



GenEpi BioTrain – Block 2 Wave 3

# Three *Salmonella* outbreak investigations

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## Example 1

Nationwide outbreak of *Salmonella* Agona associated with internationally distributed powdered infant formula, France, 2017

# Salmonella surveillance in France and S. Agona in 2017



- **National Reference Centre (NRC) for *Salmonella* (Institut Pasteur, Paris), 2017**
  - Serotyping of ~ 9,000 human *Salmonella* strains/year
  - Since 2017: progressive implementation of Whole Genome Sequencing (WGS)
  - Every week: algorithms to detect serotypes exceeding thresholds
- ***Salmonella* Agona**
  - 2012-2016: ~ 65 S. Agona strains/year, all age groups combined
- **Past S. Agona outbreak in France**
  - In 2005: 1 outbreak associated with **powdered infant formula (PIF)** with > 140 infected infants (< 1 year old)

Serotyping + PFGE

FIGURES

# Alert and initial investigations

- **30th November 2017: identification of an unusual number of S. Agona strains**
  - 8 strains isolated in 8 days from infants (< 1 yo ; stool samples)
- **1st December: phone interviews with parents of the 8 cases**
  - Food exposure: PIF (Powdered Infant Formula) names + batch numbers and dates of purchase + pictures
  - Clinical history
  - Dates of symptom onset to estimate periods of contamination and purchase
  - Method of preparation of the baby's bottles
  - 3 different brands of PIF consumed before symptom onset
- **1st December: phone conference with all partners:** the NRC, the General Directorate for Competition Policy, Consumer Affairs and Fraud Control (DGCCRF) and the Ministry of Health (DGS)
  - The 3 PIFs are produced by the same company at the same production site (facility A) in France >>>>> Same facility implicated in the 2005 outbreak

# Epidemiological investigations

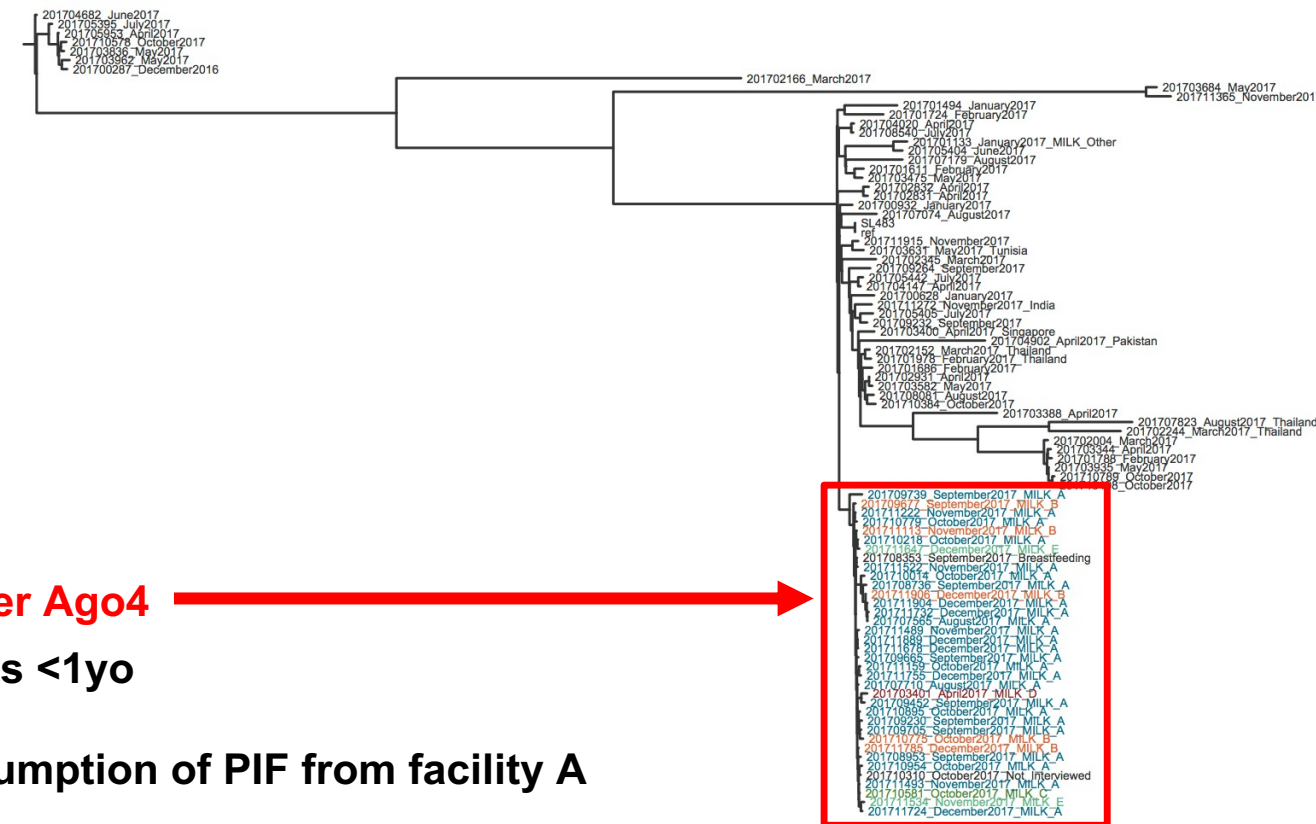
- **2nd December: recall of batches of the 3 PIFs**
    - marketed since mid July
    - corresponding to the period of production of PIFs consumed by cases
  - **3-8th December: phone interviews with parents of 17 newly identified cases:**
    - One parent reported consumption of a 4th PIF produced at facility A, in the same drying tower N°1 as the first 3 PIFs identified
    - Batch numbers of identified PIFs corresponded to a production period from February 2017 onwards
- **9th December: recall expanded to all products manufactured in the drying tower N°1 of facility A since 15 February 2017**
- **Through 19 January 2018: ongoing interviews of newly identified cases**

# Microbiological investigations

## WGS and phylogenetic analysis by the NRC:

- As of 2 December 2017: 62 *S. Agona* sequenced / 76 received in 2017
- SNP analysis showed an outbreak cluster with weak divergences, named **Ago4**
- Outbreak strains did not produce H<sub>2</sub>S or gas on Kligler iron agar
- SpFrance was informed of the cluster affiliation in real time by the NRC

Phylogenetic tree of *Salmonella Agona* strains received at the National Reference Centre, France, 2017 (n = 88)



**Cluster Ago4**

Infants <1yo

and

Consumption of PIF from facility A

and

Strains not producing gas or H<sub>2</sub>S

SNP-based phylogeny

No standardised nomenclature in 2017

# Overview

- **In total, between 1st December 2017 and 19th January 2018:**
  - 38 cases (16 boys and 22 girls) from 10 different regions in France
  - Median age of 4 months (min: 2.5 weeks, max: 9 months)
  - All strains belonged to outbreak cluster Ago4
- **Parents of 37 cases were interviewed:**
  - Symptom onset between late April and 2 December 2017
  - 18 hospitalisations (50% of cases)
  - All discharged and doing well at time of interviews
  - Consumption of 5 brands of PIF, all manufactured in facility A
  - One mother reported exclusive breastfeeding

# Overview

Figure 1: Number of cases of *S. Agona* belonging to the cluster Ago4 by week of identification by the NRC, France, April 2017-January 2018 (n=38)

