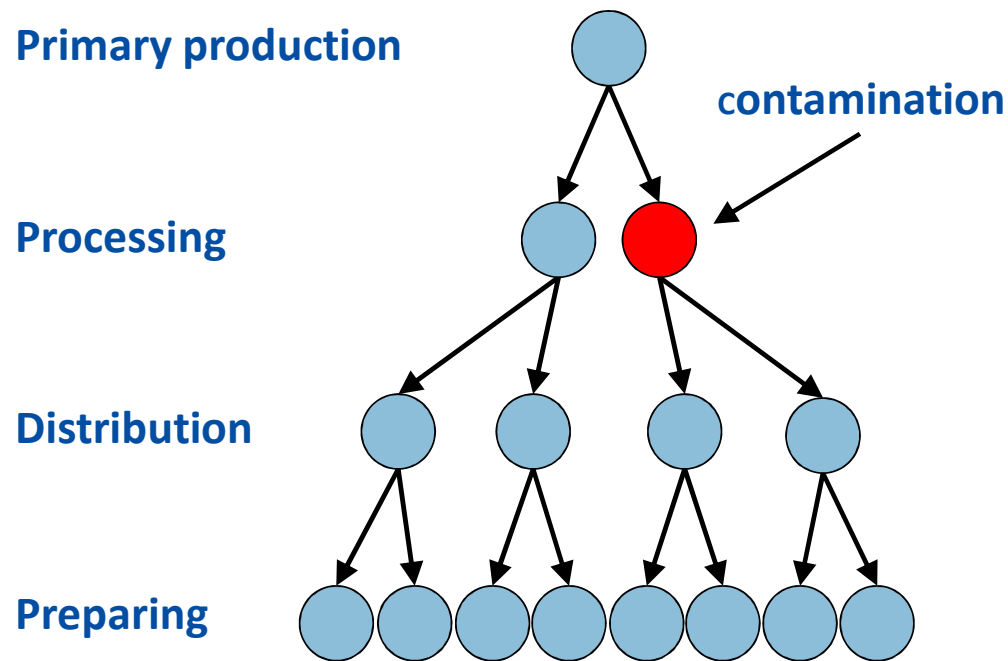
Local foodborne outbreak



- mistake during preparing
- single source, exists only for short time
- high dosis
- high rate of infection
- local accumulation of cases
- local investigation

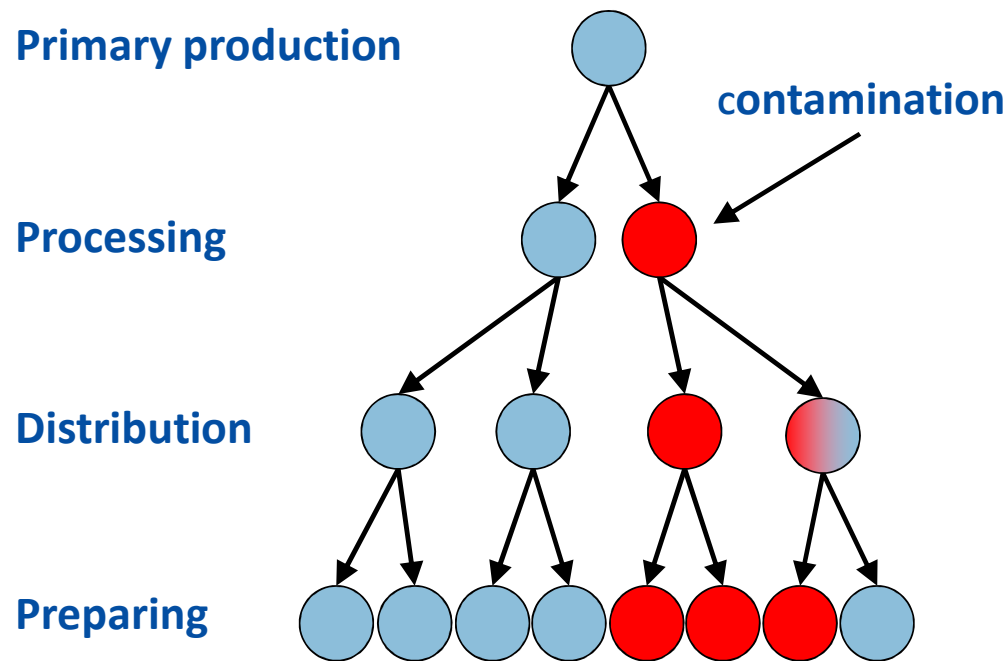


Foodborne outbreak affecting multiple locations/countries



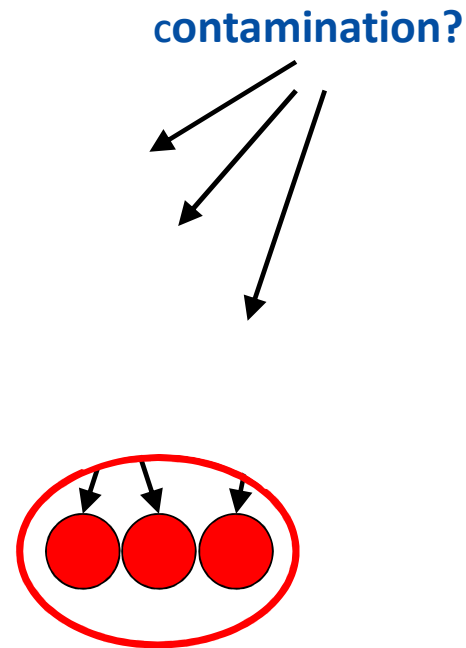
- **contamination during production/processing**
- **low dosis**
- **low rate of infection**
- **diffuse distribution of cases**
- **complex investigation**

Foodborne outbreak affecting multiple locations/countries



- contamination during production/processing
- low dosis
- low rate of infection
- diffuse distribution of cases
- complex investigation

Foodborne outbreak affecting multiple locations/countries



- contamination during production/processing
- low dosis
- low rate of infection
- diffuse distribution of cases
- complex investigation

The outbreak investigation team can only see **cases**

Tracing

When to trace? Further indications

Pathogen

- is uncommon
- is emerging/re-emerging
- causes severe diseases
- limited knowledge about pathogen → gain experience about its ecology

Food

- expected to be eaten raw or lightly heated (vegetables, shell eggs, shellfish)
- unlicensed, illegally sold food involved
- food is adulterated

