JOINT ECDC-EFSA RAPID OUTBREAK ASSESSMENT

Multi-country outbreak of *Salmonella* Enteritidis infections linked to eggs

Third update

6 February 2020

Abstract

A multi-country outbreak of *Salmonella* Enteritidis, delineated by whole genome sequencing (WGS), linked to eggs, has been ongoing in the EU/EEA for several years. From 1 February 2017 to 14 January 2020, 15 EU/EEA countries reported 656 confirmed cases and 202 probable cases. Before February 2017, 385 historical-confirmed cases and 413 historical-probable cases were identified, resulting in 18 affected countries. Due to differences in capacity for case confirmation, more countries are likely to be affected.

This prolonged outbreak peaked during the summer months of 2016–2018. A notable decrease in the frequency of the cases reported to ECDC has been observed in 2019, which is a deviation from the three previous years.

Epidemiological, microbiological and food tracing investigations have linked cases before 2018 to consumption of eggs originating from laying hen farms of a Polish consortium. A national investigation in 2018 in the UK identified epidemiological links between some cases and consumption of table eggs or egg products, with traceability possibly pointing to the Polish consortium.

Despite the control measures implemented in 2016–2017, the farms of the Polish consortium were positive in 2018–2019 with outbreak strains, suggesting persistent contamination. Investigations focusing on the laying hen production and feed supply chains did not reveal any significant insights on the possible origin of the contamination.

One of the outbreak strains was found in the period 2017-2019 in primary production in Germany.

In conclusion, the outbreak is still ongoing and since no evidence was provided that the source of contamination has been eliminated, it is expected that further infections will occur and that new cases will be reported in the coming months. Additional investigations are necessary to identify the source of contamination.

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Erratum: 12 February 2020, the title of this assessment was corrected from fourth update to third update.

Event background

Upon the launch of the urgent inquiries from Scotland (18 January 2016) and the Netherlands (25 August 2016) in the Epidemic Intelligence Information System for Food- and Waterborne Diseases and Zoonoses (EPIS-FWD), an EU/EEA-level investigation into a multi-country outbreak of *S.* Enteritidis was initiated. For the EU outbreak case definition [1] whole genome sequencing (WGS)-based typing was used, applying the Public Health England's (PHE) single nucleotide polymorphism (SNP) calling pipeline PHEnix (https://github.com/phe-bioinformatics/PHEnix) and nomenclature implemented in PHE SnapperDB [2-4]. Two distinct SNP addresses at t5 level (≤5 SNP difference to at least one other case in the cluster, based on single linkage clustering) were selected to define an outbreak-confirmed case. These SNP addresses were 1.2.3.175.175.175.% (t5.175) and 1.2.3.18.359.360.% (t5.360). Probable cases were defined based on MLVA typing. At the time of the publication of the first joint ECDC-EFSA rapid outbreak assessment [5], 112 confirmed *S.* Enteritidis cases had been identified in seven EU/EEA countries (Belgium, Denmark, Luxembourg, the Netherlands, Norway, Sweden and the United Kingdom). Extensive investigations by public health and food safety authorities suggested that eggs were likely vehicles of infection. Trace back investigations revealed that several food establishments in different countries received eggs from a packing centre in Poland (the Polish Packing Centre B). Samples of eggs and unpasteurised liquid eggs originating from Packing Centre B resulted in positive results for *S.* Enteritidis -isolates matching the representative outbreak strains. Information on the status of the farms that provided eggs to the Polish Packing Centre B was not available at the time of publishing [5].

On 7 March 2017, a second joint ECDC-EFSA assessment was published upon the notification of more confirmed cases from 14 countries: Belgium, Croatia, Denmark, Finland, France, Greece, Hungary, Italy, Luxembourg, the Netherlands, Norway, Slovenia, Sweden and the United Kingdom (Northern Ireland, England, Wales and Isle of Man) [6]. The document gathered data on the food and environmental investigations performed between the beginning of 2016 and mid-2017 in 10 countries (i.e. Austria, Belgium, Croatia, France, Hungary, the Netherlands, Norway, Poland, Sweden, and the United Kingdom). The available evidence from the microbiological and traceability investigations identified eggs positive with *S.* Enteritidis isolates matching the representative outbreak strains (i.e. SNP addresses t5.175 and t5.360) and originating from the Polish Packing Centre B. A total of 18 Polish laying hen farms suppling eggs to the Polish Packing Centre B, 14 of which belonging to the same Polish Consortium A, were found to be positive for *S.* Enteritidis. The same farms also supplied eggs to two other Polish packing centres (i.e. Polish Packing Centre C and Polish Packing Centre D). Typing information was available for isolates detected in five farms. In three farms *S.* Enteritidis matched the outbreak strains (SNP addresses t5.175 and t5.360); in the other two farms, two new genotypes were identified (SNP addresses t5.469 and t5.2440). The breeding farms, which provided pullets to the *S.* Enteritidis positive laying hen farms, were reported to be negative, based on the results from the routine tests performed between January and November 2016 by the food business operators and the official competent authorities in the framework of the *Salmonella* control programme [6].

In December 2017, the third joint ECDC-EFSA assessment on *S.* Enteritidis infections presumably linked to Polish eggs was published [7]. The EU case definition of confirmed and probable cases was restricted in time to start on 1 February 2017 and the definition of confirmed and historical-confirmed cases extended to include cases fulfilling the following t5-level SNP addresses: t5.175, t5.360, t5.469 and t5.2440. New confirmed cases were reported by France, Luxembourg, the Netherlands, Norway, Sweden and the United Kingdom. Food and environmental investigations were performed in 2017 in four countries (i.e. Norway, Poland, Sweden and the United Kingdom). Two WGS types (i.e. t5.469 and t5.360) were identified at wholesale and retail level. The Polish Packing Centre B and the Polish Packing Centre E were identified as the suppliers of eggs found in a Norwegian processing company and in a Swedish retailer that were positive for *S.* Enteritidis, matching one of the outbreak strains (t5.469) [7].

Multi-country investigations

EU outbreak case definition

The European outbreak case definition is as follows:

A confirmed outbreak case

- A laboratory-confirmed *Salmonella* Enteritidis case with symptom onset on or after 1 February 2017 (date of sampling or date of receipt by the reference laboratory if date of onset is not available)

  AND

- Fulfilling the additional laboratory criterion: with a strain sharing the same t5-level SNP address as one of the outbreak clusters defined by the PHE SNP pipeline [2]: 1.2.3.18.175.175.% (t5.175 –accession number SRR3285443) OR 1.2.3.18.359.360.% (t5.360 – accession number SRR4063700) OR 1.2.3.18.455.469.% (t5.469 – accession number ERR2173854) OR 1.2.3.18.455.2440.% (t5.2440 – accession number SRR4063739).

A probable outbreak case

- A laboratory-confirmed *Salmonella* Enteritidis case with symptom onset on or after 1 February 2017 (date of sampling or date of receipt by the reference laboratory if date of onset is not available)

AND

- Fulfilling the following laboratory criterion: with a strain matching the MLVA profile 2-9-7-3-2 or 2-9-6-3-2 or 2-9-10-3-2 or 2-10-6-3-2 or 2-10-8-3-2 or 2-11-8-3-2 corresponding to the MLVA protocol with 5 loci [8].

A historical confirmed case

- A laboratory-confirmed *Salmonella* Enteritidis case with a strain sharing the same t5-level SNP address as one of the confirmed outbreak clusters defined by the PHE SNP pipeline [2] and date of disease onset from January 2012 to January 2017 (date of sampling or date of receipt by the reference laboratory if date of onset is not available).

A historical probable case

- A laboratory-confirmed *Salmonella* Enteritidis case with a strain with MLVA profile 2-9-7-3-2 or 2-9-6-3-2 or 2-9-10-3-2 or 2-10-6-3-2 or 2-10-8-3-2 or 2-11-8-3-2 and date of disease onset from January 2012 to January 2017 (date of sampling or date of receipt by the reference laboratory if date of onset is not available).

Exclusion criteria

- Cases with travel history outside of the EU/ EEA in the seven days prior onset;
- Secondary cases defined as those confirmed cases that have had person-to-person contact with a confirmed case and no exposure to a common source;
- Cases infected with MLVA profile 2-9-6-3-2 or 2-9-7-3-2 or 2-9-10-3-2 or 2-10-6-3-2 or 2-10-8-3-2 or 2-11-8-3-2, but not sharing the t5-level SNP address as one of the confirmed outbreak WGS clusters described above.

Epidemiological and microbiological investigations of humans

As of 14 January 2020, 18 EU/EEA countries have reported 656 confirmed and 202 probable cases associated with this outbreak since February 2017, in addition to 385 historical confirmed cases and 413 historical probable cases reported before 1 February 2017 (Table 1). Since the ECDC latest update on this event, published on 19 November 2018, 248 new cases have been reported, of which 124 were confirmed, 36 probable, 42 historical-confirmed and 46 historical-probable cases [9]. The United Kingdom has reported the most cases in this outbreak with 484 confirmed cases since 1 February 2017.

