

Food Safety Needs a Memory

From Outbreak Response to Longitudinal Genomic Intelligence: What FDA's New CORE+EP Report and Europe's WGS Mandate Change for the Food Industry

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Abstract

Food safety is moving from episodic outbreak response toward persistent, data-linked surveillance. FDA's CORE+EP 2025 Annual Report, released on 6 October 2026, provides unusually clear evidence: continued sampling after a 2024 cucumber outbreak detected a genetically matching *Salmonella* strain in 2025; new evidence solved a *Listeria* outbreak whose illnesses stretched back to 2018; and a complex prepared-meal investigation required ingredient-level traceback across FDA and USDA jurisdictions. Europe has crossed a parallel regulatory threshold. Commission Implementing Regulation (EU) 2025/179 became applicable on 23 August 2026, creating obligations for collection and transmission of whole-genome-sequencing data for specified foodborne bacterial isolates associated with outbreaks. The combined signal is larger than WGS itself. Modern food safety requires institutional memory: genomic, traceability, supplier, environmental and process evidence must remain linkable across years. This article proposes a Food Safety Memory Graph and a practical evidence architecture through which manufacturers and ingredient suppliers can convert historical data into earlier detection, faster root-cause analysis and more defensible prevention.

Keywords: *whole genome sequencing; foodborne outbreaks; traceability; food safety intelligence; supplier assurance; One Health; FDA CORE+EP; Regulation (EU) 2025/179*

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Meta Description: FDA's 2025 outbreak report and Europe's new WGS rules point to a new model: food safety built on persistent genomic, traceability and process memory.

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1. The Most Important Food-Safety Document Released This Week Is Not About a New Pathogen

On 6 October 2026, the U.S. Food and Drug Administration released the 2025 annual report of its Office of Coordinated Outbreak Response, Evaluation, & Emergency Preparedness (CORE+EP). The headline numbers are useful but not revolutionary: 69 incidents evaluated, 26 outbreak responses initiated and 11 public-health advisories issued. FDA reported broadly similar activity in 2024. The deeper importance lies in how several investigations were solved.

A 2025 *Salmonella* Montevideo outbreak associated with cucumbers was detected after FDA returned to a grower linked to a 2024 outbreak and continued environmental sampling. Whole genome sequencing (WGS) connected an environmental isolate to clinical cases.

A *Listeria monocytogenes* outbreak linked to frozen supplemental shakes had illnesses dating back to 2018. It was not solved by a single new test. It was solved because new traceback information, historical illness data, updated epidemiology and inspection evidence could be brought together years later.

A separate *Listeria* investigation involving prepared meals required FDA and USDA-FSIS to trace different components through a multi-ingredient supply chain before the investigation converged on pasta.

The lesson is larger than any one outbreak: **food-safety evidence has a useful life far longer than the incident that originally generated it.**

The industry has traditionally treated an outbreak, environmental positive, supplier deviation or recall as an event to investigate, close and archive. The emerging regulatory model treats those events as additions to a persistent evidence system. Food safety increasingly needs a memory.

2. Why This Matters Now: Europe Has Just Crossed a Genomic Regulatory Threshold

The timing is exceptional.

Commission Implementing Regulation (EU) 2025/179 was published on 31 January 2025 and became applicable on 23 August 2026. It establishes obligations concerning the collection and transmission of molecular analytical data in the context of foodborne outbreaks under the legal framework of Directive 2003/99/EC. The system is not a generic requirement to sequence every microorganism found by every food business. Its scope is more specific. It strengthens official outbreak surveillance by requiring relevant WGS data for specified bacterial foodborne pathogens and transmission of those data into the European One Health architecture.

EFSA and ECDC already operate interconnected WGS platforms that combine information from food-safety and public-health sectors. The organisms covered include major bacterial hazards such as *Salmonella enterica*, *Listeria monocytogenes*, *Escherichia coli* and *Campylobacter* species within the applicable framework. This changes the evidentiary environment in which European food companies operate.

A bacterial isolate recovered today may acquire significance months or years later when it clusters genetically with human cases, another food isolate or an environmental strain from a different Member State.

The compliance question therefore changes from: “Did this batch pass?” to: “What evidence associated with this batch, process, environment and supplier must remain interpretable if a future genomic signal changes what we know?”

3. WGS Is Not Merely a Better Identification Test

It is tempting to describe whole genome sequencing as a high-resolution replacement for older microbial typing. That is correct but incomplete. Its strategic value comes from persistence and comparability.