Unusual source of contamination

New or unusual vehicle

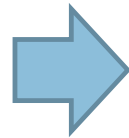
Purpose of tracing

- identify source of contamination
- identify distribution of contaminated food



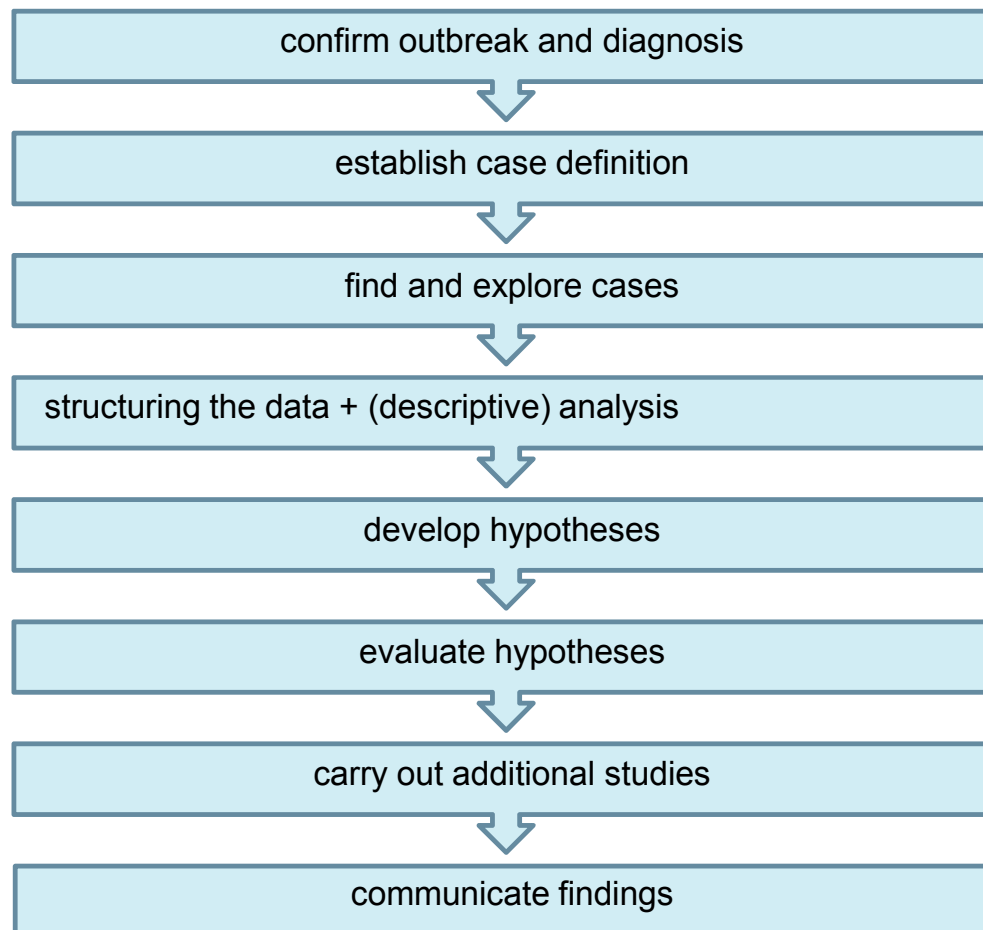
warning of consumers
remove contaminated food from market

- compare distribution of cases + contaminated food

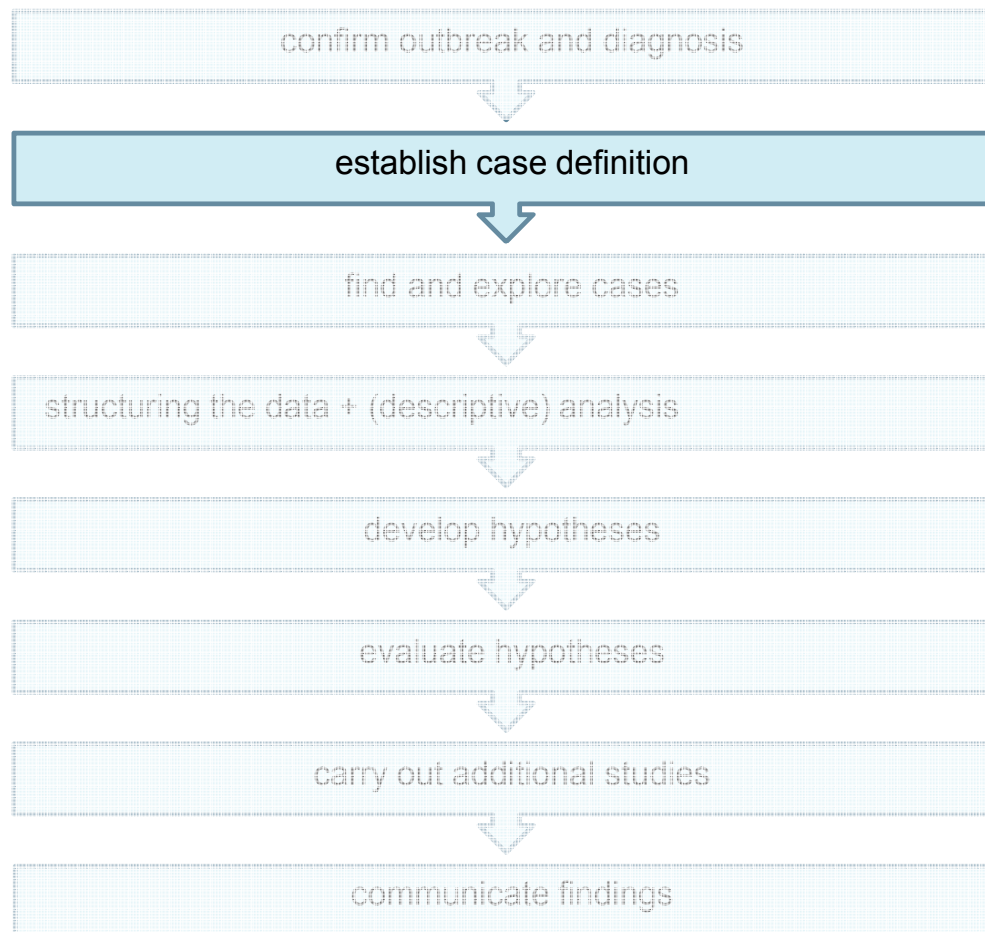


strengthen epidemiological association

Steps of an outbreak investigation – implications on tracing



Steps of an outbreak investigation – implications on tracing



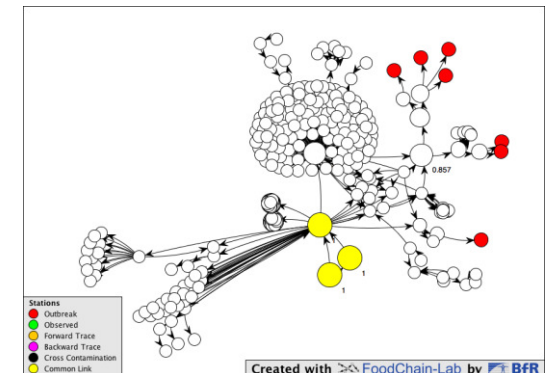
Case definition – which cases to trace back?