Table 1. Number of isolates by case classification and country, EU/EEA, February 2012 to November 2019 (n=1 656), as of 14 January 2020

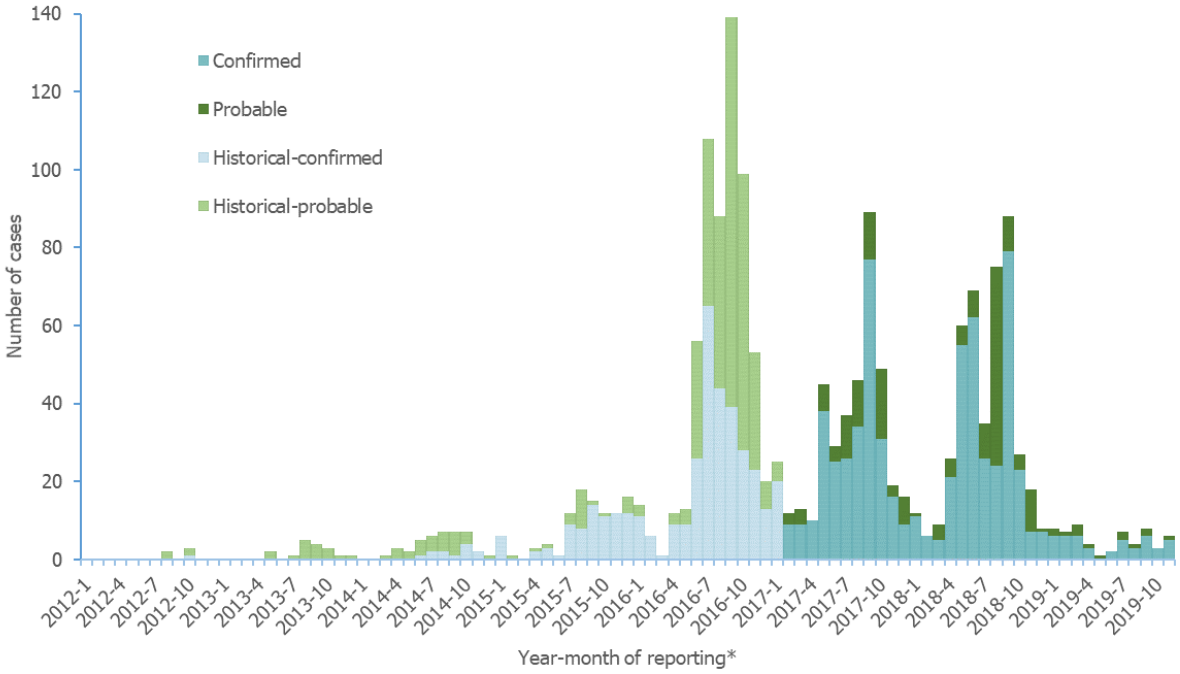
Country	Number of isolates				
	Confirmed (after 31 Jan 2017)	Probable (after 31 Jan 2017)	Historical Confirmed (before 1 Feb 2017)	Historical Probable (before 1 Feb 2017)	Total
Belgium	19	40	21	122	**202**
Croatia	0	0	4	0	**4**
Czech Republic	0	67	0	44	**111**
Denmark	17	0	6	2	**25**
Finland	0	0	1	1	**2**
France	27	0	8	1	**36**
Greece	0	0	0	2	**2**
Hungary	0	21	7	5	**33**
Ireland	18	0	4	4	**26**
Italy	7	1	19	22	**49**
Luxembourg	3	0	5	0	**8**
Netherlands	12	18	91	159	**280**
Norway	24	18	11	32	**85**
Poland	29	0	0	0	**29**
Romania	0	4	0	2	**6**
Slovenia	0	9	3	2	**14**
Sweden	16	22	13	5	**56**
United Kingdom	484	2	192	10	**688**
Total	**656**	**202**	**385**	**413**	**1 656**

Of the 656 outbreak-confirmed cases, 651 had information on age and the median age was 28 years (interquartile range (IQR) 12–52 years); information on gender was available for 650 cases, of whom 331 (51%) were female patients. Of the 202 probable cases, 201 had information on age and the median age at the time of infection was 28 years (IQR 11–51 years). Information on gender was available for 196 probable cases, of which 89 (45%) were female. In each year from 2016 to 2018, outbreak cases peaked in September (Figure 1), with large waves of cases reported between late spring and early autumn. Such a large seasonal increase was no longer observed in 2019.

Information on hospitalisation is available for 427 patients in 12 EU/EEA countries and about a third of the patients were reported hospitalised both among the confirmed and historical-confirmed cases (259 cases, of which 86 hospitalised) and the probable and historical-probable cases (168 cases, of which 50 hospitalised). Two historical-confirmed cases, a child and an elderly patient, were reported to have died due to the infection.

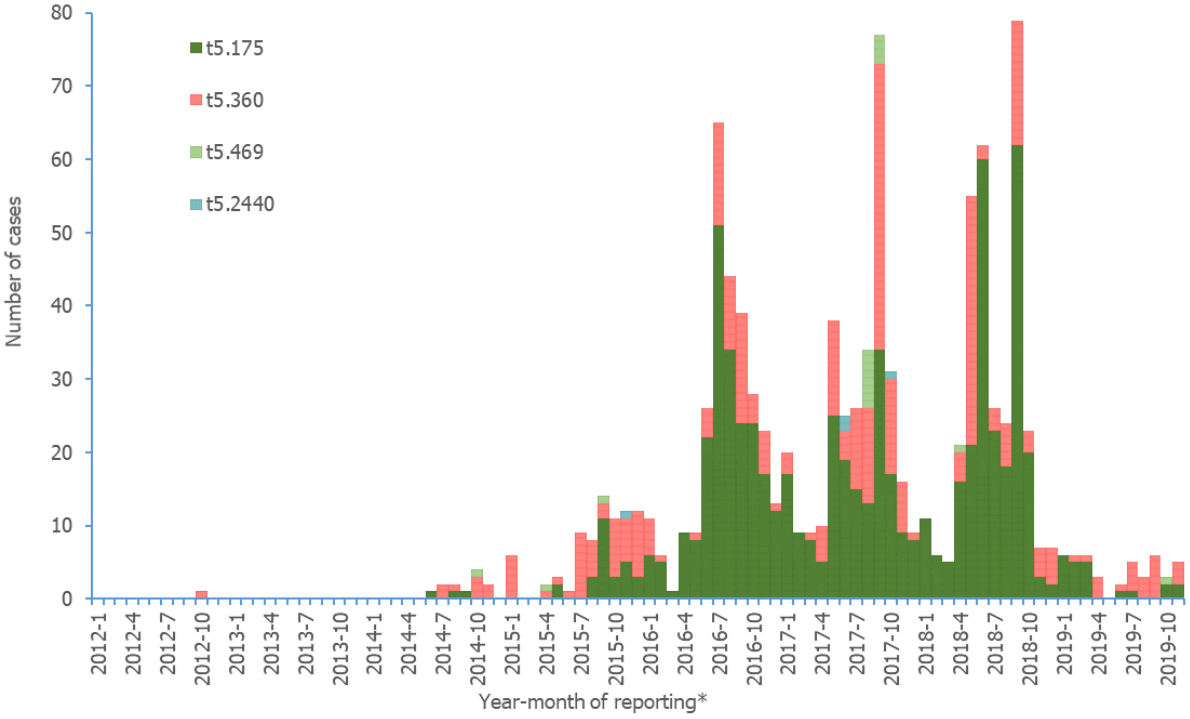
Two thirds of the 656 confirmed cases reported since 1 February 2017 belong to WGS t5.175 (432 cases), isolates belonging to t5.360 are about a third (207 cases), whilst the isolates belonging to t5.469 and t5.2440 add up together to about 3% of the confirmed cases (17 cases, of which 14 belonging to t5.469 and three to t5.2440 - Figure 2).

Figure 1. Distribution of outbreak cases by month and case definition, EU/EEA, January 2012 to November 2019 (n=1 656, one confirmed and one historical probable case missing the data of the month of reporting), as of 14 January 2020



**: month of sampling or month of receipt by the reference laboratory if month of onset is not available.*

Figure 2. Distribution of outbreak confirmed and historical confirmed cases by month and genetic cluster, EU/EEA, January 2012 to November 2019 (n=1 041; one case infected with t5.175 missing the data of the month of reporting), as of 14 January 2020



**: month of sampling or month of receipt by the reference laboratory if month of onset is not available.*

Most isolates from confirmed cases with available information on MLVA profile (n=82) have MLVA profile 2-9-7-3-2 (n=61). Five of the remaining 21 isolates had MLVA profiles corresponding to the outbreak case definition: 2-9-10-3-2 (n=3) and 2-9-6-3-2 (n=2). The remaining 16 isolates from confirmed cases have MLVA profiles not included in the EU outbreak case definition: 2-10-7-3-2 (n=12), 2-9-8-3-2, 2-8-00-3-2, 3-10-5-4-1 and 3-11-6-5-1 (1 case each). Although rather common among outbreak-confirmed cases, the MLVA type 2-10-7-3-2 was not included in the case definition because of low discriminatory power.

The most common MLVA profile for the 202 probable cases is profile 2-9-7-3-2 (n=129), followed by 2-10-6-3-2 (n=41), 2-10-8-3-2 (n=19), 2-9-6-3-2 (n=9), 2-11-8-3-2 (n=3) and 2-9-10-3-2 (n=1).

Information on travel history within a specific EU/EEA country was available for 45 outbreak cases, of which 24 were confirmed and 21 probable since February 2017. Bulgaria (11 confirmed and three probable cases), Poland (eight confirmed and four probable) and Greece (11 probable) were the most often reported countries of probable infection among cases with documented travel history. In addition, Germany, Hungary, Portugal, Spain and the United Kingdom were also reported as countries of probable infection among the remaining cases with a travel history.

Information from patient interviews

Information on patient interviews and other epidemiological investigations implicating eggs as the vehicle of infection for cases as well as outbreaks of *S.* Enteritidis matching the outbreak strains is presented in ECDC rapid risk assessments and ECDC-EFSA joint rapid outbreak assessments published before 2018.

The United Kingdom reported a cluster of nine confirmed cases occurring in September 2018 that was linked to an outbreak associated with drinking of a ready-to-eat shelf-stable liquid egg white product. Exposure information was available for seven of the nine cases, all of whom reported drinking liquid egg whites, and five of whom reported drinking the outbreak-associated brand. Patient interviews from two Irish cases occurring in the same period, showed that one of the two patients reported consumption of the liquid egg white product, while information was not available for the second case.

In April 2019, the United Kingdom also reported lack of evidence of any significant change in the frequency of reported egg or chicken exposures in trawling questionnaires between 2016, 2017 and 2018.

Microbiological and food and environmental investigations

This section summarises the results of the analytical and traceability investigations of food products -i.e. eggs and ready-to-eat (RTE) egg products - shared by countries since January 2018 under the RASFF notification number 17-836 (from fup17 onward), 2018.2615 and 2018.3424, last accessed on 23 January 2020. All the results of the analytical and traceability investigations of food products performed before January 2018 are summarised above in chapter 'Event background'.