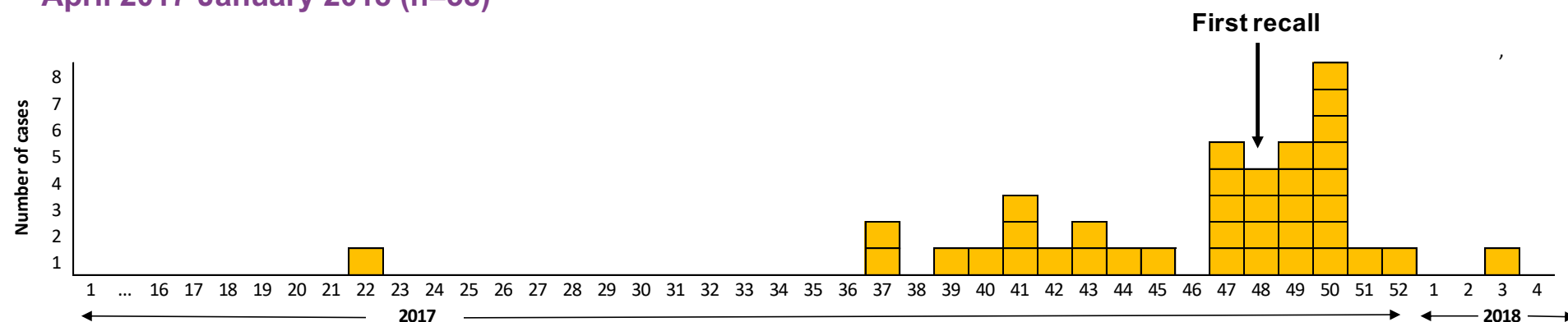
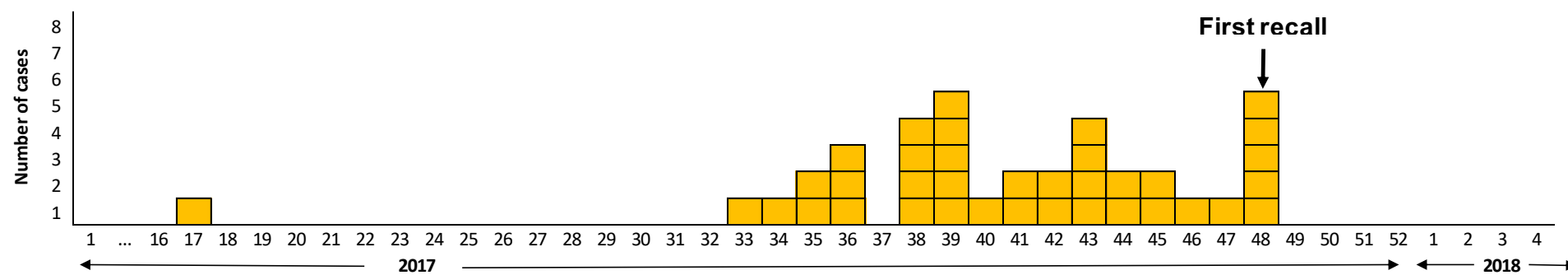


Figure 2: Number of cases of *S. Agona* belonging to the cluster Ago4 by week of symptom onset, France, April 2017-January 2018 (n=37)

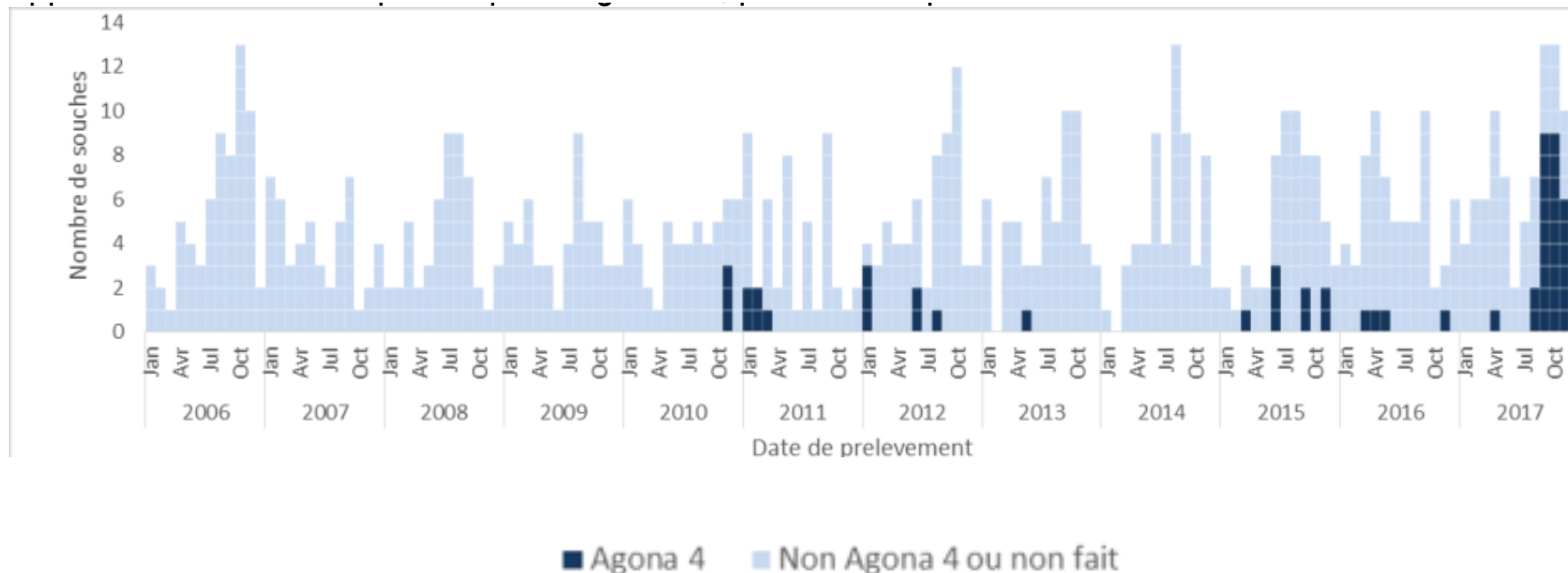


→ No cases with date of symptom onset after date of first recall



# Other microbiological investigations

- **Retrospective WGS and phylogenetic analysis by the NRC of *S. Agona* isolated in infants since 2000:**
  - Outbreak cluster Ago4 derived from the profile of *S. Agona* strains isolated in the 2005 outbreak associated with PIF from facility A
  - 27 Ago4 cases over the 2006-2016 period, **exclusively in infants**

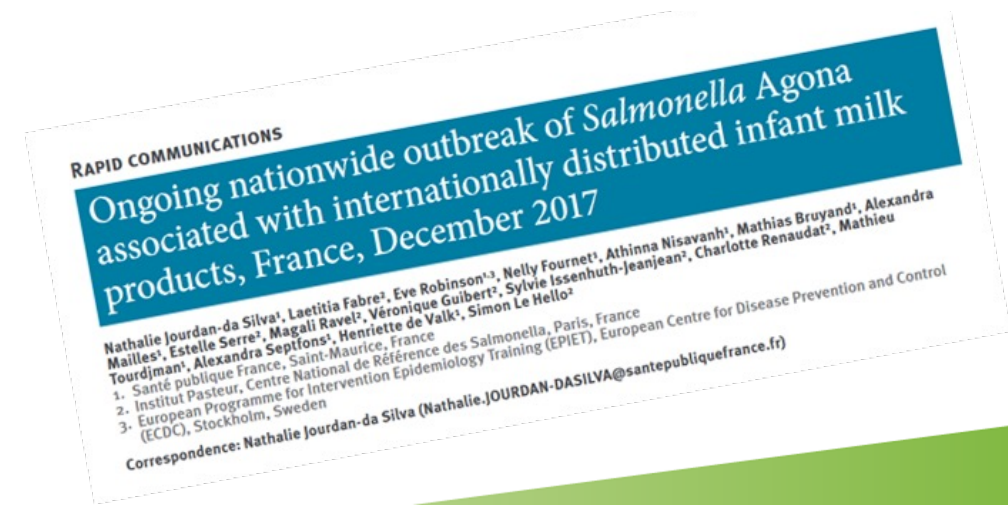


# Investigation on site and control measures

- **Investigations of the production site by official authorities:**
  - Outbreak strains isolated in environmental samples at facility A
  - No identification of the exact source of contamination
- **Subsequent recalls between 2 December 2017 and 12 January 2018**
  - **Recall of the full production of the factory as precautionary measure**
- **10 million units of different products for infants manufactured in facility A and marketed in more than 85 countries**