Exclusion criteria:

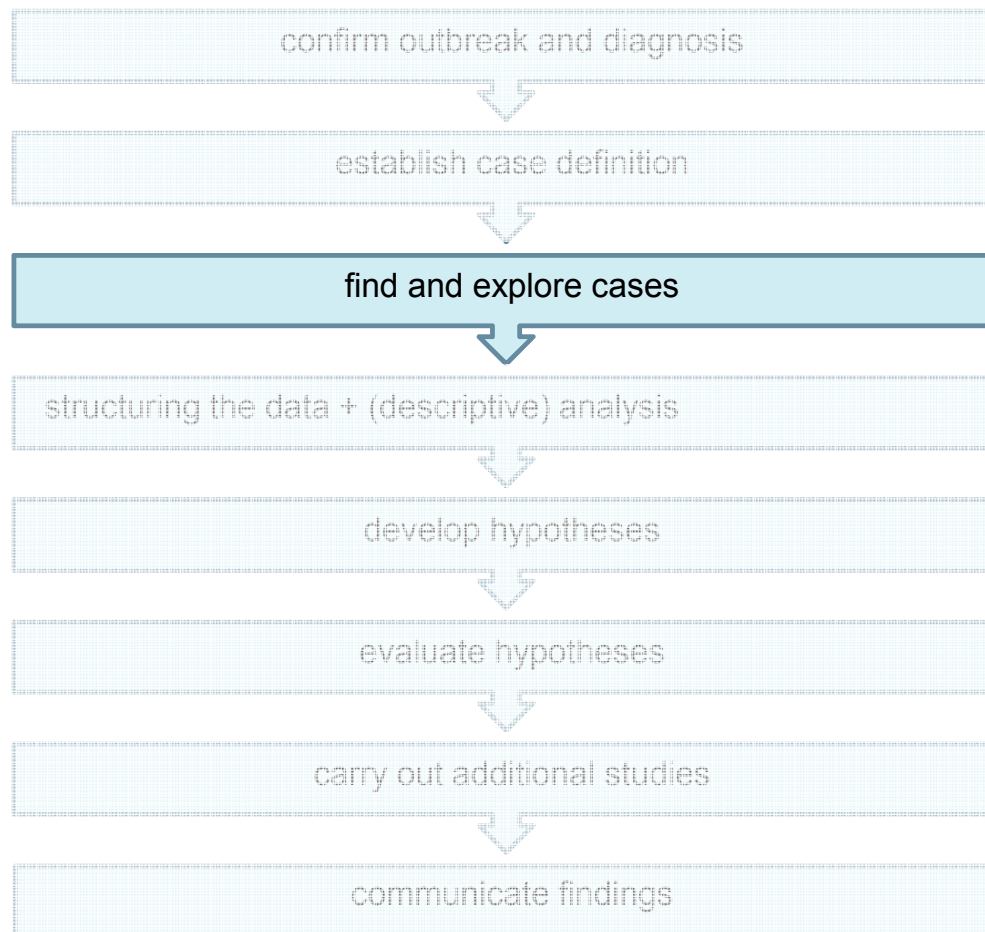
- genotype of isolate different from outbreak strain
- secondary cases
 - infection transmitted person-to-person
 - no exposure to contaminated food item
- travel-related cases
 - travel history abroad prior to a certain period of time before onset of symptoms
 - relevant for e.g. HAV outbreak

If many cases: select the most promising ones to trace back

- e.g. EHEC outbreak 2011 → 4000 cases → only 7 cases traced back (most different from each other)



Steps of an outbreak investigation – implications on tracing



Explore cases

Explore cases:

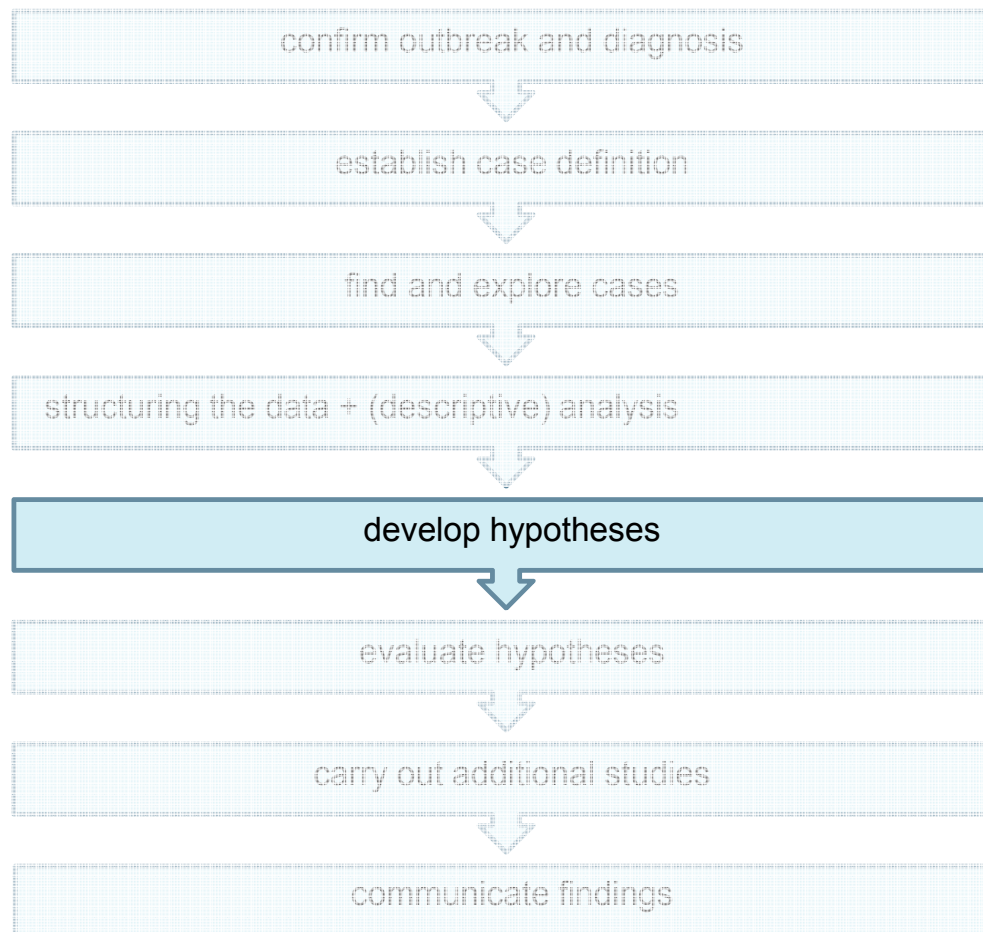
- ask for relevant exposure (food intake (what/where), other diseases, travel history, sexual contacts) → identify what is common to all cases

Who ate what, when, how much and how?

For traceback analyses:

- usual consumption and shopping habits
- fotos of fridge
- fotos of packaging of (suspect) product → product name, weight, lot number, best before date, ...