United Kingdom

Investigation of human cases in the United Kingdom linked to consumption of eggs in catering premises

Following the re-emergence of new cases in 2018, the Food Safety Authority of the United Kingdom reported a summary of the national investigation in RASFF 17-836 (*fup136*). Six catering premises and one nursery (British Premise A, British Premise B, British Premise C, British Premise D, British Premise E, British Premise F and British Premise G) were identified in 2018 where at least two human cases (infected with *S.* Enteritidis of either t.175 or t.360 SNP addresses) reported eating food at the same premises. Food and/or environmental samples were taken from three of these premises as part of routine sampling and outbreak investigation procedures. In 2018, no food or environmental samples taken at these premises were positive for *S.* Enteritidis.

Trace-back investigation identified two wholesalers based in England (British Wholesaler A and British Wholesaler B) delivering eggs to the suspected British catering premises. In 2018, these wholesalers sourced eggs from multiple packing centres from Poland, United Kingdom and Spain:

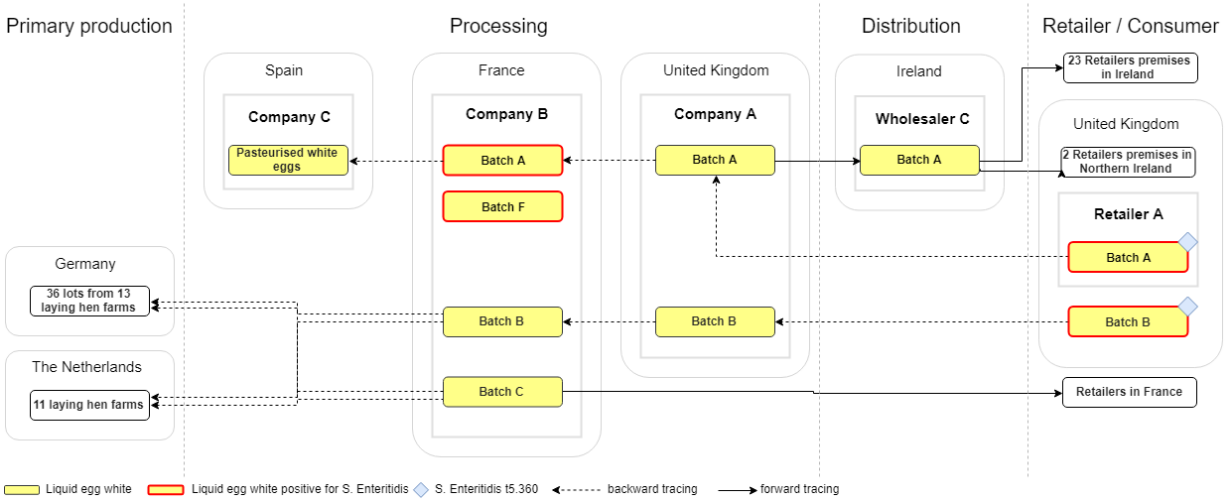
- Two Polish Packing Centres: B and C. All the eggs from the Polish Packing Centre B and the Polish Packing Centre C, that were supplied in 2018 to the four suspected British premises (A, B, C and E), were purchased through the German Broker A. Eggs originated from a total of 10 Polish Laying Hen Farms (A, D, E, F, H, I, J, M, O, P), all belonging to the Polish Consortium A. Out of these 10 farms, five were positive for one of the two outbreak clones in the period 2018–2019 (t5.175 and t5.360; see Table 2). In addition, traceability analysis performed by the Polish Food Competent Authority identified that the Polish Laying Farm L, positive for the outbreak strain t5.175, delivered eggs to several premises in the United Kingdom. However, none of these premises were linked to known human cases (*fup121, fup136*).
- Five British Packing Centres: I, J, K, L, and M (*fup136*). These packing centres delivered eggs in 2018 to the two British Wholesalers A and B. Eggs originated from several British Laying Hen Farms. Information on the *Salmonella* status of the aforementioned British Laying Hen Farms providing eggs to the implicated Catering Premises was not available in RASFF, but during the national investigation in the UK, it was confirmed that the farms were compliant with the requirements of the *Salmonella* control programme. To date, there are no reports of poultry farms in the United Kingdom that are positive for the *S.* Enteritidis genotypes matching the outbreak strains (i.e. t5.175, t5.360, t5.469 and t5.2440).
- One Spanish Packing Centre: N. The Spanish packing centre provided eggs to the British Wholesaler B. Eggs originated from the Spanish Laying Farm AD. The Spanish Competent Authority informed that in 2018 no *Salmonella* was detected from the Spanish Laying Farm AD or from the packing centre (*fup136*).

Investigation of an outbreak in the United Kingdom linked to consumption of ready-to-eat liquid egg white products

In September 2018, a cluster of nine confirmed t5.360 cases was confirmed to be associated with the consumption of a RTE raw liquid egg-white drink distributed by the British Company A (RASFF 2018.2615, *fup5*). Exposure information was available for seven of the nine cases, all of whom reported drinking liquid egg white, and five of whom reported drinking the outbreak-associated brand product (*fup5*). The Food Competent Authority of the United Kingdom notified about *Salmonella*-positive samples of RTE liquid eggs white from Batch A, taken from the British Retailer A, and from Batch B, taken from the recalled product, both sold by the British Company A (*fup1*). As communicated in ECDC EPIS (UI-367) by the Public Health Authority in the United Kingdom, isolates of *S.* Enteritidis from the batches of liquid eggs clustered with the t5.360 outbreak cluster (information not available in RASFF 2018.2615). Both batches were produced by the French Company B and subsequently delivered to the British Company A:

- **Batch A** was produced with raw materials (i.e. pasteurised white egg, *fup10*) originating from the Spanish Company C and underwent a second thermal treatment at the French Company B (*fup3*). The Spanish Food Authority reported on the outcome of an official control done in June 2018 at the Spanish Company C (*fup11*). During the inspection, the process of pasteurisation of egg white products was verified to be compliant according to the HACPP (Hazard Analysis and Critical Control Point) plan (56.5 °C/7.50 min; compliant check of pasteuriser A). The egg white products were packaged in sterile bags prior to shipment to the French Company B and microbiological analysis that were done on the final products revealed the absence of *Salmonella* and other bacteria (*fup11*). Analyses performed during an own check control at processing level (French Company B) showed the presence of *S.* Enteritidis (*fup8*) in Batch A and in another batch, Batch F (*fup8*) produced the same day of Batch A. Bottles of Batch F still present at the producer premises were destined for destruction (*fup13*). The British Company A delivered several units of Batch A to the Irish Wholesaler C which further distributed it to 23 and two retailer premises in Ireland and Northern Ireland, respectively. On September 2018, the British Company A and the Irish Wholesaler C initiated the recall of Batch A.
  On the working day before the day of production of the contaminated Batch A, Batch E of liquid eggs was produced at the French Company B with eggs supplied by the Polish Packing Centre B and the Polish Packing Centre C from farms of the Polish Consortium A: Polish Laying Farm AB, Polish Laying Farm M and Polish Laying Farm F. The French Competent Authority notified that there was no possibility of cross-contamination between Batch E and Batch A since cleaning/disinfection records were compliant. Moreover, the analytical details showed no *Salmonella* positive status of the delivered egg products from Poland (*fup31, fup41*).
- **Batch B** was produced by the French Company B with raw materials originating from 13 German laying hen farms (total of 36 lots) and 11 Dutch laying hen farms (*fup10, fup30*). The German Food Authority informed that all samples (own-check and official control) collected in 2018 at the 13 farms providing eggs to the French Company B tested negative for *Salmonella* (*fup34*). Similarly, the Dutch Food Authority informed that the Dutch laying hen farms supplying eggs to the French company B were negative for *Salmonella* in the relevant period. Batch C was produced by the French Company B with the same raw materials and on the same day as Batch B but distributed only in France. Batch B was recalled by the British Company A (*fup5*) and a public warning was issued.
  On the same working day as production of the contaminated Batch B, a different batch of liquid eggs (Batch D) was produced at the French Company B with eggs supplied by the Polish Packing Centre B from Polish Laying Farm AB belonging to the Polish Consortium A. The French Competent Authority notified that there was no possibility of cross-contamination between Batch D and Batch B due to the different production line used (with different equipment: tanks, filling machine, etc.) and because the heat treatment was done on packaged products. Moreover, the cleaning/disinfection records were satisfactory for that day and the analytical details showed no *Salmonella* positive status of the delivered egg products (*fup31, fup41*).

Figure 3. Traceability analysis of the positive ready-to-eat liquid egg white batches



The Polish Competent Authority notified (17-836; 2018.2615) the *Salmonella* status of both packing centres and the farms delivering eggs to the French Company B in RASFF:

- At the Polish Packing Centre B and the Polish Packing Centre C official swab samples collected in 2017 were *Salmonella* negative. In 2018 official samples were not taken.
- The Polish Laying Farm AB has had *Salmonella* free status since 20 February 2017. Since May 2018, the Polish Laying Farm AB also includes the premises of what was known as Polish Laying Farm N. Before 2017, the Polish Laying Farm N was positive for *S.* Enteritidis not matching the outbreak strain.
- At the Polish Laying Farm M company's own samples and official samples (i.e. faeces samples, swab samples) collected in 2017 and 2018 were *Salmonella* negative.
- At the Polish Laying Farm F the company's own samples collected in 2017 were *Salmonella* negative. However, official sample (faeces sample) collected in May 2017 from one henhouse was *S.* Enteritidis positive. Eggs from this henhouse were directed into processing and hens were slaughtered. In 2018 the company's own samples and official samples (faeces samples) collected at the Polish Laying Farm F were *Salmonella* negative.