# Information to partners and public

- **Health professionals**
- **International level, communication with:**
  - Microbiologists and epidemiologists from Public Health Institutes and NRCs in Europe through the EPIS platform of ECDC
  - WHO: Infosan network and National Focal Points of potentially impacted countries
  - European Rapid Alert System for Food and Feed network (RASFF)
- **3 cases of *S. Agona* (cluster Ago4) in infants who consumed PIF produced in the Facility A identified internationally: 2 in Spain and 1 in Greece**
- **Public information:**
  - Press releases
  - Outbreak reports on SpFrance website
  - Media interviews



# Site investigations

- **By the company:**
  - ***Salmonella* found in two environmental samples around drying tower n°1 in August and November 2017**
    - Reinforced cleaning and extensive controls
  - **Hypothesis of contamination: bacteria may have been released during construction work undertaken in first term of 2017 around drying tower 1**
- **By official authorities, December 2017-January 2018:**
  - **Controls to check if measures were appropriate to confirm the safety of marketed products**
  - **Environmental and product samples positive for *S. Agona***
    - **Hypothesis: bacteria may have been activated and dispersed because of different cleaning and disinfection processes from 2005**

## And after?

- **Definitive closure of drying tower N°1 incriminated in the production of contaminated milk powder**
- **Re-start of production activity on tower N°2 (powder for adults) at the end of May 2018 with blockage of the batches. Market authorisation for distribution since July 4<sup>th</sup> 2018.**
- **Reinforced sampling of the products (ANSES recommendations 2018-SA-0077)**
- **July 4th, authorisation for production of infant powder, but no authorisation for marketing.**
- **September 18th: authorization for the marketing of all infant products manufactured at Facility A**
- **No confirmation of the exact source of contamination inside facility A**
- **« Food chain surveillance platform » working group on Salmonella contamination in cattle**

# Discussion

- **Prompt investigations:**
  - Pointing to PIF from facility A as the source of the outbreak
  - Same facility implicated in the 2005 outbreak
  - **First control measures taken on the basis of descriptive** epidemiological investigations, before biological confirmation of contamination of the product → no case identified after 1<sup>st</sup> recall
- **WGS made it possible to:**
  - Retrospectively trace the history of S. Agona strains
  - Affiliate past, national and international strains to the outbreak cluster
    - **2005 outbreak strains**
    - **27 inter-epidemic case strains**
    - **2017 outbreak strains**
    - **3 international strains in 2017**

# Conclusion

- Significant outbreak in terms of epidemiological and microbiological investigations
- **WGS** contributed ++ to the case investigations: identification of the outbreak cluster Ago4  
→ **Persistent contamination in facility A for 12 years** but exact source of contamination inside the facility not identified
- International reach
- Intense media and political interest

# Example 2



## Example 2

Disentangling a complex nationwide *Salmonella* Dublin outbreak associated with raw milk cheese consumption, France, 2015-2016: findings from a case-case, a case-control study and Whole Genome Sequencing

# Introduction and objectives

## 18 January 2016: excess of *Salmonella* Dublin (*S. Dublin*) infections

Reported by the National Reference Centre (NRC) for *Salmonella*

### **S. Dublin infections:**

Occasional outbreaks detected (raw-milk cheese)

Particularly invasive in humans, more often leading to severe diseases; higher rates of lethality compared to other serotypes

Serotype predominantly found in cattle

### **Multidisciplinary investigation team to:**

Confirm outbreak

Identify source of infection

Implement control measures

# Microbiological investigation (2016)

- Identification and serotyping using conventional methods of all *Salmonella* strains received at NRC and National Reference Laboratories (NRL)
- Antimicrobial susceptibility testing performed on all *S. Dublin* strains
- Multiple-Locus Variable number tandem repeat Analysis (MLVA) assay done
- Whole Genome Sequencing (WGS), WGS subtype definition: <10 single nucleotide divergence obtained by core-genome comparison

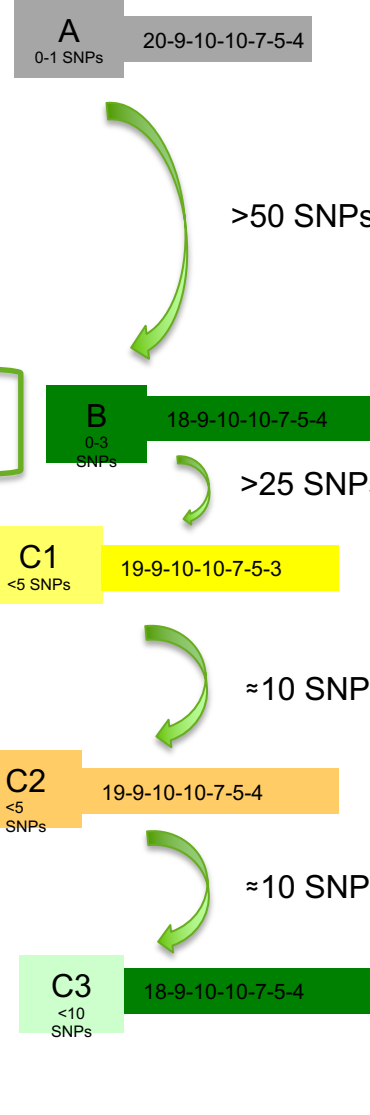
# Phylogenetic tree



**SNP-based phylogeny**  
**No standardised nomenclature**

**WGS type**

**MLVA (Dublin)**



Maximum SNP divergence for all strains sequenced during the outbreak approximately 200 SNPs suggesting a genetically homogeneous population for S. Dublin

Variation of Inter-cluster SNP divergence from >50 to 10 SNPs

MLVA	WGS							Total
	A	B	C <sub>3</sub>	C <sub>other</sub>	F	K	Other <sup>b</sup>	
15-8-10-7-5-3	0	0	0	1	19 <sup>c</sup>	0	0	20
17-8-10-7-5-4	0	9 <sup>d</sup>	0	6	0	0	0	15
18-8-10-7-5-4	0	14 <sup>e</sup>	28	3	0	0	2	47
19-8-10-7-5-3	0	0	0	22 <sup>f</sup>	0	0	0	22
19-8-10-7-5-4	1	4	1	18 <sup>g</sup>	0	0	3	27
20-8-10-7-5-3	0	0	0	10	0	0	0	10
20-8-10-7-5-4	15	1	0	0	0	0	1	17
Other <sup>h</sup>	0	5	1	11	15	11	40	83
Missing	2	2	5	17	4	0	18	48
Total	18	35	35	88	38	11	64	289