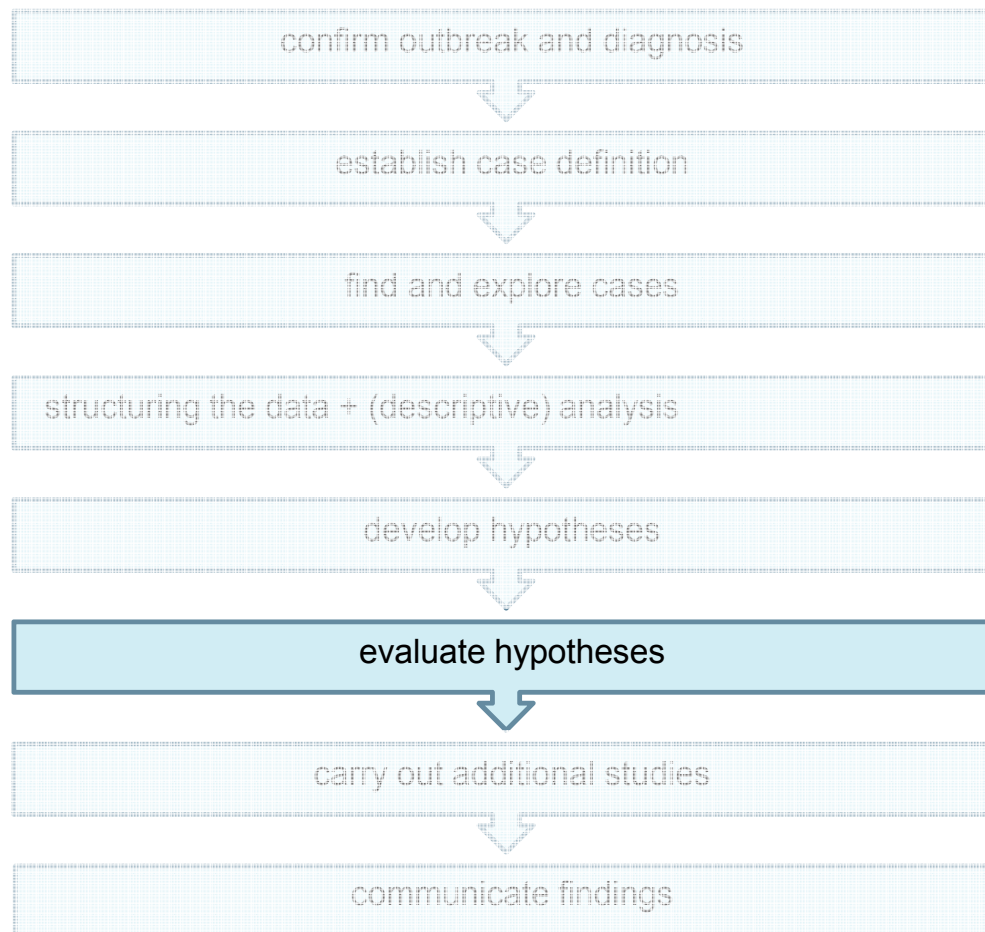
Steps of an outbreak investigation – implications on tracing



Food and feed safety partners involved as soon as food is suspected as vehicle of infection

visit kitchen/food company
interviews with caterers, kitchen staff
tracing

Steps of an outbreak investigation – implications on tracing



Evaluate hypotheses

Interpreting example from EHEC, 2011:

b. Matched case control study in 3 hospitals focussed on fruits and vegetables, May – June 2011

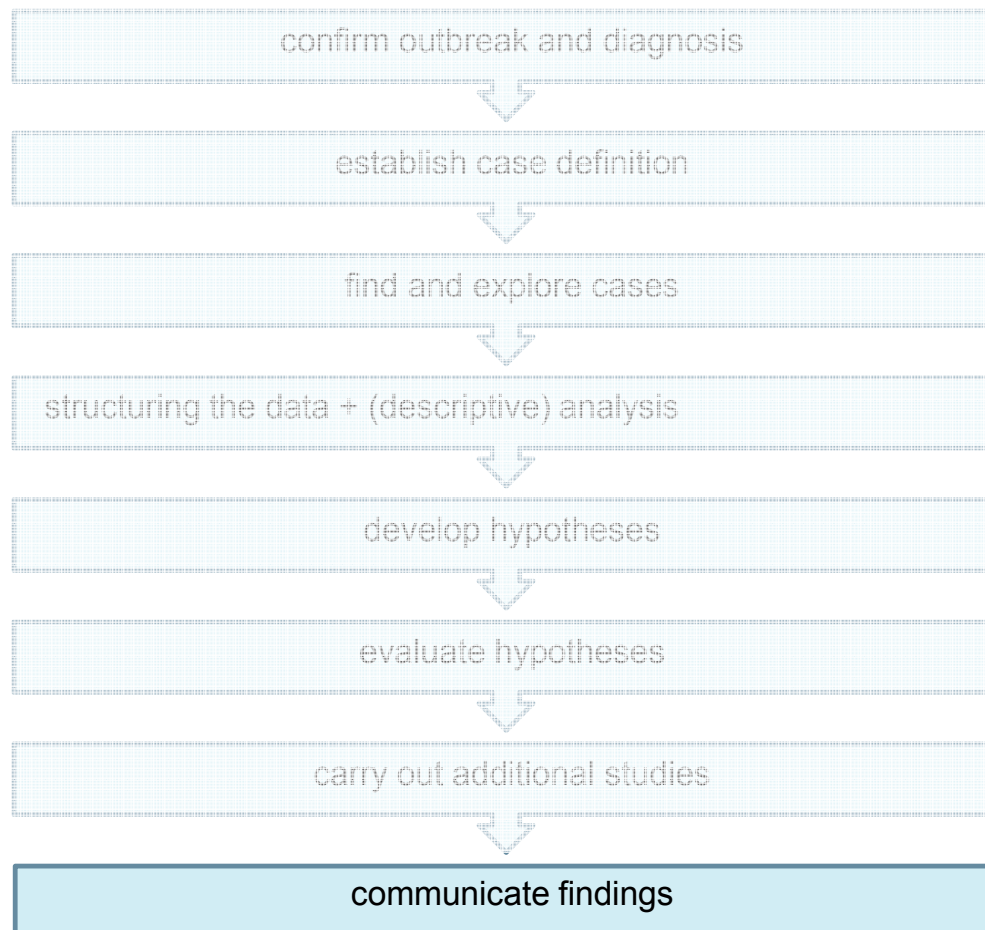
Table 1. Vegetables or Fruits Evaluated in a Case–Control Study in the German Outbreak.*

Food Item	Case Subjects	Control Subjects	Matched Odds Ratio (95% CI)	P Value
	Exposed <i>no./total no. (%)</i>	Exposed <i>no./total no. (%)</i>		
Sprouts	6/24 (25)	7/80 (9)	4.35 (1.05–18.0)	0.04
Cucumbers	22/25 (88)	52/79 (66)	3.53 (0.96–12.9)	0.06
Apples	22/24 (92)	57/81 (70)	3.91 (0.86–17.7)	0.08
Peppers	16/24 (67)	35/80 (44)	2.66 (0.90–7.9)	0.08
Strawberries	19/26 (73)	43/81 (53)	2.33 (0.90–6.0)	0.08

Buchholz et al., N Engl J Med 2011; 365:1763-1770

What food item would you like to trace?