The French Food Authority indicated that a reinforced cleaning and disinfection was applied on 24 September 2018 at the French Company B. The French authority notified in RASFF that a maintenance intervention at the French Company B on the cannula of the machine filling the bottles, without proper cleaning/disinfection afterwards, was suspected to have caused the contamination of Batch A and Batch B (*fup38*).

The French Food Authority informed (RASFF 2018.2615, *fup13*) that the French Company B initiated, on a voluntary basis and as precautionary measure, a withdrawal of many batches intended to be distributed to the United Kingdom and the Netherlands, although having satisfying results.

Investigation in the United Kingdom of cases related to travel to Cyprus

In addition to the British premises described above, investigations performed in the United Kingdom identified 14 cases with the SNP cluster address t5.175 travelling to Cyprus and staying in the same Cypriot Premise H between end of May and end of June 2018. Investigations performed by the Health Services of the Cyprus Ministry of Health confirmed that during the same period, the Cypriot Premise H received eggs from the Polish Laying Farm F through the Polish Packing Centre C and the Dutch Wholesaler D. In 2018, the Polish Laying Farm F was *Salmonella* negative.

Poland

Following the re-emergence of new cases and the results of the British, Cypriot and French national investigations concerning the egg supply chain of the implicated food business operators, the Polish Food Authority notified in RASFF (17-836; 2018.2615) the results on official controls and own-checks on farms belonging to the Polish Consortium A performed in 2018 and 2019 as well as the restrictive measures applied.

Between August 2018 and December 2019, seven out of the 13 sampled Polish Laying Hen Farms tested positive for *S.* Enteritidis and isolates from 13 henhouses clustered with the reference genomic clusters of t5:360, t5:175 or t5.469 (Table 2). The Polish Food Authority informed that in 2018, all but two farms delivered eggs to one of the implicated food business operators in the United Kingdom, Cyprus or France. In 2019, the seven positive farms distributed eggs to multiple food business operators in different EU countries through the two Polish Packing Centres (B and C), including Belgium, Bulgaria, Germany, the Netherlands, France, Poland and the United Kingdom.

Table 2. Summary of the sampling activity performed in 2018 and 2019 at 13 the Polish Laying Hen Farms positive for *S.* Enteritidis

Farm	Country of distribution in 2018/2019	Henhouse	Sample type	Type of control	Date of sampling	SE positive /total samples	SNP address
A	UK	na	na	O	2018	0/na	-
D	UK, BE, DE	3	Socks	O	14/11/2018	3/3	t5.360*
		2	Socks	O	19/11/2018	2/3	t5.360*
		56, 57, 58, 59, 60, 61, 62	Faeces and dust	O	05/12/2018	0/7	-
		63, 9, 64, 65	Faeces and dust	O	10/12/2018	0/7	-
		66, 67, 68, 18	Faeces and dust	O	11/12/2018	0/7	-
		9	Faeces and dust	O	24/04/2019	2/7	t5.175
E	UK	na	na	O	2018	0/na	-
F	UK, DE, NL, CY, FR	na	Faeces	O/W	2018	0/na	-
		6	Faeces and dust	O	30/04/2019	4/7	t5.4414
		5	Faeces and dust	O	01/05/2019	2/7	t5.6398
		17	Faeces and dust	O	01/05/2019	5/7	t5.469
G	FR, PL, DE	7	Faeces and dust	O	29/04/2019	1/7	t5.175
H	UK, PL	na	Faeces	O/W	2018	0/na	-
		8	Egg shell swabs	O	12/03/2019	1/157 (pool of 10)	t5:360*
		10	Egg shell swabs	O	11/03/2019	1/157 (pool of 10)	t5:360*
		8, 30, 69, 70, 71, 32, 72	Faeces	O	27/03/2019	0/3	-
I	UK, BG, DE, PL, RO	na	Faeces	O/W	2018	0/na	-
		11	Faeces and dust	O	23/04/2019	1/7	t5.175
		36, 34, 73, 35, 33	Faeces and dust	O	23/04/2019	0/7	-
J	UK	na	Faeces	O/W	2018	0/na	-
L	UK, BG, DE, PL, RO	89	Faeces and dust	O	24/04/2019	0/7	-
		12	Faeces and dust	O	24/04/2019	1/7	t5.175
M	UK, FR	na	Faeces	O/W	2018	0/na	-
O	UK, BE, FR, DE, PL, RO	74, 75, 76, 13, 77, 15, 78, 79	Socks	O	15/11/2018	0/3	-
		78, 79, 47, 82, 83	Faeces and dust	O	24/04/2019	0/7	-
		13	Faeces and dust	O	25/04/2019	1/7	t5:360
		14	Faeces and dust	O	25/04/2019	2/7	t5.175
		15	Faeces and dust	O	25/04/2019	1/7	t5.258***
		74, 75, 80, 76, 81, 77	Faeces and dust	O	25/04/2019	0/7	-
P	UK	50, 85, 51, 87, 88	na	O	28/11/2018	0/na	-
		84, 49, 86	na	O	12/12/2018	0/na	-
AB**	FR	na	na	O/W	2018	0/na	-

Legend: na: not available; -: not applicable; O: Official Control; W: Own-check; SE: Salmonella *Enteritidis; t5.175 = 1.2.3.18.175.175.%; t5.4414 = 1.2.3.18.455.4414.%; t5.469 = 1.2.3.18.455.469.%; t5.6398 = 1.2.3.18.175.6398.%; t5.360 = 1.2.3.18.359.360.%; t5.258 = 1.26.144.258.258.258.%*

**: typing information was provided by the Polish Food Authority through iRASFF and it was not confirmed by the Public Health England*

***: from May 2018 it includes also the Polish Laying Farm N.*

****: vaccine strain*

In bold the farms with at least one henhouse positive for the outbreak strains.

In the period from November 2019 to January 2020, all flocks belonging to the Polish Consortium A were tested with an expanded scheme in accordance with Regulation 2160/2003. *Salmonella* was never detected. In 2020 further increased sampling will be carried out in poultry flocks belonging to Polish Consortium A.

Based on the information provided by the Polish authorities (*fup76*), all hens in the farms of the Polish Consortium A were vaccinated for *S.* Enteritidis (before mid-2019, two doses of vaccine were administrated). Since mid-2019, the live attenuated vaccine is administered in drinking water at the age of one-day, 6 weeks and 12 weeks.

Control measures in the affected farms in the period 2016–2017

Restrictive measures were taken by the Polish Food Competent Authority since 20 October 2016. The restrictive measures consisted of banning the placement of table eggs originating from the positive flocks (as per the requirements of EU legislation) on the market and additionally, from the concerned Polish packing centres as a precautionary measure until comprehensive monitoring could demonstrate the absence of *Salmonella*.

The Polish Food Competent Authority reported that in 2016 and 2017 the *Salmonella* positive flocks were depopulated, and cleanings and disinfections were performed (RASFF 17-836 *fup137*). Specifically, on 38 henhouses of 16 affected Polish Laying Hen Farms (A, B, C, D, F, G, H, I, J, K, M, N, O, P, Q, and R) one disinfection after cleaning was carried out. In the case of three henhouses of three Polish Laying Hen Farms (L, M and E) two disinfections after cleaning were carried out. More than two disinfections after cleaning were carried out on two henhouses of the Polish Laying Hen Farms I and E. Feeders and drinkers were disinfected, and pest control was carried out in all farms. New pullets were introduced after the culling of *Salmonella*-positive flocks and the cleaning and disinfection of the poultry henhouses, all under the supervision of the Polish Competent Authority. Houses were unpopulated for a period shorter than six weeks for 34 henhouses of 16 Polish Laying Hen Farms (A, C, D, E, F, G, H, I, J, K, L, M, N, O, P, and Q). For nine henhouses of six 6 Polish Laying Hen Farms (B, F, G, H, M and R) the culling period was six weeks or longer. Following the above-mentioned cleanings and disinfections, the Polish Competent Authority carried out official controls in the affected farms. A total of 38 henhouses from 16 farms were tested once, five henhouses from four farms were controlled twice or three times after the completion of cleaning and disinfection procedures. At each control, four to five samples were collected. None of these official samples collected after cleaning and disinfection tested positive for *S.* Enteritidis.

Control measures in the affected farms in the period 2018–2019, including recall and withdrawal of eggs from positive farms

According to data received from the Polish Food Authority (RASFF 17-836; *fup137*), following the isolation of *S.* Enteritidis at farm level, affected farms proceeded to pasteurisation of eggs from positive henhouses. This measure was taken in the period 2018–2019 and notified in RASFF for the Polish Laying Hen Farms D, I and L (*fup46, fup104* and *fup107*). In addition to pasteurisation, eggs from positive flocks were also destroyed if these were within 27 and 28 day of their use-by date, if the use-by date had already been exceeded or if the eggs were broken.

In the period 2018–2019, a total of 10 positive henhouses (13, 14, 2, 3, 9, 7, 5, 17, 89 and 11) from six Polish Laying Hen Farms (D, F, G, I, L and O) were depopulated, and cleaning and disinfection of the henhouses were performed. In all henhouses, culling period after cleaning and disinfection was shorter than six weeks (details are available in Table A1, Annex 1. On 30 January 2020 the Polish Competent Authority informed that all the *Salmonella* Enteritidis positive flocks belonging to the Polish Consortium A were depopulated, including flocks found positive in May 2019, i.e.: Laying Hen Farm G henhouse 7; Laying Hen Farm F henhouses 6, 17 and 5; Laying Hen Farm I henhouse 11; Laying Hen Farm L henhouse 12; Laying Hen Farm O henhouses 13, 15 and 14; Laying Hen Farm D henhouse 9 (*fup145*).