Traditional microbiological results often collapse into binary records: detected/not detected, conforming/non-conforming, released/rejected. WGS creates a reusable biological fingerprint.

That fingerprint can be compared against:

- future clinical isolates;
- historical food isolates;
- environmental isolates;
- supplier isolates;
- strains from other countries;
- strains from different products;
- isolates recovered after sanitation or corrective action.

The value of the original sample therefore increases when other data become available. This reverses a familiar logic. In conventional quality control, old data often depreciate. In genomic epidemiology, old data can appreciate. A 2024 environmental isolate may become decisive in 2025. A 2018 clinical cluster may become interpretable when a 2025 factory sample finally provides the missing link.

The CORE+EP report demonstrates both phenomena.

4. Case One: The Cucumber Outbreak and the Value of Returning After the Crisis

FDA highlights the 2025 Salmonella Montevideo cucumber investigation as an example of post-outbreak surveillance.

A large cucumber outbreak had occurred in 2024. During a follow-up inspection and sampling assignment in April 2025, FDA recovered Salmonella Montevideo from the environment of a grower associated with the earlier event. WGS showed that the environmental isolate matched a cluster of human illnesses occurring in 2025. That finding accelerated recognition of a new outbreak. The important control concept is **longitudinal verification**.

Corrective action after an outbreak is usually assessed through documentation, sanitation, training, repairs, supplier changes and a finite period of follow-up testing. But persistent or recurring environmental reservoirs can outlive the formal closure of an investigation. A facility or agricultural environment that has generated a pathogen signal should therefore not automatically return to a blank risk state when the incident closes. Historical microbiology should modify future surveillance intensity. This does not mean permanent punishment of a supplier or site. It means that risk models should remember.

5. Case Two: Listeria and the Value of Unresolved Evidence

The frozen supplemental-shake outbreak is even more instructive. FDA describes a *Listeria monocytogenes* outbreak with illnesses dating to 2018 that was eventually linked to frozen supplemental shakes consumed predominantly by residents of long-term-care facilities. The investigation became solvable when new traceback information, historical illness records, epidemiological evidence and laboratory findings from an FDA inspection converged. This illustrates a crucial property of unresolved outbreaks: **unresolved does not mean valueless**. A cluster that cannot be attributed today may become attributable tomorrow if the underlying records, isolates and metadata remain available.

For industry, this creates a difficult governance question. How long should environmental isolates, WGS data, supplier records, formulation histories, lot genealogies and processing metadata be retained?

The legally required retention period is only the floor. For high-risk foods, vulnerable populations, persistent organisms and complex ingredient networks, the scientifically useful retention period may be considerably longer.

6. Case Three: Multi-Ingredient Foods Break Linear Traceability

The prepared-meal *Listeria* investigation shows a different problem. Multi-ingredient foods are not linear supply chains. They are graphs. A ready meal may contain pasta, meat, sauce, vegetables, cheese, spices, packaging and rework streams produced by different businesses under different regulatory jurisdictions. A finished-product positive does not identify which branch introduced the hazard.

FDA and USDA-FSIS had to coordinate because different components and facilities fell under different federal responsibilities. Traceback eventually narrowed attention to pasta manufactured by a supplier. This exposes the limits of treating traceability as a list of invoices. The operational object is not “the supplier”.

It is the **lot genealogy**: *raw-material lot → transformation event → intermediate lot → combination event → finished lot → distribution node*.

When one intermediate ingredient feeds many finished products, a single contaminated node can create a dispersed outbreak footprint that looks unrelated at retail level. Digital traceability should therefore model transformations, not just transactions.

7. The Difference Between Traceability and Investigability

A company can be legally traceable and still be difficult to investigate. Under Article 18 of Regulation (EC) No 178/2002, EU food businesses must be able to identify from whom they received food, feed, food-producing animals or relevant substances and to whom products were supplied. This is commonly described as the “one step back, one step forward” principle.

That framework remains fundamental, but outbreak reconstruction often requires more.

Investigability asks whether the business can rapidly connect:

- supplier lot;
- internal batch;
- line and shift;
- rework;
- cleaning event;
- environmental result;
- laboratory isolate;
- formulation version;
- packaging lot;
- customer shipment;
- complaint;
- deviation;
- corrective action.

A traceability system can tell investigators where a pallet went. An investigability system can explain what happened to the product before it became that pallet. The second capability is increasingly where outbreak time is won or lost.