Steps of an outbreak investigation – implications on tracing



Communication between authorities during investigation

public health authorities

food safety authorities



discuss available information

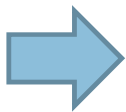
prioritize (what to trace?)

agree on investigation plan

regularly share updates on tracing investigation

joint interpretation of results (how do results relate to epi-, lab-,
environmental results?)

Ideally even before crisis:

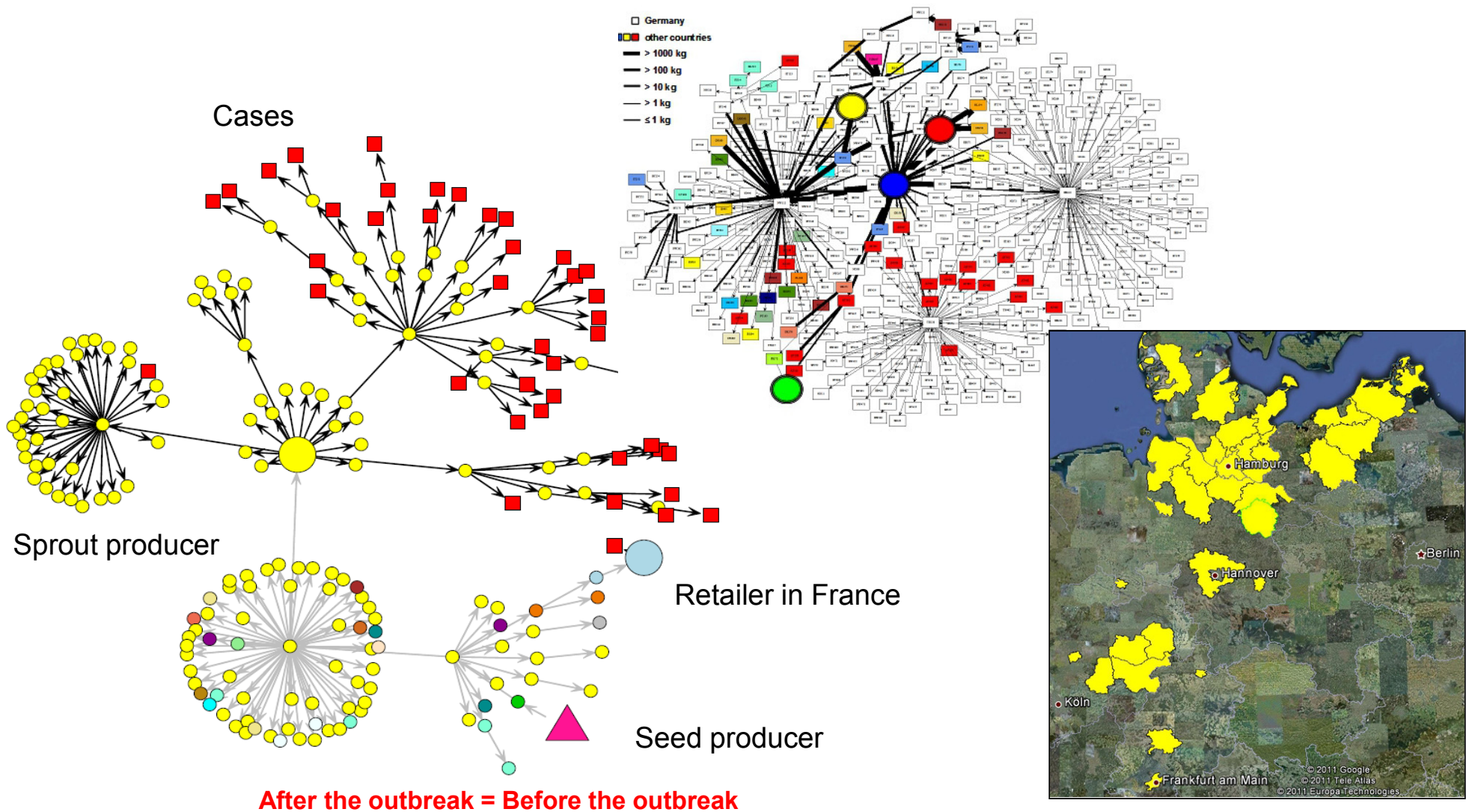


build functional network, set up contact list, set up tracing system, develop joint protocols

FoodChain-Lab – ante



FoodChain-Lab – ad hoc



Weiser et al., 2013: “Trace-Back and Trace-Forward Tools Developed Ad Hoc and Used During the STEC O104:H4 Outbreak 2011 in Germany and Generic Concepts for Future Outbreak Situations”, **Foodborne Pathog Dis.** 2013.

Weiser et al., 2016: “FoodChain-Lab: a trace-back and trace-forward tool developed and applied during food-borne disease outbreak investigations in Germany and Europe”, **PLoS ONE**.

FoodChain-Lab

Past events



19 – 20 March 2015, Berlin Germany

FoodChain-Lab - An innovative tool for food safety through product chain analyzes

12 – 13 May 2015, Bern, Switzerland

Introduction to the FoodChain-Lab software - an innovative tool for food safety through product chain analysis

12 – 13 November 2015, Berlin Germany

International FoodChain-Lab Workshop 2015

8 – 9 February 2016, Berlin Germany

HoA workshop: Tools supporting food chain safety assessments

15 – 17 March 2016, Riga, Latvia

Baltic Countries 2016 Workshop on Crisis preparedness

2016/2017, NRW, Germany

Linking FoodChain-Lab to the regional tracing database

14 – 16 June 2017, London, UK

Specific FoodChain-Lab Workshop for UK

08 – 10 November 2017, Berlin, Germany

International FoodChain-Lab Workshop 2017

19 – 21 March 2018, Budapest, Hungary

Specific FoodChain-Lab Workshop for HU

17– 18 April 2018, Vienna, Austria

Specific FoodChain-Lab Workshop for AT

NEXT: Autumn 2018 in Parma

Framework Partnership Agreement

EFSA and BfR to work jointly on global food safety tools

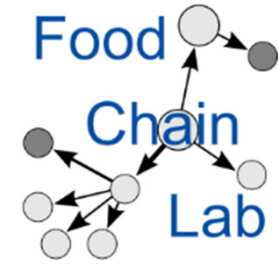
Title: Risk Assessment Tools for the Safety of Global Food and Feed Supply Chains (Number: GP/EFSA/AMU/2016/01)

- ED visit to Germany on 30th October 2014
- Framework Partnership Agreement, signed on 8th December 2016



- Description: Trace-back and predictive modelling tools for use during food safety outbreaks and created by scientific teams led by the German Federal Institute for Risk Assessment (BfR) will be further rolled out under a new funding partnership agreed between EFSA and BfR. The two agencies will be able to further benefit from each other's research efforts and avoid duplication of future work programmes.
- Life span: 4 years
- Press releases: <https://www.efsa.europa.eu/en/press/news/161208>
<http://www.bfr.bund.de/cm/349/efsa-and-bfr-to-work-jointly-on-global-food-safety-tools.pdf>

What is FoodChain-Lab?