≈200 SNPs

0.05

# Case and cluster definitions

## Case definition

Residents in mainland France

Diagnosed with S. Dublin infection during 17 Nov 2015 to 11 March 2016

## Cluster definition

At least 10 cases with the same WGS subtype

# Epidemiological investigation (2016)



## Study design

**Case-case study:** Compared food consumption of S. Dublin cases of different WGS clusters with other subtyped cases

**Case-control study:** Compared food consumption of S. Dublin cases of different WGS clusters with controls

## Controls

**Recruited from the online GrippeNet.fr cohort**

**Web-based surveillance system for influenza-like illness**

**Symptoms reporting by 6,500 individuals on a weekly basis**

## Questionnaires

Cases: interviews by telephone

Controls: online questionnaire

# Data analysis, food trace-back and veterinary investigation (2016)

## Data analysis

- Crude Odds ratios (OR) for case-case study

- Adjusted OR using multivariate logistic regression for case-control study

## Food trace-back

- Customer loyalty card numbers collected to identify points of purchase and identify product batch numbers

- Analysis of identified food products if samples available

## Veterinary investigation

- Samples collected in production chains and dairy farms

# Results: cases, food consumption and controls description (2016)

## Description of cases

**83 cases** identified in all mainland France

12% deceased

23% in the Bourgogne-Franche-Comté (BFC) region

**63 (76%) cases with questionnaire** included in further analyses:

51% female

64 years (median age, range 1 - 92)

66% existing pathologies

68% hospitalised for *Salmonella* symptoms

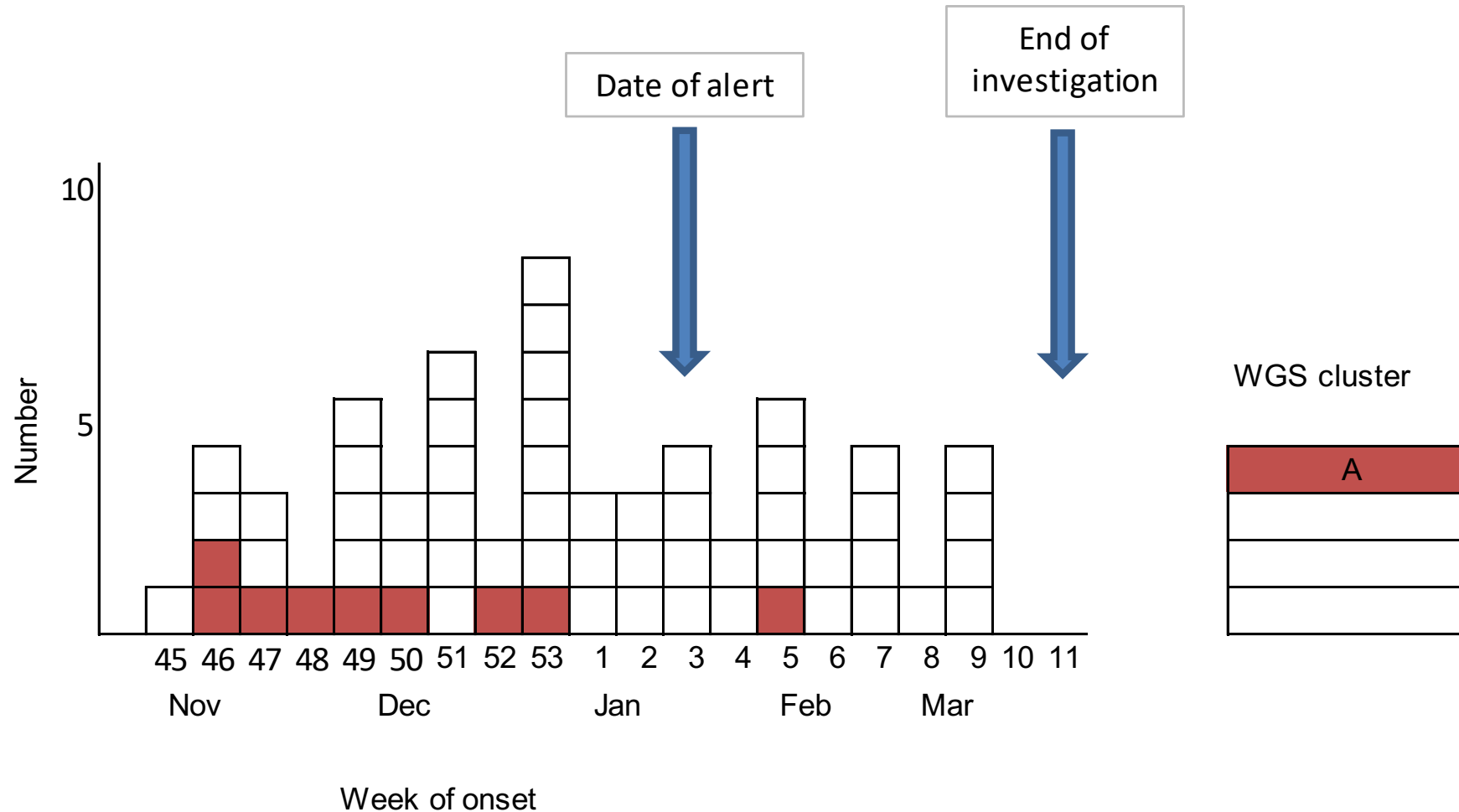
Cheese consumption reported by all cases

## Description of controls

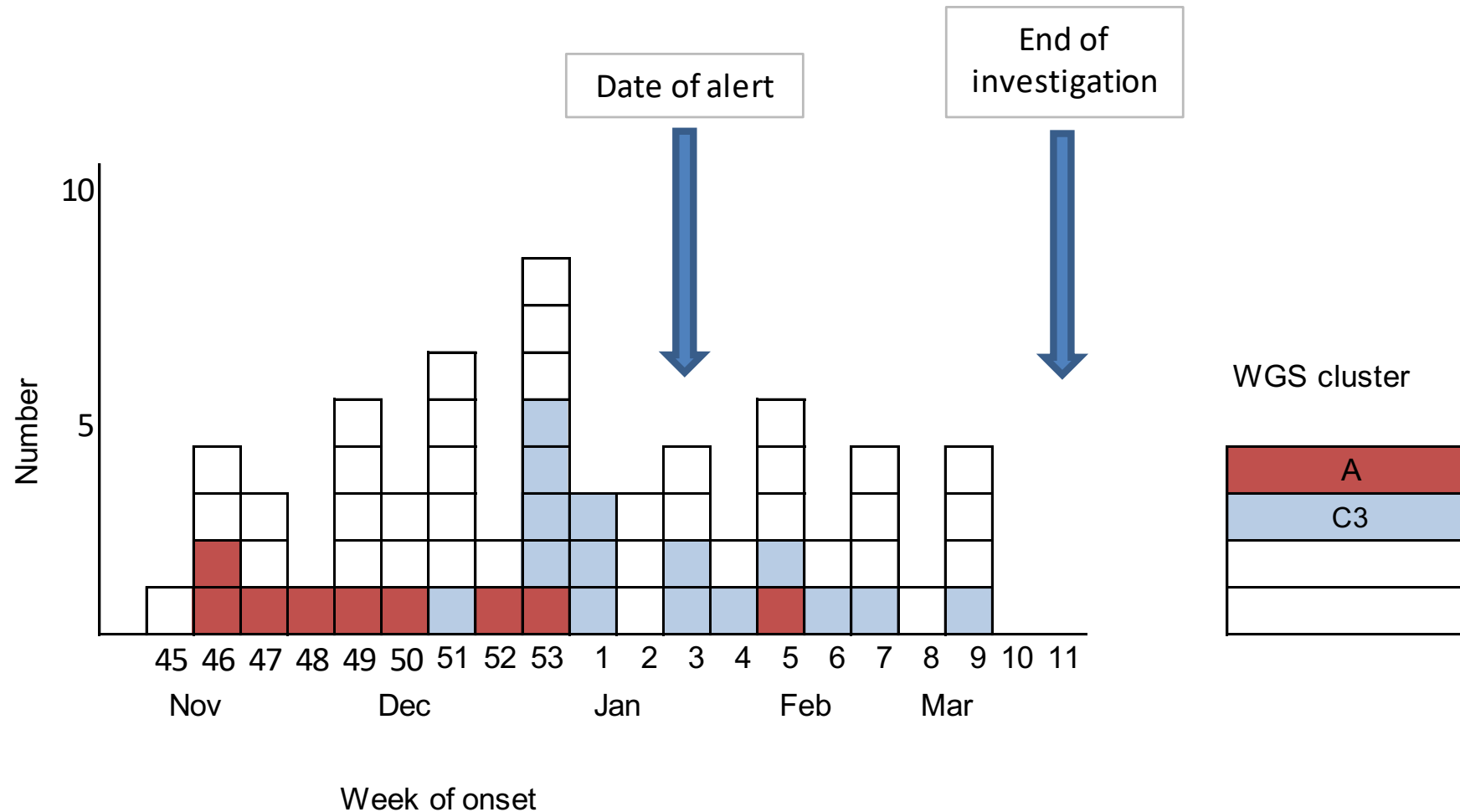
**1,284 controls** (same sex and age group distribution than cases)