8. Europe’s One Health WGS System Makes Cross-Sector Memory Operational

EFSA and ECDC’s One Health WGS system has been operational since 2022. It links separate food-safety and public-health genomic platforms so that bacterial profiles can be compared across sectors. The 2026 regulatory change matters because it moves the system from voluntary and heterogeneous participation toward a more structured legal data flow for outbreak-related isolates.

This is a major development in European food law.

For decades, food safety regulation has required operators to control hazards and authorities to monitor zoonoses. The new genomic layer adds something qualitatively different: the capacity to recognise that isolates separated by geography, time and product category belong to the same biological event.

The legal unit remains the food business, the batch, the official control or the Member State. The biological unit is the clone. Those units do not respect the same boundaries. A clone can move across suppliers, factories, countries and years. WGS makes that continuity visible.

9. What WGS Can Prove — and What It Cannot

Genomic similarity is powerful evidence, but it is not magic.

A close genomic relationship can support the inference that isolates share a recent common ancestor. It can help define outbreak clusters and connect food, environmental and clinical evidence.

It does not, by itself, prove:

- the direction of transmission;
- the precise contamination event;
- which ingredient was contaminated first;
- whether a positive environment contaminated the food or vice versa;
- the exact date contamination occurred;
- legal fault.

Those questions require epidemiology, traceback, process knowledge and contextual evidence. This distinction is essential because WGS can create an illusion of certainty. The correct model is evidentiary triangulation: **genomics + epidemiology + traceability + process evidence + temporal plausibility**. The strongest investigations are those in which independent evidence streams converge.

10. The New Strategic Asset: Microbial Metadata

A sequence without context has limited industrial value. The metadata around an isolate can be as important as the sequence itself.

At minimum, useful metadata may include:

- organism and analytical method;
- sample type;
- exact sampling point;
- date and time;
- product or environmental context;
- supplier and ingredient;
- lot/batch;
- production line;
- shift;
- sanitation status;
- temperature;
- formulation;
- rework status;
- laboratory identifier;
- WGS identifier;
- corrective action;
- disposition;
- linked customer lots.

The objective is not indiscriminate data accumulation. It is preserving enough context so that a future match can be interpreted. This is where many companies remain weak. Microbiology sits in the laboratory information system; production data sit in ERP; supplier documents sit in quality folders; complaints sit in CRM; maintenance sits elsewhere. The data exist, but the relationships do not.

11. AI Is Useful Here — but Only After Data Architecture

Food safety is an attractive domain for artificial intelligence because the relevant evidence is heterogeneous and distributed.

AI can potentially help identify:

- recurring strain-location relationships;
- suppliers associated with repeated deviations;
- unusual combinations of complaints and microbiology;
- temporal clusters;
- sanitation failures preceding positives;
- products sharing hidden intermediate ingredients;
- historical records relevant to a new genomic cluster.

But an AI model cannot reconstruct relationships that were never captured. The first innovation requirement is therefore not a chatbot. It is data architecture. Every critical entity needs a persistent identifier: supplier, material, lot, site, line, sample, isolate, sequence, customer lot and investigation. Once those entities are linked, graph analytics and machine learning become useful. Without that foundation, “AI food safety” risks becoming document search with a fashionable label.

12. Research & Innovation Opportunity

The Food Safety Memory Graph

Unresolved problem. Food companies generate large quantities of safety evidence, but the information is fragmented across systems and loses relational meaning over time.

Why it matters. FDA’s 2025 investigations show that old environmental isolates, historical clinical clusters and ingredient-level traceback can become decisive years after the original event. Europe’s new WGS framework increases the probability that future genomic comparisons will reactivate historical evidence.

What is already known. WGS can connect microbial isolates at high resolution. Traceability systems can reconstruct product movement. Knowledge graphs can represent relationships between heterogeneous entities. Machine learning can identify patterns across large linked datasets.

What remains unknown. There is no widely adopted, validated industrial standard for combining genomic, traceability, process, supplier and investigation data into a persistent food-safety knowledge graph.

Proposed hypothesis. A Food Safety Memory Graph could reduce time-to-hypothesis and time-to-source during investigations by making historical relationships machine-queryable.

A minimal graph would connect:

supplier → ingredient → incoming lot → process event → finished lot → environmental sample → isolate → WGS profile → shipment → customer → complaint/case → investigation → corrective action.

Validation programme.