- Open source software

<https://foodrisklabs.bfr.bund.de>

- Database for managing food tracing data
- Tool for data cleaning, enrichment & processing
 - Validation (also online: <https://foodrisklabs.bfr.bund.de/templatevalidator/>)
 - Cleaning (e.g. Duplicate Detection)
 - Enrichment (e.g. Geocoding)
 - Analysis (Clustering, Tracing, Scoring, etc.)
- Tool for visualization and interactive reasoning

REGULATION (EC) No. 178/2002, Article 18, Traceability

- (1) The **traceability** of food, feed, food-producing animals, and any other substance intended to be, or expected to be, incorporated into a food or feed **at all stages of production, processing and distribution**
- (2) **Food and feed business operators** shall be able to **identify any person from whom they have been supplied**

To this end, such operators shall have in place systems and procedures which allow for this information to be made available to the competent authorities on demand.

- (3) **Food and feed business operators** shall have in place systems and procedures **to which their products have been supplied** been supplied. This information shall be made available to the competent authorities on demand.

Data gathering – Development of a new “simple” template

old:

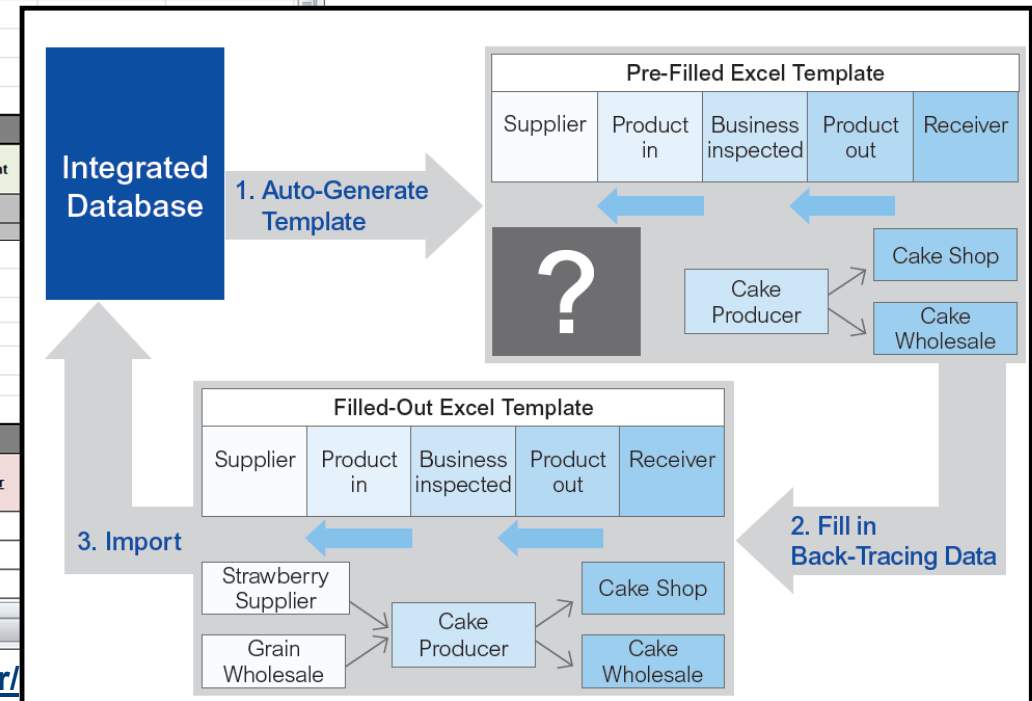
“one step back-one step forward”- principle of REGULATION (EC) No 178/2002, Article 18

->

Endless supply chains with arbitrary complexity realizable

new:

Reporter Information										
Reporting Officer	Reporting Date	Reporting Remark								
Station in Focus:		3001	Caterer 01							
Products Out										
Product Name	Lot Number	Delivery Date Departure			Delivery Date Arrival			Unit weight/vol./pck.		Recipient
		Day	Month	Year	Day	Month	Year	Quantity	Type / Unit	
Menü 1	M01	3	9	2014	3	9	2014	62	Portionen	9012
Menü 2	M02	3	9	2014	3	9	2014	101	Portionen	9008
Lot Information										
Lot Number of "Product Out"	Lot size									
	Quantity	Type / Unit								
M01	900	Portionen								
M02	900	Portionen								
Ingredients for Lot(s)										
Ingredient Name	Lot Number of Ingredient	Delivery Date Departure			Delivery Date Arrival (if departure unknown)			Unit weight/vol./pck.		Supplier
		Day	Month	Year	Day	Month	Year	Quantity	Type / Unit	