According to data received from the Polish Food Authority (*fup137*), eggs from positive henhouses of affected farms still on the market and/or not yet consumed were withdrawn from the market and recalled from consumers. Specifically, in the period 2018–2019 three recall/withdrawal actions were notified in RASFF by the Polish Food Authority:

- Upon identification of positive eggshell swabs from two batches of eggs originated from the Polish Laying Farm H (henhouses 8 and 10), a recall of these batches was notified on 29 April 2019. However, since samples collected afterwards in the henhouses 8 and 10 of Farm H did not reveal the presence of *Salmonella*, the veterinary inspector did not request withdrawal of other batches that originated from these henhouses of Farm H (Table 2).
- On 30 April 2019, the Polish Food Authority ordered the withdrawal from the market of all table eggs from henhouse 11 of the Polish Laying Farm I and from henhouse 12 of the Polish Laying Farm L which have been placed on the market since 23 and 24 April 2019, respectively.
- On 09 May 2019, the withdrawal from the market of eggs from henhouse 7 of the Polish Laying Farm G was notified.

In addition, the Romanian Food Authority notified that in January 2019, three supermarket chains in Romania had started the withdrawal from the market of all eggs from Polish farms of the Polish Consortium A (*fup52, fup62*).

Overview of isolation of *Salmonella* Enteritidis matching the outbreak strains from the implicated Polish laying hen farms in the period 2015–2019

Along the food chain the common points between the food business operators involved in the national investigations since 2015 and the operators acting in the primary production in Poland are the Polish Packing Centre B and the Polish Packing Centre C. From 2016 to 2019, a total of 19 Polish laying hen farms delivered eggs to these two packing centres. The *Salmonella* status of these farms in the period 2015–2019, including the SNP addresses, is summarised in Table 3. The genomes of the *S.* Enteritidis isolates from samples collected at the *S.* Enteritidis positive farms identified in the ECDC-EFSA joint ROA published on 7 March 2017 were shared in February 2018 (RASFF 16-824, *fup111-112*), after the publication of the ROA.

In the period 2015–2019, 16 laying hen farms, 13 of which belonged to the Polish Consortium A, were found to be positive for at least one of the four SNP addresses causing human infections (i.e. t5.175, t5.360, t5.469 and t5.2440; Table 3). A total of 50 henhouses were sampled within the 16 farms, two of which were sampled twice. Seven farms (D, F, H, I, L, M and O) were positive to two or more different outbreak clones over the time.

Two farms (A and K) were *S.* Enteritidis positive at least once in the period 2015–2019, but the isolates never matched the outbreak clusters; the farm AB was always found *Salmonella* negative in the period 2015–2019.

Table 3. Distribution of WGS types of *Salmonella* Enteritidis clones matching the outbreak strains in Polish laying hen farms in the period 2015-2019

FARM	Part of the Polish Consortium A	2015	2016		2017	2018	2019	
A	yes							
B	no		**t5.175**					
C	yes		**t5.175**					
D	yes		**t5.175**			**t5.360$**	**t5.175**	
E	yes		**t5.175**					
F	yes		**t5.175**	**t.2440**			**t.469**	
G	yes		**t5.175**				**t5.175**	
H	yes	**t5.175***	**t5.175**				**t5.360$***	
I	yes		**t5.175**	**t5.360**			**t5.175**	
J	yes		**t5.175**					
K	no							
L	yes		**t5.360***				**t5.175***	
M	yes		**t5.175**	**t.469**				
N	no		**t.2440**					
O	yes		**t5.175**	**t5.360**			**t5.175**	**t5.360**
P	yes		**t5.175**					
Q	no		**t5.175**					
R	yes		**t5.175**					
AB^	yes							

The table summarises the information provided by the competent authority; empty cells do not indicate negative Salmonella *status. Grey cells indicate that the farm was closed or merged with another one.*
** Same sampled and tested henhouse. ^ from May 2018 it includes also the Polish Farm N; $: typing information was provided by the Polish Food Authority through iRASFF and it was not confirmed by the Public Health England.*
t5.175 = 1.2.3.18.175.175.%; t5.4414 = 1.2.3.18.455.4414.%; t5.469 = 1.2.3.18.455.469.%; t5.6398 = 1.2.3.18.175.6398.%; t5.360 = 1.2.3.18.359.360.%; t5.258 = 1.26.144.258.258.258.

In order to investigate the possible origin of *Salmonella* contamination of the 16 Polish Laying Hen Farms positive for the outbreak strains, the feed supply chain as well as the origin of the animals up to parent stocks were investigated. The Polish Food Authority has been asked to provide information for the period 2016–2019 on feed suppliers, and data on parent stocks, hatcheries and rearing farms delivering the animals to the implicated laying hen farms.

Feed supply chain of the Polish Laying Hen Farms found positive for the outbreak strains

According to data received from Polish authorities (RASFF 17-836; *fup137*), the 16 affected farms have received feed from three Polish Feed Suppliers (A, B and C) in the period 2016–2019. Throughout this period, each farm received feed from the same supplier.

- The Polish Feed Supplier A provided feed to 14 of the implicated Polish Laying Hen Farms all belonging to the Polish Consortium A (C, D, E, F, G, H, I, J, L, M, N, O, P, R).

After detection of *S.* Enteritidis in henhouses 2 and 3 of Farm D in 2018, two official feed samples were collected from the Polish Feed Supplier A in November 2018 in accordance with the 'National Program for the eradication of certain *Salmonella* serotypes in flocks of laying hens of *Gallus gallus* for the presence of *Salmonella*'. *Salmonella* was not detected in these samples.

- The Polish Feed Supplier B provided feed to the Polish Laying Hen Farm B
- The Polish Feed Supplier C delivered feed to the Polish Laying Hen Farm Q.

Rearing facilities, hatcheries and parent stocks linked to the Polish Laying Hen Farms found positive for the outbreak strains

According to data received from Polish authorities (RASFF 17-836; *fup137*), in the period from March 2015 to March 2019, 76 deliveries of pullets/young hens were done to the 16 Polish laying hen farms contaminated with the outbreak strains from 15 Polish rearing farms (D, F, O, Q, S, T, U, V, W, X, Y, Z, AA, AE and AF). Ten of the 15 rearing farms (D, F, O, S, T, U, V, W, Y and AA) belong to the Polish Consortium A. The Polish Rearing Farm T accounted for the highest number (27) of deliveries of animals between April 2015 and March 2019 to ten positive Polish laying hen farms.

In total four rearing farms (D, F, O and Z) were found positive for *S.* Enteritidis in the period January 2017- July 2019 (Table 4).

- The Polish Rearing Farms D, F and O belong to the Polish Consortium A and are also laying hen farms that are positive for the outbreak clones. In the period May 2015 – January 2019, these three Polish Rearing Farms delivered animals to a total of six positive Polish laying hen farms (Table 4). No information on the typing is available for the isolates obtained from these rearing farms.
- the Polish Rearing Farm Z delivered animals to two positive Polish laying hen farms in the period May 2015 – January 2019 (Table 4). cgMLST Analysis performed at the European Reference Laboratory (EURL)-*Salmonella* revealed that the *S.* Enteritidis isolate originated from this rearing farm has several allelic differences (> 30) to any of the four outbreak strains.

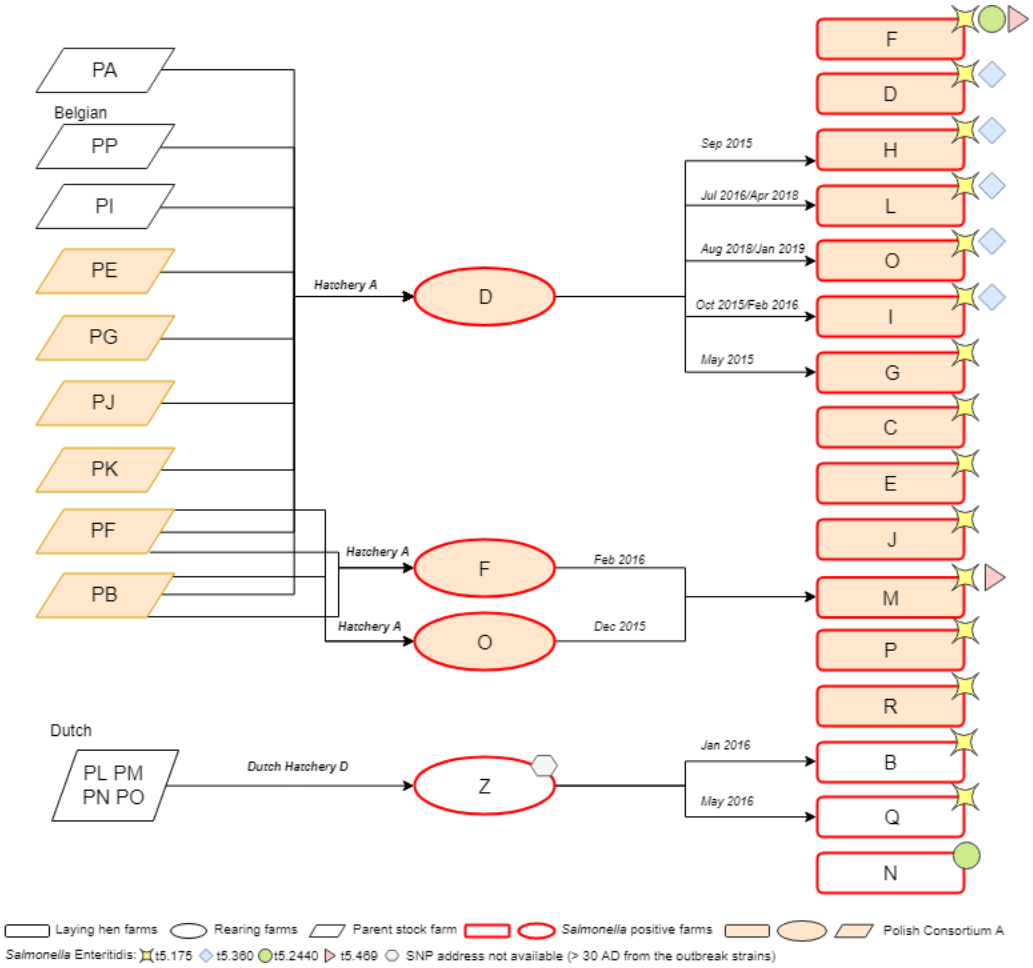
Figure 4 shows the animal trace back and trace forward supply chain (from parent stocks to laying hens farms) for the *Salmonella*-positive Polish Rearing Farms.