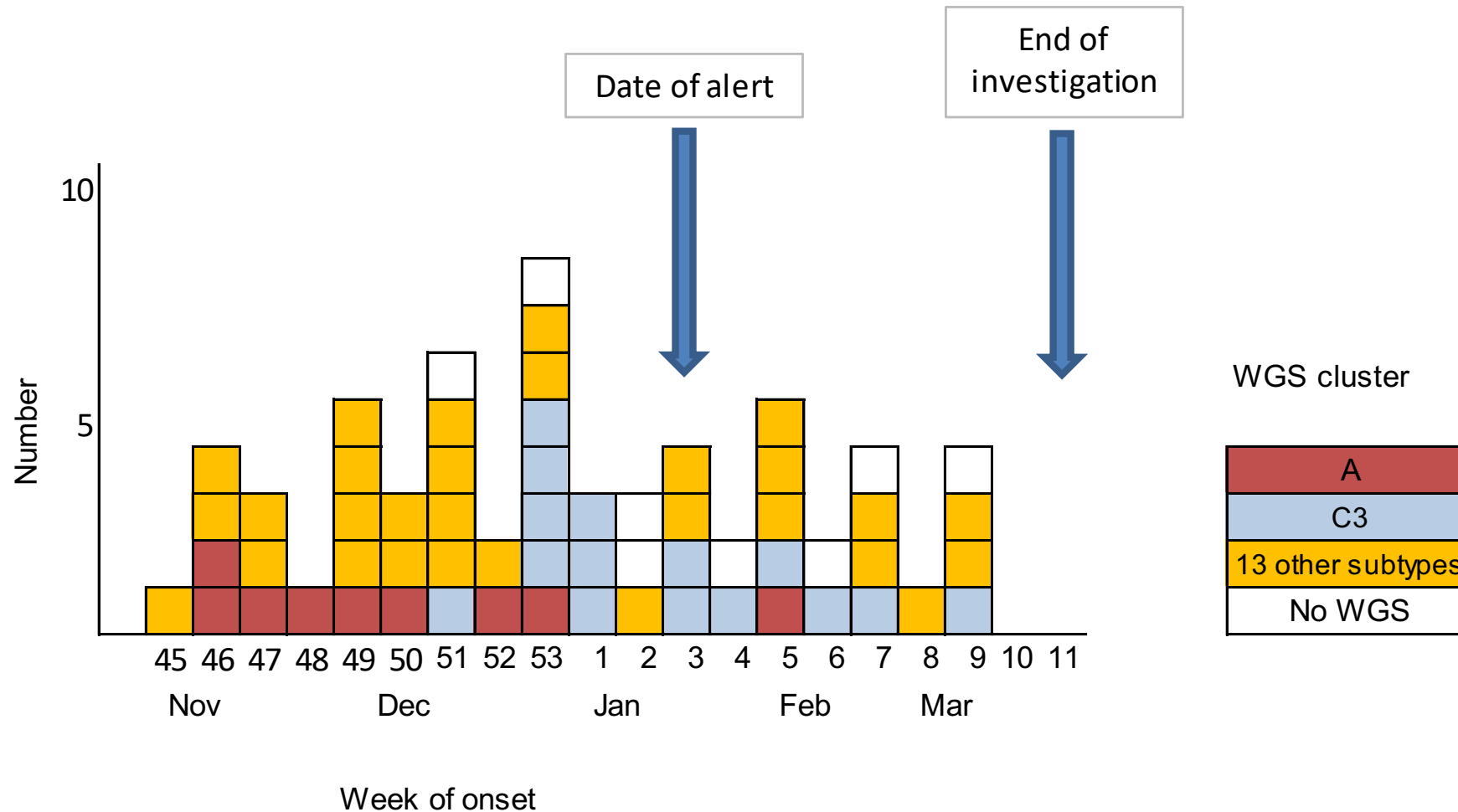
# Number of cases of *S. Dublin* by reported date of onset, November 2015 – March 2016



# Number of cases of *S. Dublin* by reported date of onset, November 2015 – March 2016



# Number of cases of *S. Dublin* by reported date of onset, November 2015 – March 2016



# Cluster A: Frequency of reported cheese consumption, November 2015 – March 2016, France (N=10)

Type of cheese	Cluster		Controls n (%)	Case-case study		Case-control	
	cases n (%)	Other cases† n (%)		OR	95% CI	aOR	95% CI
<b>V.</b>	<b>6 (67)</b>	<b>14 (35)</b>	<b>233 (08)</b>	<b>3.7</b>	<b>0.7-26</b>	<b>23</b>	<b>5.8-95</b>
C.	5 (63)	25 (61)	1375 (47)	1.1	0.2-7.8	NS	-
Goat cheese	3 (50)	21 (54)	1381 (47)	0.9	0.1-7.2	NS	-
G.	6 (75)	30 (79)	1847 (63)	0.8	0.1-9.6	NS	-
Camembert type	5 (63)	27 (68)	741 (25)	0.8	0.1-6.0	NS	-

† cases that belong to the other known subtypes

NS: not significant in multivariate logistic regression

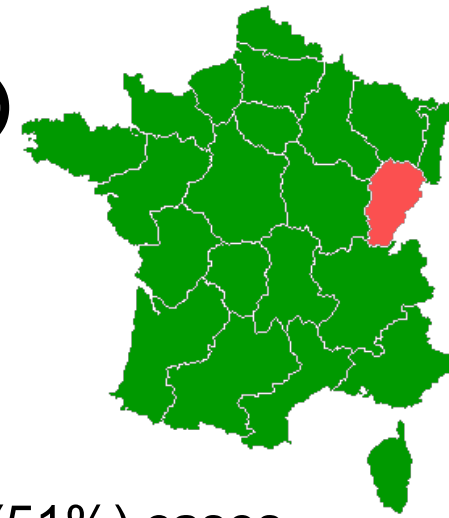
# Cluster C3: Frequency of reported cheese consumption, November 2015 – March 2016, France (N=17)