Online Validation: <https://foodrisklabs.bfr.bund.de/templatevalidator/>

Data Cleaning – Duplicate Detection

Company	Street	House Number
Bäcker Maier	Hauptstr.	1
Bäcker Meier	Hauptstraße	1

Levenshtein distance

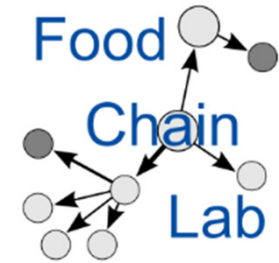
Works well for finding typos

B	I	O	M	R	A	K	T
=	=	=	=	-	-	=	=
B	I	O	M	A	R	K	T

E	L	E	P	H	A	N	T
=	=	=	o	-	=	=	=
E	L	E	F		A	N	T

FoodChain-Lab

Data Enrichment – Geocoding



Start_Tracing_Caterers.xlsx - Microsoft Excel

B20 f_x Caterer 2

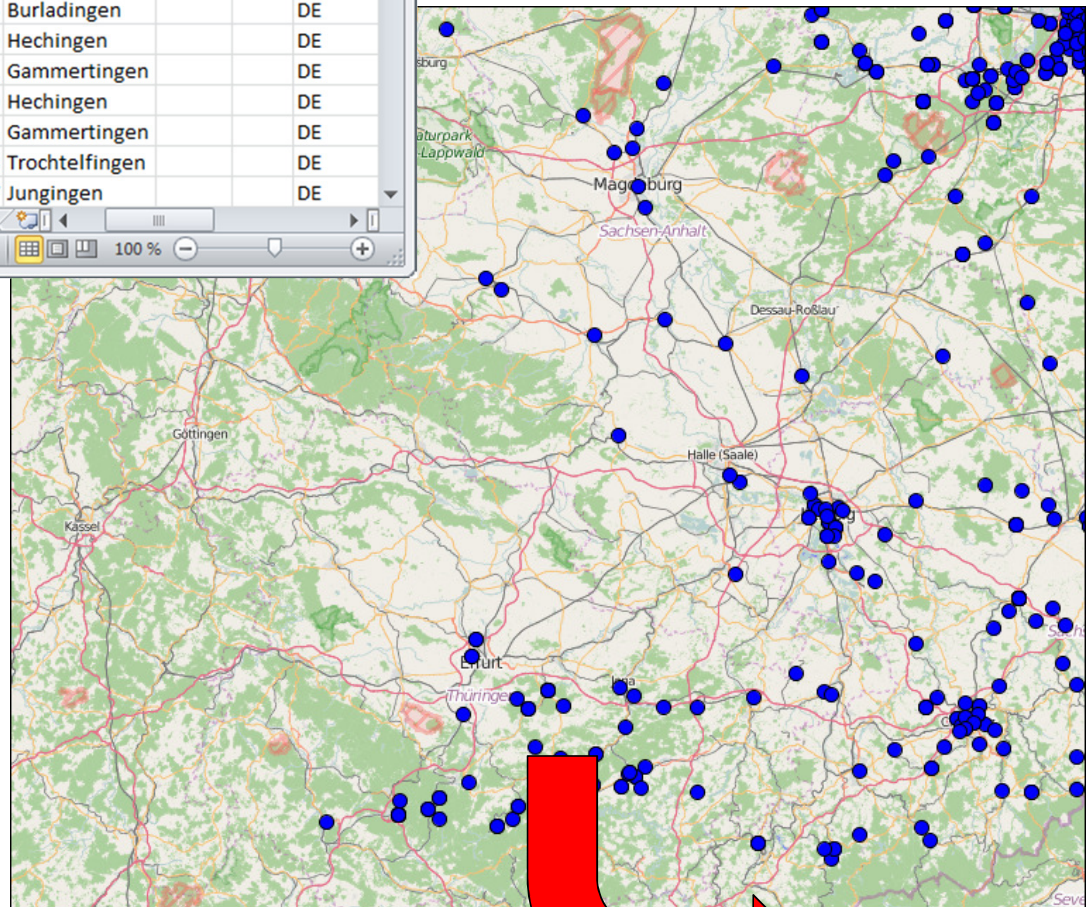
	C	D	E	F	G	H	I
	Street	Street Number	Postal	City	District	State	Country
1							
2	Kantstraße	1	72393	Burladingen			DE
3	Heuweg	1	72417	Jungingen			DE
4	Lichtensteinweg	1	72393	Burladingen			DE
5	Stillfriedstraße	1	72379	Hechingen			DE
6	Steinbeisstraße	1	72501	Gammertingen			DE
7	Gammertinger Straße	1	72379	Hechingen			DE
8	Hechinger Straße	1	72501	Gammertingen			DE
9	Schillerstraße	1	72818	Trochtelfingen			DE
10	Brunnenstraße	1	72417	Jungingen			DE

Stations Deliveries LookUp Help

Bereit 100 %

Available Providers:

- (Google, Bing)
 - Web service
- MapQuest
 - Web service with open data
- Bundesamt für Kartografie und Geodäsie
 - Germany only
- Photon / Gisgraphy
 - Locally installable
 - Data stays confidential
 - Unlimited requests



Tracing Features

Trace: path, a contamination can take via the food chain network

Score: ~ likelihood a station is involved in the outbreak

$$\text{Score}(s_i) = \frac{\sum_{j=1}^n w_j t_{ij}}{\sum_{j=1}^n w_j}$$

s_i :	Station i
w_j :	Weight of station j
t_{ij} :	1 if there is trace from station i
to j	0 otherwise
n :	Number of stations

- Backward / forward “trace” can be visualized
- User can define:
 - Cross Contamination
 - Regional Effects (e.g. environmental contamination)
 - Weights for Outbreak Stations