1. Define a common data model and controlled vocabulary.
2. Ingest historical microbiology, traceability and deviation data from participating sites.

3. Link isolates to WGS identifiers where sequencing exists.
4. Run blinded retrospective outbreak reconstructions.
5. Compare investigation speed and completeness with conventional document-based methods.
6. Measure false associations and missing-data sensitivity.
7. Establish human-review thresholds for algorithmic alerts.
8. Test interoperability with regulatory reporting formats.
9. Conduct cybersecurity, confidentiality and governance assessment.

Regulatory constraints. The graph would not replace legally required records, official WGS systems or competent-authority investigations. Personal health data would require strict separation and lawful processing. Commercially sensitive supplier data would require access controls and governance.

Industrial relevance. The architecture could improve root-cause analysis, supplier qualification, environmental-monitoring trend analysis, recall scoping and evidence preservation.

This is a proposed research architecture, not an established regulatory method.

13. A Second Research Opportunity: The Microbial Passport

A complementary concept is a **Microbial Passport** for high-risk production environments and ingredients. The idea is not to certify that a factory has a harmless microbiome. That would be scientifically simplistic. Instead, a site or high-risk ingredient category could maintain a longitudinal library of significant isolates and associated metadata.

The passport would document:

- recurring resident strains;
- transient strains;
- sampling locations;
- dates;
- sanitation interventions;
- process changes;
- supplier changes;
- genomic distances;
- disappearance or re-emergence.

For *Listeria* control, this could help distinguish a one-off introduction from a persistent resident clone. For dry ingredients, it could reveal recurrence across lots or suppliers. For imported ingredients, it could support comparison of isolates recovered at origin, entry, processing and finished-product stages.

The research question is whether structured longitudinal microbial identity improves prevention sufficiently to justify sequencing and data-management costs. The answer is likely to vary by risk class. High-care RTE foods, infant nutrition, vulnerable-population foods and facilities with persistent-pathogen histories are the most plausible initial use cases.

14. Supplier Assurance Must Become Temporally Aware

Supplier approval is usually periodic. A supplier passes qualification, provides certificates, completes questionnaires, undergoes audit and is reviewed annually. Outbreak evidence is not periodic.

A supplier considered low risk today may acquire new significance when a strain from its ingredient matches a clinical cluster six months later. Supplier assurance therefore needs a temporal dimension.

A mature system should ask:

- Has this supplier ever been associated with a pathogen event?

- Have related isolates appeared elsewhere?
- Has the process changed since qualification?
- Has the ingredient's hazard profile changed?
- Are there new regulatory alerts?
- Does a current deviation resemble a historical pattern?

This does not justify blacklisting suppliers because of remote historical events. It justifies preserving and weighting history instead of resetting risk to zero after corrective action.

15. Retention Policy Is Becoming a Food-Safety Control

Record retention is often managed by legal or quality departments as an administrative schedule. Genomic epidemiology turns it into a risk-control decision. If sequence data remain useful for years, the metadata needed to interpret those sequences should remain useful for years as well.

Companies should therefore distinguish:

- statutory minimum retention;
- commercial retention;
- scientific retention.

For a low-risk ambient ingredient, extended retention may offer limited value. For infant formula, RTE foods supporting *Listeria* growth, high-risk fresh produce or ingredients distributed into many downstream products, longer retention may materially improve future investigations. The correct retention period should therefore be risk-based, not merely document-type-based.

16. Recall Precision Depends on Data Precision

Better memory does not only identify outbreaks faster. It can reduce unnecessary recall scope.

When lot genealogy is weak, companies must recall broadly because they cannot prove where contaminated material went. When genomic and traceability evidence are linked precisely, the potentially affected universe can sometimes be narrowed. This has two benefits.

First, consumers receive clearer, more actionable information.

Second, unaffected production can remain on the market, reducing waste and economic damage.

However, precision must not become false reassurance. A narrow recall is defensible only when the evidence supporting exclusion of other lots is robust. The goal is not smaller recalls but correctly sized recalls.

17. The Transparency Problem

FDA's annual report also exposes an uncomfortable distinction between investigation and public communication.

CORE+EP responded to 26 incidents in 2025 but issued 11 public advisories. FDA explains that not every response requires an advisory; in many cases a vehicle is not identified while an ongoing public-health risk exists, or no specific consumer action is necessary. The report also identifies products linked to illnesses in several responses for which no public advisory was issued, including mangoes, cilantro, parsley, spring mix and sprouts.