Table 4. Deliveries from *S.* Enteritidis-positive Polish Rearing Farms

Rearing Farm	Date of delivery	Laying Farm	SNPs addresses detected in Laying Hen Farms (2015-2019)
D	May 2015	G	t5.175
	Sept 2015	H	t5.175/t5.360*
	Oct 2015	I	t5.175/t5.360
	Feb 2016		
	Jul 2016	L	t5.175/t5.360
	Apr 2018		
	Aug 2018	O	t5.175/t5.360
	Jan 2019		
F	Feb 2016	M	t5.175/t5.469
O	Dec 2015		
Z	Jan 2016	B	t5.175
	May 2016	Q	t5.175

**: typing information was provided by the Polish Food Authority and it was not confirmed by the Public Health England*

Figure 4. Animal supply chain (from parent stocks to laying hens farms) for the four positive Polish Rearing Farms, 2015-2019*.



** Otherwise stated all the farms included in the figure are from Poland*

In total **two Polish Hatcheries** (A and B) and **two Dutch Hatcheries** (C and D) supplied chicks to the 16 affected farms.

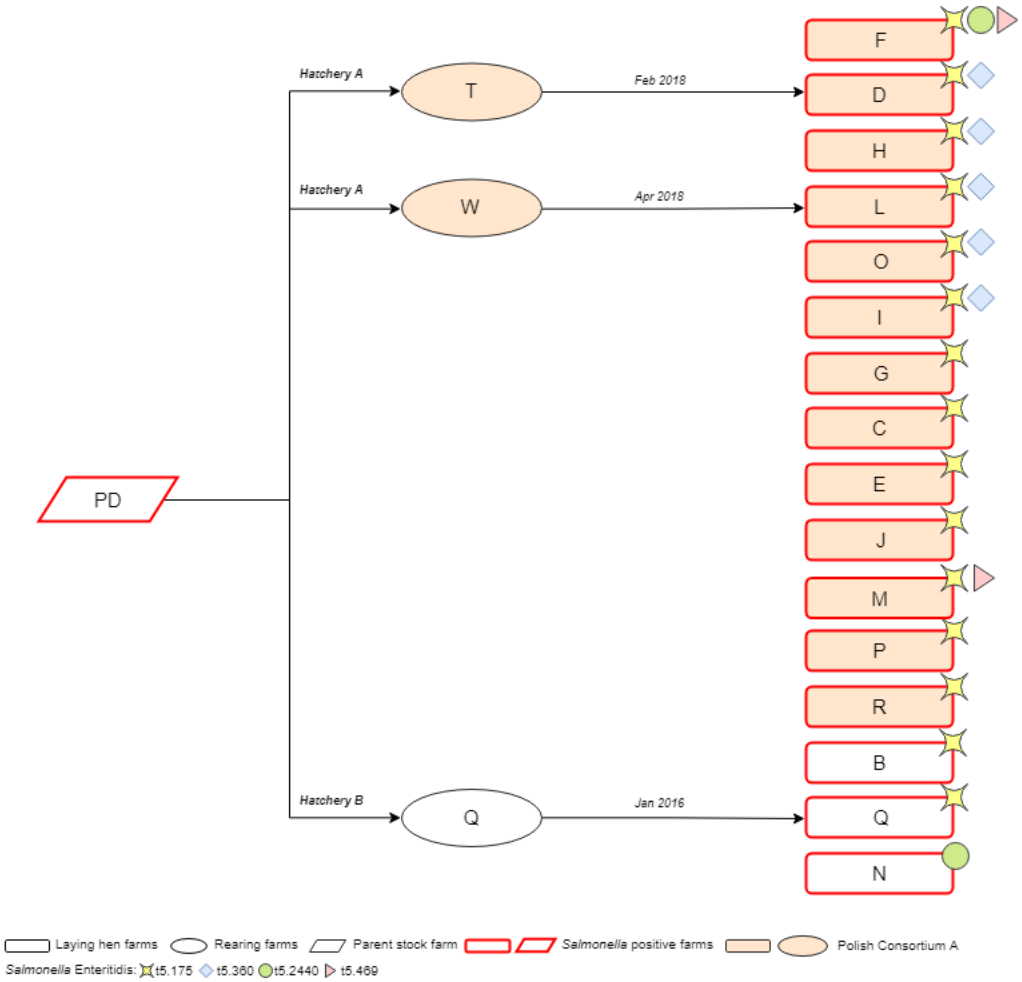
- The Polish Hatchery A belonging to the Polish Consortium A supplied chicks to 13 Polish rearing farms (including *S.* Enteritidis-positive Rearing farms D, F, O) which in turn delivered pullets to all the affected Polish laying hen farms at least once.
- The Polish Hatchery B supplied chicks to the Polish Rearing Q and Laying Hen Farm Q.
- The Dutch Hatchery C supplied chicks to the *S.* Enteritidis positive Rearing Farm Z which in turn delivered pullets to the Polish Laying Hen Farm B.
- The Dutch Hatchery D supplied chicks to the *S.* Enteritidis positive Rearing Farm Z which in turn delivered pullets to the Polish Laying Hen Farm Q.

Trace back information on parent stock farms have been provided only for 15 affected laying hen farms in the period January 2017 – July 2019. For farm B, the parent stock origin of the laying hens was not reported. A total of **11 Polish parent stocks** (PA, PB, PC, PD, PE, PF, PG, PH, PI, PJ and PK) and the Belgian parent stock farm PP delivered eggs to the two Polish Hatcheries A and B.

- Six (PB, PE, PF, PG, PJ and PK) of the 11 Polish parent stocks belong to the Polish Consortium A.
- Out of the 156 deliveries reported in total, 130 deliveries come from these parent stocks belonging to the Polish Consortium A.
- The Polish Parent Stocks PD has been found positive once for *S.* Enteritidis in the period January 2017-July 2019. However, cgMLST analysis performed at EURL-*Salmonella* revealed that the *S.* Enteritidis isolate originated from this farm has several allelic differences (> 30) compared with any of the four outbreak strains. This parent stocks farm delivered eggs to both Polish Hatcheries (A and B) which supplied animals, through three Polish Rearing Farms (Q, W and T), to the Polish Laying Hen Farms D, L and Q (Figure 5).

In addition to the Polish Parent Stock Farms, four Dutch Parent Stock (PL, PM, PO and PN) supplied eggs to the Dutch Hatchery D.

Figure 5. Forward traceability supply chain (from eggs to laying hens) for the positive Parent Stocks D 2015-2019



Germany

Following the call for data launched by EURL-*Salmonella*, the German Food Authorities reported on the presence of 11 isolates from the NRL-*Salmonella* database - five in 2017, two in 2018 and four in 2019 (RASFF 17-836, *fup*140, *fup*141, *fup*143) closely related to the outbreak strains. In January 2020, PHE confirmed that all the sequences matched the representative outbreak strain with SNP address 1.2.3.18.175.175.%. The isolates originated as follows:

- One isolate derived from a dust sample collected 3 March 2017 at the German broiler farm AT. The day-old chicks originated from the Dutch Hatchery E.
- Three isolates derived from three environmental samples (i.e. slug, racoon faeces and boot swab) collected in 2017 in the frame of own-check controls from the same German broiler breeding parent holding farm PQ. This farm delivered eggs to the German Hatchery F. Between 8 and 14 June 2017 a total of 342,000 hatching eggs arriving at the German Hatchery F from the German breeding parent holding farm PQ were destroyed and disposed.
- One environmental own-check sample collected in 2017 in the surroundings of the German Hatchery F premises was found positive for *S.* Enteritidis and confirmed in January 2020 by PHE to match SNP address t5.175. The German Hatchery F is closed since 11 August 2018. The competent veterinary and food control authority has informed that *S.* Enteritidis haven't occurred or haven't been officially notified in 2017, neither in the German Hatchery F nor in the adjacent poultry slaughterhouse.
- The two 2018-isolates collected in the frame of own-check controls on 17 May and on 13 September 2018 originated from faeces/boot swabs and faecal samples, respectively, taken at the German laying hen Farm AR and the German laying hen Farm AS.
- All the four isolates collected in 2019 originated from environmental samples (boot swabs) collected from the same German laying hen farm AU and AK, belonging to the German consortium B, whose chicks were reared at the German rearing farm AT. On 12 July, animals were sent to the abattoir. The eggs of the German laying hen farms AU and AK were consequently destined to processing or destruction.

In 2018 the German laying hen farms of the German Consortium B delivered eggs to the German Packing Centre O that sourced eggs to the French Company B. These eggs were part of the 36 German egg lots used to produce the Batch B of RTE liquid white egg which was found to be positive for the t5.360 outbreak strain. In 2018, egg (own check) and environmental samples (socks) (official control) tested negative for *Salmonella* (2018.2615, fup24).

European whole genome sequencing analysis of human and non-human isolates

ECDC requested Member States public health laboratories submit isolate sequences from suspected outbreak cases for joint analysis and centralised case confirmation. Member States were asked to select isolates with close genetic distance to the outbreak representative sequences using national WGS pipelines. For *S.* Enteritidis isolates of MLVA types 2-9-7-3-2, 2-9-6-3-2, 2-9-10-3-2, 2-10-6-3-2, 2-10-8-3-2 and 2-11-8-3-2 but with no sequence data available, ECDC offered WGS support through the ECDC's laboratory contractor.

Similarly, the EURL-*Salmonella* requested National Reference Laboratories (NRL) at Member States to submit sequences of isolates with close genetic distance to the outbreak representative sequences using national WGS pipelines or with MLVA types 2-9-7-3-2, 2-9-6-3-2, 2-9-10-3-2, 2-10-6-3-2, 2-10-8-3-2 and 2-11-8-3-2. Moreover, the EURL-*Salmonella* requested the NRL of Poland to submit for joint analysis and typing confirmation all the sequences of the isolates for which information have been shared in iRASFF 17-836, 2018.2615 and 2018.3424.