Type of cheese	Cluster cases	Other cases†	Controls	Case-case		Case-control	
	n (%)	n (%)	n (%)	OR	95% CI	aOR	95% CI
<b>M.</b>	<b>10 (67)</b>	<b>13 (39)</b>	<b>360 (12)</b>	<b>3.1</b>	<b>0.7-14</b>	<b>14</b>	<b>4.8-42</b>
Camembert type	11 (73)	21 (64)	741 (25)	1.6	0.4-8.2	NS	-
Gruyère	10 (71)	26 (81)	1847 (63)	0.6	0.1-3.4	NS	-
C.	7 (50)	23 (66)	1375 (47)	0.5	0.1-2.2	NS	-

† cases that belong to the other known subtypes

NS: not significant in multivariate logistic regression

# Food trace-back and veterinary investigation (2016)



## Food trace-back

- Not linked to a single cheese producer
- 10 supermarket brands investigated using loyalty cards of 32 (51%) cases

V. cheese

## Veterinary investigation

- **V. cheese** from 3 producers in BFC region tested positive with S. Dublin WGS **cluster A** linked with 5 cases (Nov-Dec 2015 and Feb 2016)
- **M. cheese** from 1 producer in BFC region tested positive with S. Dublin WGS **cluster C3** linked with 2 cases (Dec 2015)
- High prevalence of S. Dublin in cattle in the BFC region of production of these 2 cheeses (Fall 2015)

M. cheese

# Conclusion

- **One of the largest S. Dublin outbreak in France** in past years
- **Complex** investigation with **no common exposure** identified using different epidemiological & microbiological approaches
- **Two main outbreaks linked to 2 microbiological clusters**
- **Two different cheeses M. cheese & V.cheese** identified as likely sources of S. Dublin infection
- Cheeses produced by **producers located in one region** and spreading in all mainland France

# Control measures and recommendations



## Control measures implemented following investigation

Reinforced control plan launched by Ministry of Agriculture for processing plants of raw-milk cheeses in the region of production:

Systematic analyses of batches sold since 1 February 2016

Veterinary visits, detection and elimination of contaminated cattle

Enhanced sanitary protocol with reinforced control measures on milk

## Controls

**Use of online Grippenet.fr cohort to recruit controls**

**Data rapidly available**

**To be used for future foodborne outbreaks**

## Use of WGS by the NRC and the NRL

Routinely from 2017 (for NRL, non human strains related to food-borne outbreaks)

### OUTBREAKS

#### Disentangling a complex nationwide *Salmonella* Dublin outbreak associated with raw-milk cheese consumption, France, 2015 to 2016

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# Example 3

## Example 3

Investigation of an international outbreak of multidrug-resistant monophasic *Salmonella* Typhimurium associated with chocolate products, EU/EEA and United Kingdom, February to April 2022

# Decembre 2021 – January 2022

Ferrero factory in Arlon (Belgium):

**December 3:** isolation of a strain of *S. enterica* serotype **Typhimurium** in a finished product

**December 14 – January 25: 80 positive samples** (finished product environment). Identification of a reservoir of **anhydrous milk fat** as the source of the contamination. Production line stoppages followed by cleaning and restarts.

Public Health Agencies in the UK are currently investigating a 5-single nucleotide polymorphism (SNP) cluster of monophasic *Salmonella* Typhimurium eBG1 (SNP designations using the UKHSA pipeline: 1.1.1.124.6096.7575.%) identified through the analysis of whole genome sequencing (WGS) data. 18 cases have been identified to date with case sample dates between 21 December 2021 to 01 February 2022. Cases are distributed across England (16 cases), Wales (1 case) and Scotland (1 case). All cases have been aged 18 years or less, with the majority aged under 5 years (61%). Median age is 4 years old. Females have been affected more than males (62%). For those with information available, 5/7 cases reported being hospitalised for their illness (71%). 5/5 cases with information available reported bloody stools.

Limited exposure information is available for 6 cases: 4 cases had eaten at the same chain of fast food restaurants as well as 6/6 cases reporting pork/pork meat products. For the 6 cases for which information is available, none report travel in the week prior to symptom onset.

Antimicrobial resistance determinants predicted by WGS include the following classes of antibiotics: penicillins, aminoglycosides, trimethoprim, tetracyclines, sulphonamides and chloramphenicol. Phenotypic testing has not been undertaken to confirm the genotypic multidrug resistance profile.

The Enterobase cgMLST hierarchical cluster designation for the outbreak isolates is HC5:296366

SRA numbers for representative sequences from the outbreak are:

- SRR17830210
- SRR18021617

**18 cases** onset 21/12/2021 to 01/02/2022

England (16), Wales (1) & Scotland (1)

majority aged **under 5 years** (61%)

5/7 cases being **hospitalised** for their illness (71%)

4 cases had eaten at the same **fast food**

6/6 cases reporting **pork/pork meat** product

**none report travel** prior to symptom onset

Monophasic *Salmonella* Typhimurium **eBG1**

Antimicrobial resistance profile (by WGS):

**AMP GEN SMX TMP TET CHL**

5-SNP cluster by the UKHSA pipeline:

**1.1.1.124.6096.7575.% (t5.7575).**

Enterobase HierCC-cgMLST designation:

**HC5\_296366**

**France: two cases**  
Children 1y and 4y

## France (cumulated cases)

- 11 March, 6 cases
- 18 March, 12 cases
- 25 March, 17 cases
- 30 March, 19 cases
- 1<sup>st</sup> April, 20 cases

## FIGURES

April 3rd



Derek Brown



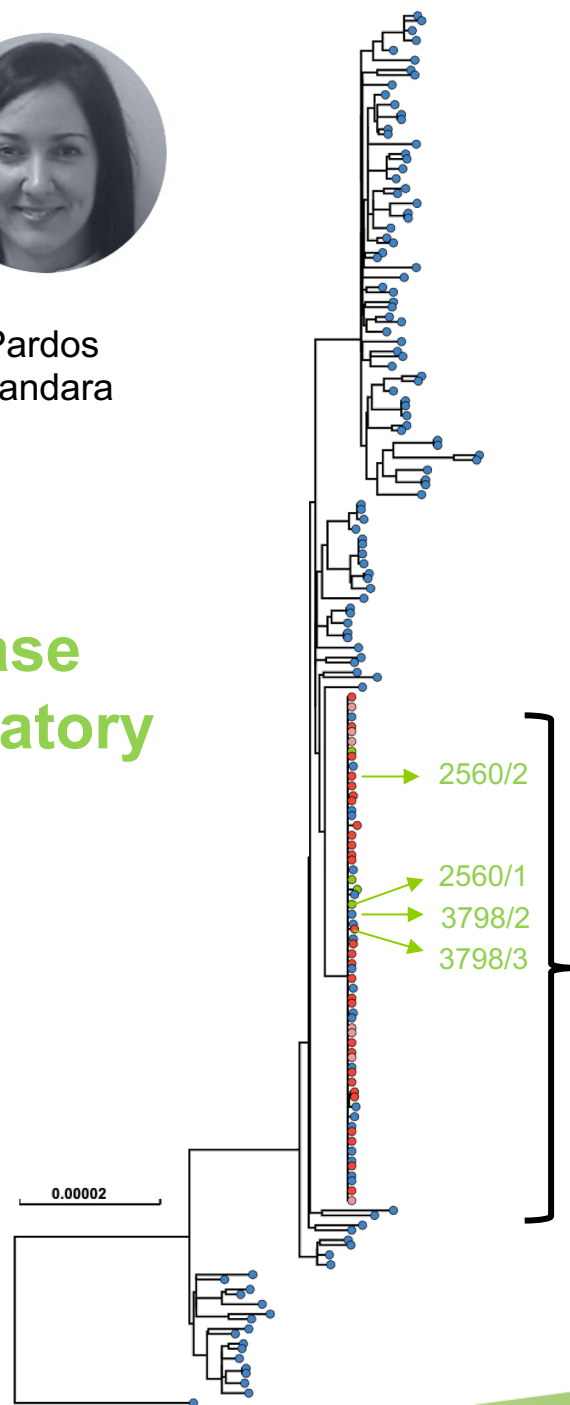
Maria Pardos  
de la Gandara

Four genomes submitted to EnteroBase  
on March 21<sup>st</sup> 2022 by an Italian laboratory