Benefits of using FoodChain-Lab

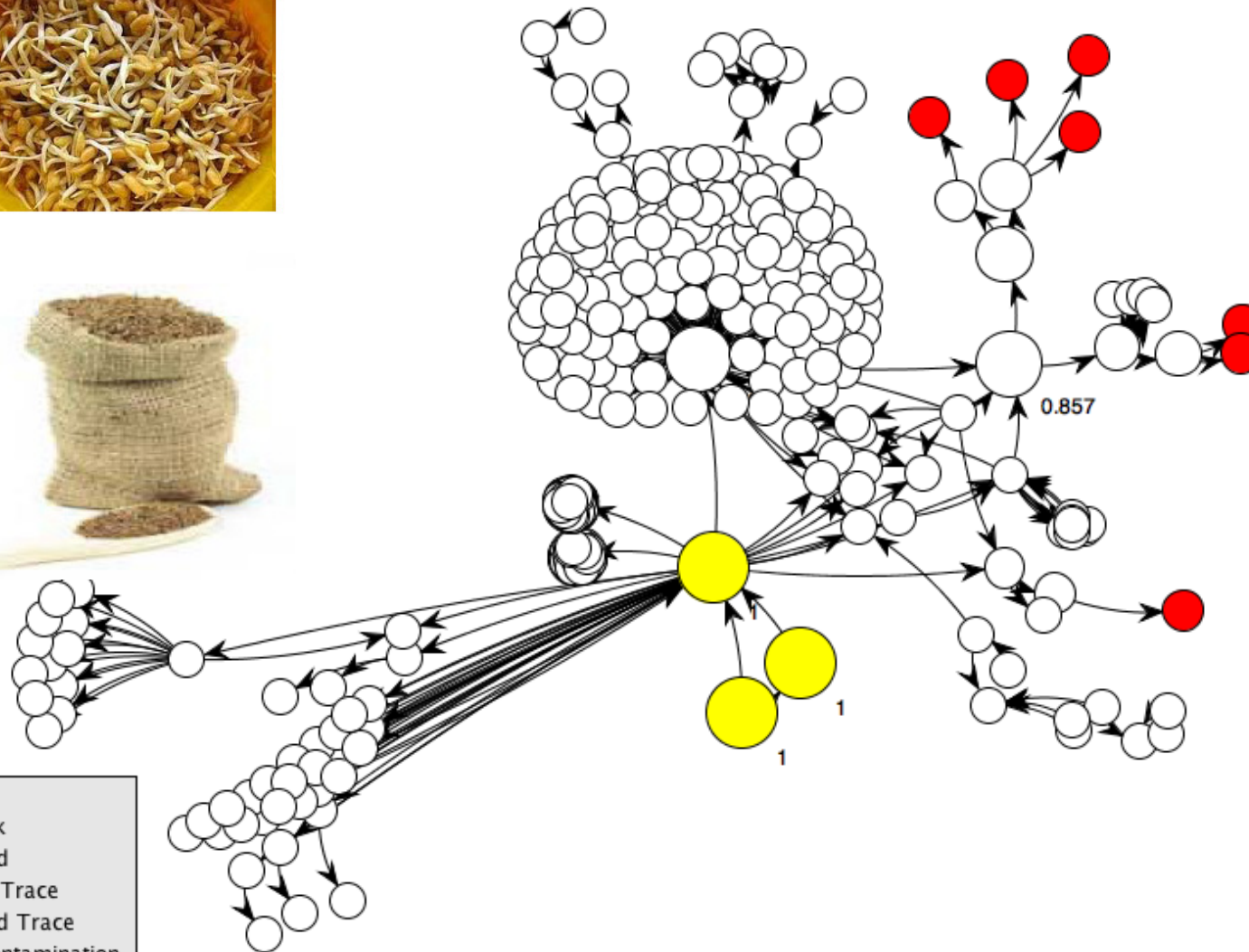


- All steps integrated in one modular framework
 - Data Management
 - Data Cleaning
 - Data Analysis
- Helps during Outbreak Investigation
 - Assists in Brainstorming / Prioritizing
 - Identifies missing data
 - Tests hypotheses and generates new ones

Real world application



EHEC 2011



- Stations**
- Red circle: Outbreak
 - Green circle: Observed
 - Yellow circle: Forward Trace
 - Magenta circle: Backward Trace
 - Black circle: Cross Contamination
 - Yellow circle: Common Link

Created with FoodChain-Lab by BfR

Other cases:

DE:
Norovirus 2012

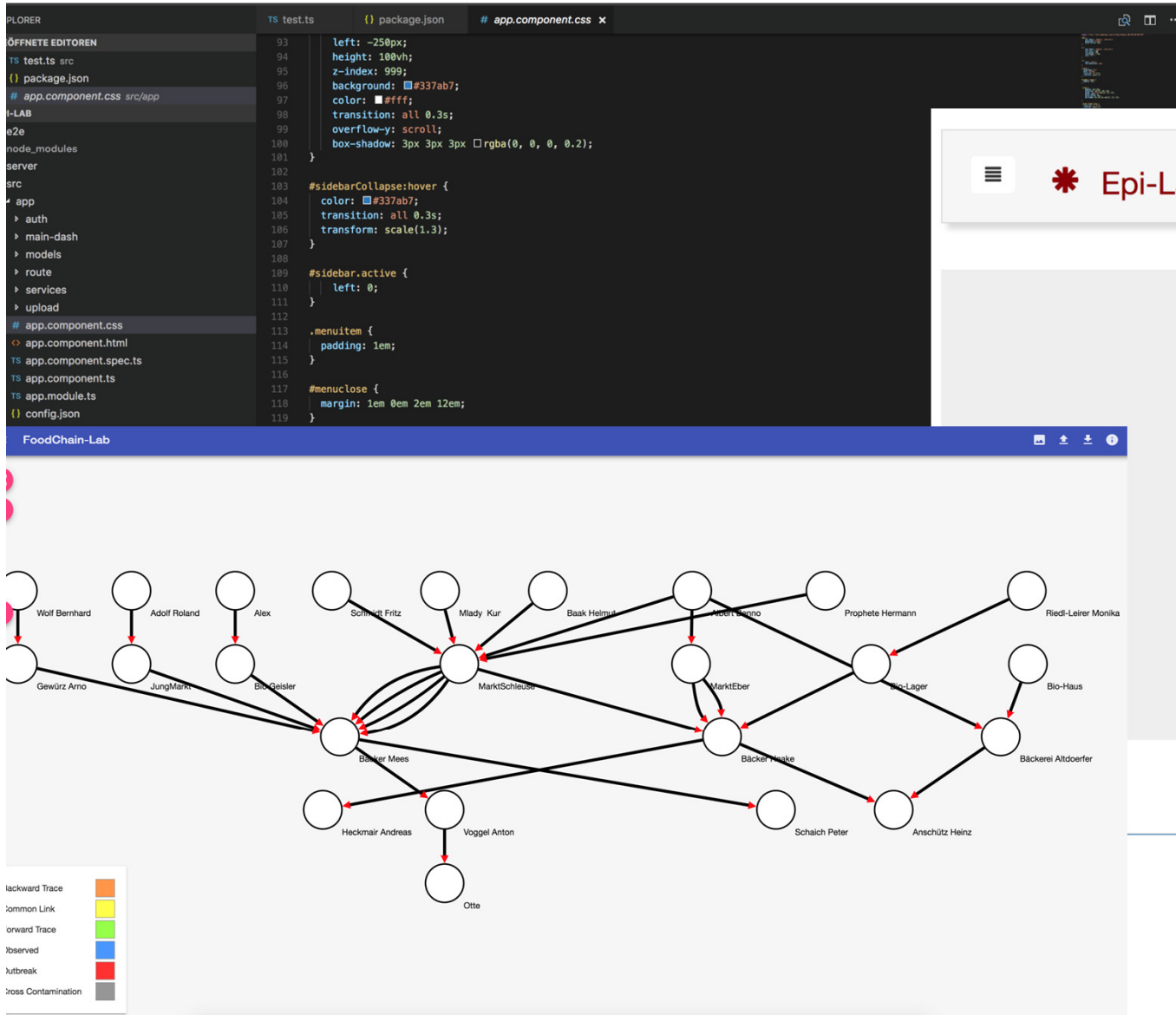


EHEC 2017
Fipronil 2017

EU:
HAV 2013/14
C. Bot. 2017 (Plötze)
Salm 2017 (Sesam)
List 2018

UK:
EHEC 2016

Next Generation FoodChain-Lab



Epi-Lab

Login

Email

Passwort

[Login](#) [Register](#) [Forgot Password?](#)

BfR – Bundesinstitut für Risikobewertung

FoodRisk – Labs

<https://foodrisklabs.bfr.bund.de>

FoodRiskLabs



FoodChain-Lab

Predictive Microbial
Modeling Lab (PMM-Lab)

FoodProcess-Lab

Open Food Safety Model
Repository

Events

Contact

Disclaimer

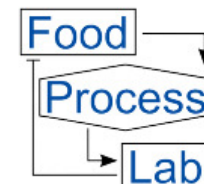
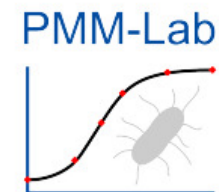
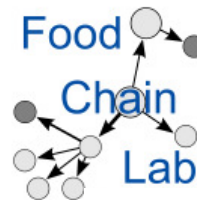
FoodRisk-Labs



FoodRisk-Labs is a portal

to the following tools

developed by the Federal Institute for Risk Assessment (BfR):



open
FSMR

Live



Thank you for your attention

Armin Weiser

<https://foodrisklabs.bfr.bund.de>

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