Sequences were submitted to PHE who used their in-house SNP-based WGS pipeline (PHENix and SnapperDB) for final case confirmation [1-3].

Within the WGS clusters, the maximum SNP distance is 20 SNPs within t5.175, 103 SNPs within t5.360, 7 SNPs within t5.2440 and 17 SNPs within t5.469. The large variability within the t5.360 is due to some isolates in the cluster carrying an insertion with most of the SNP diversity in the cluster occurring within this region. The minimum SNP difference between the two larger clusters, t5.175 and t5.360, is 61 SNPs. There is a minimum SNP distance of 24 SNPs between t5.360 and t5.469 and a minimum of 25 SNPs between t5.360 and t5.2440. Altogether, the four clusters fall within a 25-SNP single linkage cluster. Isolates from confirmed cases reported in 2018 and 2019 are distributed over most part of the phylogeny of collected isolates of the t5.175 and t5.360 clusters.

Disease background

Disease characteristics

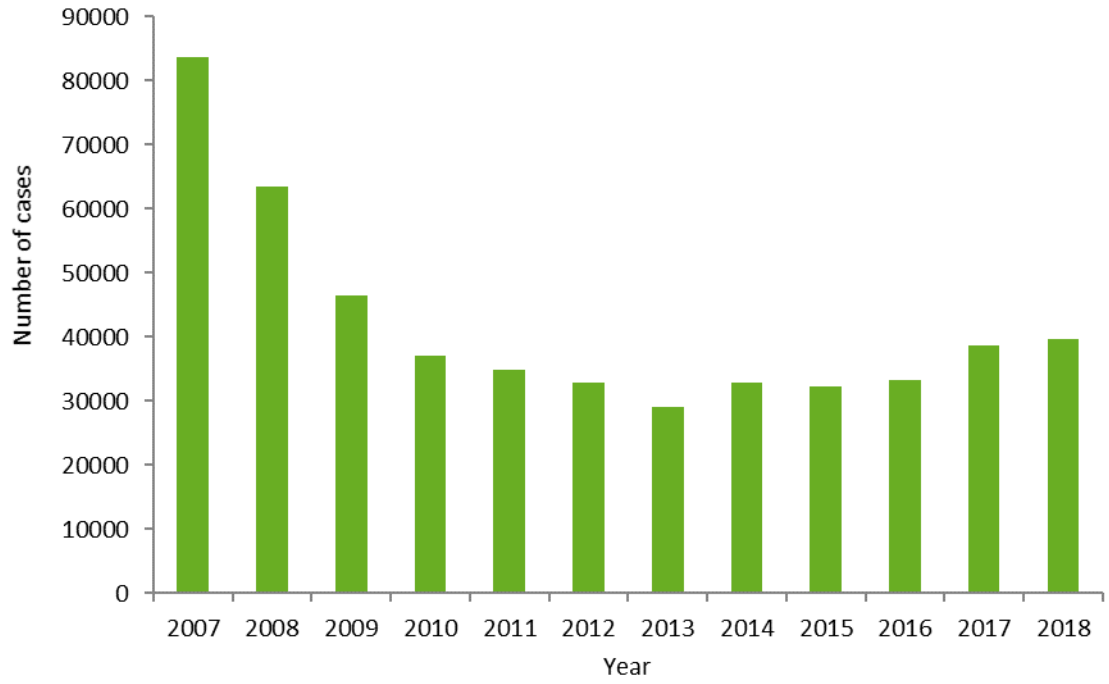
Background information about salmonellosis can be found in disease fact sheets from ECDC, CDC and WHO [13-15].

Disease surveillance for salmonellosis in the EU

Salmonella Enteritidis isolations in humans

From 2007 to 2018, 504 665 cases of *S.* Enteritidis were reported to The European Surveillance System (TESSy) (mean number of cases per year 42 055, range 29 089 to 83 756) by 29 countries, with Germany and the Czech Republic reporting together almost 50% of all cases. The median age for all cases with information available was 28 years (IQR: 5-49 years), 52% (n=256 702) were female, and 90% (n=384 125) of infections were acquired in the reporting country. Reporting dates were distributed over the year, with a peak from July to September (Figure 6) [14].

Figure 6. Number of confirmed cases of *Salmonella* Enteritidis by year, EU/EEA, TESSy 2007–2018



Salmonella Enteritidis MLVA profiles in TESSy

EU/EEA-wide collection of *S.* Enteritidis MLVA data into TESSy using a validated scheme started in June 2016 [8]. As of 12 December 2019, 11 countries have submitted MLVA data for *S.* Enteritidis, including 250 *S.* Enteritidis isolates with the MLVA profile 2-9-7-3-2, the main MLVA type associated with this outbreak. In addition, 214 isolates with the outbreak-associated MLVA types (2-9-6-3-2, 2-9-10-3-2, 2-10-6-3-2, 2-10-8-3-2 and 2-11-8-3-2) have been reported. Altogether, these isolates constitute 7.2% of the total number of isolates with MLVA characterisation data submitted to TESSy.

Food-borne outbreaks caused by *Salmonella* Enteritidis

In EU, during 2015-2018, the annual number of reported strong-evidence food-borne outbreaks by 'eggs and egg products' increased significantly. The increase was particularly important in Italy, Poland, Slovakia and Spain.

In 2018 'eggs and egg products' ranked first as food vehicle incriminated in strong-evidence food-borne outbreaks (n=143) and were reported in one of five strong-evidence outbreaks (n=709, 13.8% of all reported outbreaks). 'Eggs and egg products' also ranked first in four Member States (Italy, Poland, Slovakia and Spain). Overall, the number of illnesses in these egg-borne outbreaks with strong evidence increased importantly in 2018 compared with 2017 (+1,044 cases; 101% increase).

Disease outbreaks by consumption of 'eggs and eggs products' were almost exclusively caused during 2018 by *Salmonella*. This agent/food pair was responsible for the highest numbers of strong-evidence food-borne outbreaks, of illnesses and of hospitalisations. Still, salmonellosis egg-borne outbreaks were observed in less than half of Member States reporting strong-evidence outbreaks (10 out of 22 Member States) and it were three Member States (Poland, Slovakia, Spain) that accounted for 74.8% of salmonellosis egg-borne outbreaks in the EU [15].

Occurrence of *Salmonella* Enteritidis in egg and egg products and in food-producing animals

Regarding general occurrence monitoring data, overall 23 (0.37%) of the 6 252 tested table egg units reported by 13 Member States for the year 2018 were *Salmonella*-positive and the positive eggs were reported by Bulgaria, the Czech Republic, Italy, Poland, Portugal, Slovakia, Spain and Romania. Nine Member States (Austria, Bulgaria, the Czech Republic, Germany, Greece, Poland, Romania, Spain, Sweden) reported together results of 880 egg products sampling units. Thirty-one (3.52%) were *Salmonella*-positive and were all reported by Romania.

Overall, for the year 2018, Member States reported a total of 16 438 serotyped *Salmonella* isolates from food and animals. *S.* Enteritidis was primarily associated with broiler sources (57.4% of the *S.* Enteritidis isolates were from broiler flocks and meat) and secondly with layers (37.4%). A marginal number of *S.* Enteritidis isolates was obtained from turkey (3.7%) sources.

In 2018, the prevalence of laying hen flocks that were positive for any of the two target serovars was 1.1% (413 flocks), and the situation remained unchanged compared with 2017. Six Member States (Croatia, Denmark, Estonia, Malta, Poland and Romania) did not meet their reduction target of maximum 2%. Croatia, Estonia and Poland also failed to reach their reduction target in 2016 and in 2017. The commonest reported target serovar was *S.* Enteritidis (0.86%), with 93 of the 312 positive flocks (29.8%) notified by Poland [15].

Risk assessment questions

This document provides an update of the assessment of the public health risk associated with a multi-country outbreak of *S.* Enteritidis, which has previously been epidemiologically and microbiologically linked to contaminated eggs from Poland, and can be characterised by at least six MLVA profiles and four clusters defined by WGS (PHE SNP analysis). This event has been described in the urgent inquiries UI-339 and UI-367 in ECDC EPIS-FWD. Results on analytical and traceability investigations of food products (i.e. eggs and RTE egg products) were shared by countries under the RASFF notification numbers 16-824, 2017.1419, 2017.0849, 17-836, 2018.2615 and 2018.3424. A large proportion of the cases under analysis have previously been presented in publicly available outputs produced by ECDC independently or in collaboration with EFSA from 2016 to 2018 [1,2,6,7,13-15].

ECDC and EFSA risk assessment for the EU/EEA

A multi-country outbreak of *S.* Enteritidis was confirmed by epidemiological and WGS analysis in seven EU/EEA countries in 2016. Cases genetically linked to the four distinct outbreak strains have been continuously identified since then. As of 14 January 2020, 18 EU/EEA countries have reported 1 656 cases, of which 656 were classified as confirmed, 202 as probable, 385 as historical-confirmed and 413 as historical-probable. This is the largest European *S.* Enteritidis outbreak reported in the literature [17].

In most countries, the number of cases found to be genetically linked to this outbreak (confirmed and historical-confirmed cases) is not only influenced by the incidence of the infection, but also by national laboratory practice and capacity. If not available at national level, ECDC has supported countries who have identified probable cases by MLVA with sequencing services for case confirmation. However, for about half of the Member States who are not routinely reporting MLVA or sequencing data to ECDC, the epidemiological situation of this outbreak remains unknown. The true extent of this outbreak is likely under-estimated. Information on the travel history of some outbreak cases point at transmission occurring in countries not yet performing molecular typing and therefore without the capacities to detect outbreak cases.

From 2016 to 2018, more than 370 new outbreak cases were reported annually, with large seasonal increases from May to October. The frequency of new cases strongly decreased in 2019, with almost no observed increase between May and October. Due to the delay in reporting and sequencing, it is likely that more cases will be reported for 2019 in the coming months, but it is still expected that the number of 2019 cases will be substantially lower than in the previous three years, at least in those EU/EEA countries that report molecular typing data to ECDC.