**Lab Contact**

- F.X.Weill, Institut Pasteur [128]
- Public Health England [29]
- D. Brown (Scotland) [7]
- Certis [4]

cgMLST HC5 nomenclature  
SNP-based phylogeny



Outbreak strain  
**HC5\_296366**

Name	Serov...	Lab Contac...	Date Enter...	Release Da...	Data Source	Source	Location		St	HC2	HC5	HC10	HC20	HC50	HC100	
3798/3		Certis	2022-03-21	2022-03-21	⊕Uploaded Reads	⊕	⊕	👁	2	2	296366	296366	158790	2	2	2
6068/2		Certis	2022-03-21	2022-03-21	⊕Uploaded Reads	⊕	⊕	👁	2	2	298160	298160	298160	2	2	2
2560/2		Certis	2022-03-21	2022-03-21	⊕Uploaded Reads	⊕	⊕	👁	2	2	296366	296366	158790	2	2	2
3798/1		Certis	2022-03-21	2022-03-21	⊕Uploaded Reads	⊕	⊕	👁	3	3	298160	298160	298160	2	2	2
2560/1		Certis	2022-03-21	2022-03-21	⊕Uploaded Reads	⊕	⊕	👁	2	2	296366	296366	158790	2	2	2
11535		Certis	2022-03-21	2022-03-21	⊕Uploaded Reads	⊕	⊕	👁	3	3	298160	298160	298160	2	2	2
6068/1		Certis	2022-03-21	2022-03-21	⊕Uploaded Reads	⊕	⊕	👁	2	2	298160	298160	298160	2	2	2
3798/2		Certis	2022-03-21	2022-03-21	⊕Uploaded Reads	⊕	⊕	👁	2	2	296366	296366	158790	2	2	2
508		Certis	2022-03-21	2022-03-21	⊕Uploaded Reads	⊕	⊕	👁	2	2	298160	298160	298160	2	2	2

Ferrero recognizes that these strains come from the Arlon factory

And there is even a **second strain** of monophasic Typhimurium (**HC5\_298160**)

### Strain 1

- cgMLST **HC5\_296399**
- UKHSA SLC **t5.7575**
- MLVA **3-11-14-NA-0211**
- AMR:
  - **AMP** (*bla<sub>TEM-1</sub>*)
  - **STR SPE KAN GEN** (*strAB*, *aph(3')\_la*, *aac(3)-IId*)
  - **SSS** (*sul3*) **TMP** (*dfrA12*)
  - **TET** (*tetB*, *tetM*)
  - **CHL**(*cmlA1*, *floR*)

### Strain 2

- cgMLST **HC5\_298160**
- UKHSA SLC **t5.7643**
- MLVA: **3-8-10-NA-0211**
- AMR:
  - **Amp** (*bla<sub>TEM-1</sub>*)
  - **STR SPE KAN** (*strAB*, *aph(3')\_la*)
  - **SSS** (*sul2*)
  - **TET** (*tetA/B*)

4 April 2022  
11 April 2022



Factory closed on April 8th



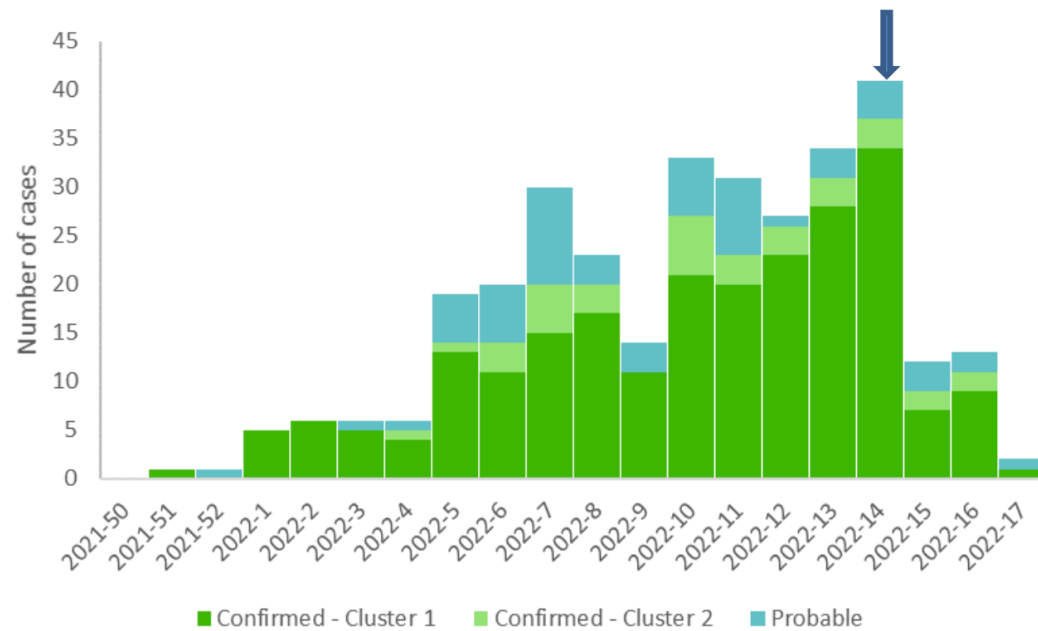
**Table 1. Number of confirmed and probable cases of monophasic *S. Typhimurium* and hospitalisations by country, as of 18 May 2022**

Country	Confirmed cases		Probable cases	Total number of cases	Hospitalised (among cases with available data)
	Cluster 1	Cluster 2			
Austria	7	7	0	14	35.7%
Belgium	7	5	52	64	39.2%
Denmark	1	1	0	2	NA
France	73	8	0	81	42.9%
Germany	15	4	3	22	66.7%
Ireland	15	1	0	16	30.8%
Italy	0	1	0	1	NA
Luxembourg	2	0	0	2	NA
Netherlands	2	1	0	3	NA
Norway	1	0	0	1	NA
Spain	2	0	3	5	NA
Sweden	4	0	0	4	NA
<b>Total EU/EEA</b>	<b>129</b>	<b>28</b>	<b>58</b>	<b>215</b>	<b>41.9%</b>
United Kingdom	102	7	0	109	39.7%
<b>Total EU/EEA and UK</b>	<b>231</b>	<b>35</b>	<b>58</b>	<b>324</b>	<b>41.3%</b>
Canada	1	0	0	1	NA
Switzerland	41	2	0	43	NA
United States	1	0	0	1	NA
<b>Total</b>	<b>274</b>	<b>37</b>	<b>58</b>	<b>369</b>	<b>NA</b>

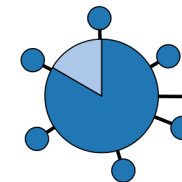
HC5\_296366

Joint ECDC-EFSA rapid outbreak assessment, 18 May 2012

**Figure 2.** Distribution of 324 confirmed (cluster 1 + cluster 2) and probable monophasic *S. Typhimurium* cases by week-year\* in 12 EU/EEA countries and the United Kingdom, as of 18 May 2022 (arrow shows the closure of the Belgian Processing Plant B)



Cluster 1



Cluster 2



62 AD

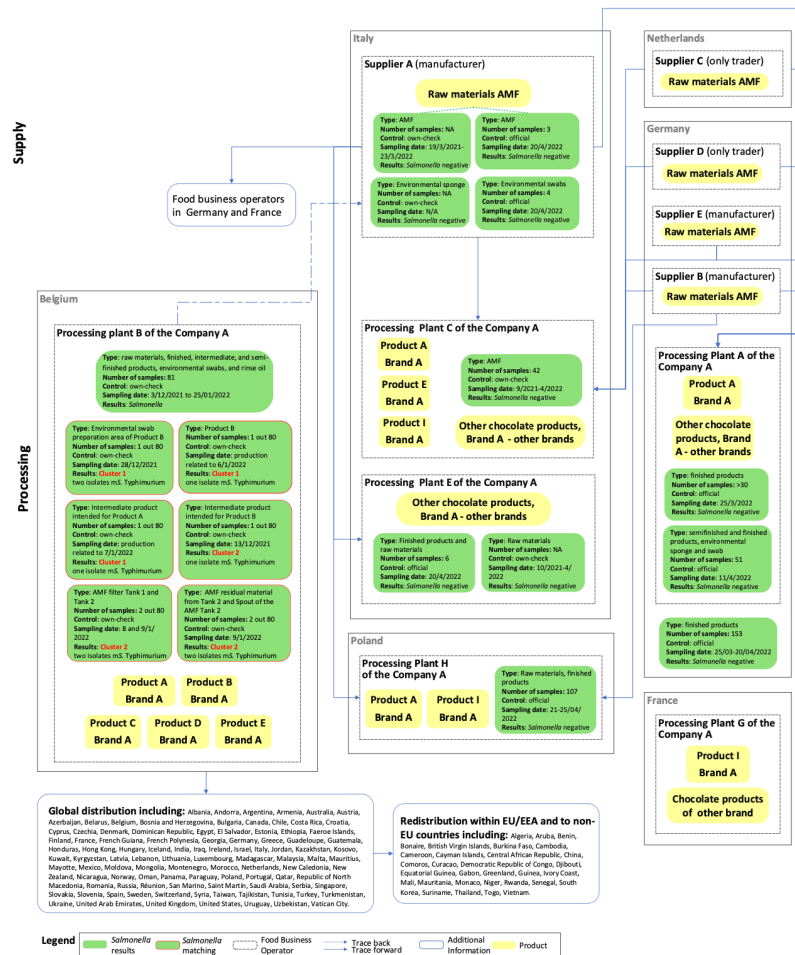
Origin

- HUMAN [32]
- FOOD [9]

\*Date of sampling (n=295), date of receipt to the laboratory (n=26), or date of notification (n=3)

# ROA updated on 18 May 2022

**Figure A1.** Graphical representation of the traceability, testing information and distribution of raw materials and chocolate products from the Belgium Processing Plant B, as reported by the involved countries under RASFF notification 2022.1799, 2022.2201, and 2022.2452



## Processing plant B of the Company A

Type: raw materials, finished, intermediate, and semi-finished products, environmental swabs, and rinse oil  
Number of samples: 81  
Control: own-check  
Sampling date: 3/12/2021 to 25/01/2022  
Results: *Salmonella*

- Type: Environmental swab preparation area of Product B  
Number of samples: 1 out 80  
Control: own-check  
Sampling date: 28/12/2021  
Results: **Cluster 1**  
two isolates mS. Typhimurium
- Type: Product B  
Number of samples: 1 out 80  
Control: own-check  
Sampling date: production related to 6/1/2022  
Results: **Cluster 1**  
one isolate mS. Typhimurium
- Type: Intermediate product intended for Product A  
Number of samples: 1 out 80  
Control: own-check  
Sampling date: production related to 7/1/2022  
Results: **Cluster 1**  
one isolate mS. Typhimurium
- Type: Intermediate product intended for Product B  
Number of samples: 1 out 80  
Control: own-check  
Sampling date: 13/12/2021  
Results: **Cluster 2**  
one isolate mS. Typhimurium
- Type: AMF filter Tank 1 and Tank 2  
Number of samples: 2 out 80  
Control: own-check  
Sampling date: 8 and 9/1/2022  
Results: **Cluster 2**  
two isolates mS. Typhimurium
- Type: AMF residual material from Tank 2 and Spout of the AMF Tank 2  
Number of samples: 2 out 80  
Control: own-check  
Sampling date: 9/1/2022  
Results: **Cluster 2**  
two isolates mS. Typhimurium

# Further reading

## RAPID COMMUNICATIONS

2018

### Ongoing nationwide outbreak of *Salmonella* Agona associated with internationally distributed infant milk products, France, December 2017

Nathalie Jourdan-da Silva<sup>1</sup>, Laetitia Fabre<sup>2</sup>, Eve Robinson<sup>1,3</sup>, Nelly Fournet<sup>1</sup>, Athinna Nisavanh<sup>1</sup>, Mathias Bruyand<sup>1</sup>, Alexandra Mailles<sup>1</sup>, Estelle Serre<sup>2</sup>, Magali Ravel<sup>2</sup>, Véronique Guibert<sup>2</sup>, Sylvie Issenhuth-Jeanjean<sup>2</sup>, Charlotte Renaudat<sup>2</sup>, Mathieu Tourdjman<sup>1</sup>, Alexandra Septfons<sup>1</sup>, Henriette de Valk<sup>1</sup>, Simon Le Hello<sup>2</sup>

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2. Institut Pasteur, Centre National de Référence des *Salmonella*, Paris, France

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## OUTBREAKS

2019

### Disentangling a complex nationwide *Salmonella* Dublin outbreak associated with raw-milk cheese consumption, France, 2015 to 2016

Aymeric Ung<sup>1,2,3</sup>, Amrish Y. Baidjoe<sup>3,4,5</sup>, Dieter Van Cauteren<sup>1</sup>, Nizar Fawal<sup>5</sup>, Laetitia Fabre<sup>5</sup>, Caroline Guerrisi<sup>6</sup>, Kostas Danis<sup>1,2</sup>, Anne Morand<sup>7</sup>, Marie-Pierre Donguy<sup>7</sup>, Etienne Lucas<sup>1</sup>, Louise Rossignol<sup>6</sup>, Sophie Lefèvre<sup>5</sup>, Marie-Léone Vignaud<sup>8</sup>, Sabrina Cadel-Six<sup>8</sup>, Renaud Lailier<sup>8</sup>, Nathalie Jourdan-Da Silva<sup>1,9</sup>, Simon Le Hello<sup>5,9</sup>

Larkin L, et al. Eurosurveillance. 2022

<https://doi.org/10.2807/1560-7917.ES.2022.27.15.2200314>

## RAPID COMMUNICATION

### Investigation of an international outbreak of multidrug-resistant monophasic *Salmonella* Typhimurium associated with chocolate products, EU/EEA and United Kingdom, February to April 2022



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