The close genetic relatedness of the isolates from the confirmed and historical confirmed cases suggests common sources of infection. The temporal distribution of cases indicates a prolonged outbreak taking place in the EU/EEA in the last years. Isolates from confirmed cases reported in 2018 and 2019 are distributed across the phylogeny of collected isolates of the t5.175 and t5.360 clusters from this prolonged outbreak. This implies that the sources of the outbreak still contain a restricted diversity of *S.* Enteritidis clusters.

Epidemiological, microbiological and food-traceability investigations ongoing since 2016 provided evidence of a link between this outbreak and contaminated eggs from Poland (the Polish Consortium A). During 2018, investigations in the UK identified that some of the cases were linked to the consumption of eggs in catering premises. Traceability of the egg supply chain of the premises pointed to the Polish Consortium A as the possible source of infection. The investigation of the UK outbreak in 2018, which was linked to the consumption of RTE liquid egg white products, showed that the t5.360 positive batches of products were produced with eggs originating from Spain, the Netherlands and Germany (all supplying *Salmonella*-free eggs to the French company B). The possibility of cross-contamination of these batches at processing in the French company B with eggs originating from farms of the Polish Consortium A was neither confirmed nor excluded.

Measures taken in the period 2016–2017, including depopulation of the positive flocks, were not enough for eliminating the contamination in the Polish Consortium A. As a consequence, the laying hen farms of this consortium were still positive for the outbreak strains in 2018 and 2019. The reason for this might be either constant reintroduction of the outbreak *S.* Enteritidis strains in the implicated henhouses or the ineffective cleaning and disinfection of the premises and/or equipment. Some of the laying hen farms that were positive for one outbreak strain in the period 2015–2017 were found positive with the same strain or with multiple ones in the

period 2018–2019 indicating the presence of persistent contamination and/or possible multiple routes of contamination.

It was not possible to identify a common point of contamination in the laying hen production chain for the positive Polish farms. Investigations focusing on parent stocks, hatcheries and rearing farms did not reveal any significant insights on possible origin of the contamination. Similarly, it was not possible to identify a common point of contamination in the feed supply chain of the positive Polish laying hen farms. Although a single company has been identified as a unique supplier of feed of the positive farms belonging to the Polish Consortium A for the entire period (2015–2019), multiple feed suppliers have been found to deliver feed to the other positive Polish farms.

There is also evidence showing the spread of *S*. Enteritidis t5.175 in German laying hen farms and German broiler production chain since at least 2017, and of t5.175 and t5.2440 in other Polish laying hen farms not belonging to the Polish Consortium A. So far, *S*. Enteritidis t5.360 and t5.469 have only been detected in farms belonging to the Polish Consortium A, and they were still detected in 2019. However, we cannot exclude the possibility that these latter genotypes are circulating outside the Polish Consortium A or outside Poland.

Despite the microbiological evidence, epidemiological information provided to ECDC for cases infected in 2019 has been limited regarding information on exposure, thus not linking the recent cases to a specific vehicle of infection or a particular producer. In addition, the identification of the outbreak strain t5.175, which represents two-thirds of the confirmed human cases, in the primary production in Germany as well as in Poland, raises the question of how many human cases since 2017 can be attributed to the eggs from farms of the Polish Consortium A, which was implicated as a major source in previous investigations. Nevertheless, it is worth noting that Poland reported about one third of the EU-*S*. Enteritidis positive flocks (i.e. 93 over 312) and in 2018, together with Croatia, Denmark, Estonia, Malta and Romania, did not meet the reduction target of maximum 2% for *S*. Enteritidis and *S*. Typhimurium [15].

Regardless of the genotypes, all *S*. Enteritidis strains are covered by the food business operators' and official control in the context of the National *Salmonella* control programmes approved by European Commission. However, this assessment illustrates the difficulties in investigating egg-associated outbreaks due to complex supply chains and the difficulty in identifying specific producers potentially implicated.

In conclusion, the outbreak is still ongoing and since no evidence has been provided that the source of contamination has been eliminated, it is expected that further infections will occur and that new cases will be reported in the coming months. Additional investigations are necessary to identify the source of contamination.

Options for response

EU/EEA countries competent authorities should consider interviewing patients infected with outbreak strains of *S*. Enteritidis (including questions about egg consumption and related brand information), following up on clusters associated with food outlets and performing appropriate investigations in food and related supply chains at those food outlets. Information on the travel history of outbreak cases should be collected and communicated, particularly when involving countries lacking laboratory capacities to perform molecular typing, so that investigations can be initiated and measures taken.

Isolates with outbreak MLVA profiles should be sequenced**.** Alternatively, a subset of isolates from domestically-acquired *S*. Enteritidis infections could be sequenced or sent for sequencing in another laboratory. ECDC offers sequencing services for human isolates. Countries that routinely perform WGS are kindly requested to share sequences from suspected outbreak isolates with ECDC for centralised analysis and case confirmation. Sequences from representative human isolates of the outbreak strain are available upon request to ECDC.

EU/EEA countries should consider performing WGS on food/veterinary *S. Enteritidis* isolates that have an epidemiological link to human cases and/ or positive premises in order to support the multi-country analyses. EFSA and the EURL-*Salmonella* provide support to Member States who do not have WGS capacity to sequence and analyse non-human isolates possibly related to this outbreak.

In addition to the control measures already in place, it is recommended that countries possibly involved in this outbreak apply all measures that can reduce the risk of *Salmonella* contamination in laying hen and broiler farms.

Lack of reporting of human cases and data gaps regarding food investigations in some countries have hampered the proper assessment of the epidemiological connections and microbiological contamination at primary production level and at other food business operators downstream in the food chain. Epidemiological data, especially for food/veterinary isolates, are essential to confirm the outcome of microbiological investigations. It is recommended that the involved countries carry out further epidemiological studies and tracing investigations to identify the food business operators at the source of the outbreak.

New human cases and developments on public health investigations should be reported to EPIS-FWD. Moreover, ECDC and EFSA encourage the competent authorities in the food safety and the public health sectors in the affected EU/EEA countries and at the European level to continue sharing information on the epidemiological, microbiological and environmental investigations, including issuing relevant notifications using the Early Warning

and Response System (EWRS)[1] and RASFF[2]. RASFF notifications should be completed with information on the exposure to food of related human cases, traceability information on the suspected food vehicles and WGS/MLVA results to support traceability investigations.

New human cases and developments on public health investigations should be reported to EPIS-FWD.

Source and date of request

European Commission Directorate General for Health and Food Safety (DG SANTE) request on 24 October 2019.

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All experts have submitted declarations of interest, and a review of these declarations did not reveal any conflict of interest.

RASFF contact points in Bulgaria, Cyprus, France, Germany, Ireland, the Netherlands, Poland, Romania, Spain, the United Kingdom were consulted by EFSA to clarify and validate their national data on food and environmental investigations.

[1] EWRS is a rapid alert system for notifying alerts at EU level in relation to serious cross-border threats to health of biological, chemical, environmental or unknown origin. EWRS enables the European Commission and competent authorities of the Member States to be in permanent communication for the purposes of alerting, assessing public health risks and determining measures that may be required to protect public health. National competent authorities should notify an alert in EWRS when the development or emergence of a serious cross-border threat to health fulfils the criteria listed in Article 9 of Decision 1082/2013/EU.

[2] RASFF is the official EU system for sharing information on hazards found in food and feed, trade of potentially contaminated batches between Member States and tracing of such batches. RASFF notifications should be completed with information on exposure to food for related human cases, as well as traceability information on the suspected food vehicles and analytical results to support traceability investigations.

Disclaimer

ECDC issued this outbreak assessment document in accordance with Article 10 of Decision No 1082/13/EC and Article 7(1) of Regulation (EC) No 851/2004 establishing a European Centre for Disease Prevention and Control (ECDC), and with the contribution of EFSA in accordance with Article 31 of Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002, laying down the general principles and requirements of food law, establishing the European Food Safety Authority (EFSA) and laying down procedures in matters of food safety.

In the framework of ECDC's mandate, the specific purpose of an ECDC-EFSA outbreak assessment is to present different options on a certain matter. The responsibility on the choice of which option to pursue and which actions to take, including the adoption of mandatory rules or guidelines, lies exclusively with EU/EEA Member States. In its activities, ECDC strives to ensure its independence, high scientific quality, transparency and efficiency.

This report was written under the coordination of an internal response team at ECDC, with contributions from EFSA, at the behest of the European Commission based on a mandate requesting scientific assistance from EFSA in the investigation of multinational food-borne outbreaks (Ares (2013) 2576387, Mandate M-2013-0119, 7 July 2013).

All data published in this rapid outbreak assessment are correct to the best of ECDC's and EFSA's knowledge as of 30 January 2020. Maps and figures published do not represent a statement on the part of ECDC, EFSA or its partners on the legal or border status of the countries and territories shown.

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Annex 1.

Table A1. Depopulation carried out in the positive Polish laying hen farm henhouses followed by cleaning and disinfection, 2018-2019

Farm	Henhouse	Cleaning date	N. of disinfections after cleaning	Date of microbiological examination after cleaning and disinfection	SE positive
D	2	09/12/18	1	12/12/2018	No
	3	09/12/18	1	12/12/2018	No
	9	14/11/19	1	25/11/2019	No
F	5	19-22/05/2019	2	27/05/2019	Yes
		31/05–07/06/2019		11/06/2019	No
	17	20-25/05/2019	>2	27/05/2019	Yes
		31/05-01/06/2019		03/06/2019	Yes
		10-11/06/2019		13/06/2019	No
	6	20-22/05/2019	2	03/06/2019	Yes
		10-11/06/2019		13/06/2019	No
G	7	26/07/19	1	30/07/2019	No
I	11	03-16/06/2019	2	24/05/2019	Yes
				01/06/2019	No
L	12	15-23/05/2019	2	27/05/2019	No
				01/07/2019	No
O	13	5-7/11/2019	1	15/11/2019	No
	14	26-28/05/2019	1	04/07/2019	No