This should not be converted into a simplistic claim that authorities "hid" outbreaks. Public warnings require actionable, sufficiently reliable information. But the issue deserves serious debate.

As genomic surveillance becomes more sensitive, authorities will increasingly detect clusters before brand-level attribution is possible. The system must balance:

- speed;
- evidentiary confidence;
- commercial harm;
- consumer actionability;
- transparency.

The future challenge is not merely detecting signals earlier. It is deciding when a signal becomes communicable.

18. EU–US Comparison: Different Legal Tools, Converging Direction

The United States and European Union are not adopting identical systems. In the United States, FDA combines outbreak surveillance, WGS, FSMA preventive controls, the Food Traceability Rule, inspections, recalls, import controls and interagency coordination. CORE+EP now also includes emergency preparedness, food defense, traceability and supply-chain monitoring functions.

In the European Union, the legal architecture is distributed across the General Food Law, hygiene legislation, zoonoses monitoring, RASFF, official controls and the new outbreak-related WGS data-sharing framework. The direction nevertheless converges.

Both systems are moving toward:

- higher-resolution microbial identification;
- faster cross-jurisdictional comparison;
- stronger traceability;
- integration of laboratory and supply-chain evidence;
- reuse of historical data;
- prevention informed by prior outbreaks.

The regulatory systems differ. The information problem is the same.

19. Implications for Spain

Spanish food businesses operate within the EU legal framework and therefore within an environment in which genomic outbreak surveillance is becoming more structured. The direct obligations of Implementing Regulation (EU) 2025/179 concern the competent surveillance architecture and relevant data transmission; they should not be misrepresented as a universal sequencing mandate imposed directly on every Spanish food company. Nevertheless, the practical consequences reach industry.

When official laboratories generate WGS data from food, environmental or outbreak-related isolates, those data can be compared across the EU One Health system. A Spanish operator may therefore face an investigation triggered by a genomic relationship first detected elsewhere.

Preparedness requires:

- rapid lot genealogy;
- preserved isolate metadata;
- supplier traceability;
- environmental sampling maps;
- access to competent WGS laboratories;
- defined escalation procedures;
- documentation capable of supporting or refuting a suspected link.

The better the company's own evidence, the more effectively it can participate in the investigation.

20. Practical Implications for Ingredient Companies

Ingredient suppliers occupy a particularly important position because one lot can enter many downstream foods. A contaminated finished product usually creates a bounded recall. A contaminated ingredient can create a network.

For ingredient businesses, a modern food-safety dossier should therefore include more than specification and certificate-of-analysis data. Depending on risk, it should preserve:

- raw-material genealogy;
- manufacturing lot relationships;
- significant microbiological isolates;
- environmental monitoring trends;
- process deviations;
- rework history;
- sanitation interventions;
- supplier changes;
- customer distribution mapping;
- sequence data or access to retained isolates where justified.

This is especially relevant for powders, spices, proteins, fermentation-derived ingredients, infant-nutrition inputs and other materials distributed across multiple manufacturers. The strategic asset is not the certificate. It is reconstructability.

21. Implications for industry and operators

For all those implicated in operations, the strongest opportunity is not to become a sequencing laboratory. It is to build an evidence architecture around ingredient and process technologies. A technically mature dossier could progressively link: **product identity** → **raw-material source** → **manufacturing batch** → **analytical profile** → **microbiological evidence** → **customer application** → **technical deviation** → **corrective action**.

For technologies used in food-safety or process-water contexts, validation data should be retained in a form that remains comparable across time, matrices and customers.

For ingredients, supplier changes should trigger explicit comparison of manufacturing route, microbiological profile and relevant hazards.

For future AI development, the priority should be structured identifiers and relationships before predictive modelling. This is a realistic area in which AI, regulatory science and food technology can reinforce each other without overclaiming.

22. A Practical Five-Level Maturity Model

Companies can assess their current position using a simple maturity model.

Level 1 — Document archive. Certificates, reports and investigations exist as files but are weakly connected.

Level 2 — Digital traceability. Lots, suppliers and customers can be reconstructed electronically.

Level 3 — Evidence linkage. Traceability connects to environmental monitoring, deviations, complaints and laboratory results.

Level 4 — Genomic memory. Significant isolates and WGS profiles are retained with interpretable metadata and can be compared longitudinally.

Level 5 — Predictive food-safety intelligence. Graph analytics and validated algorithms identify recurring patterns, emerging supplier risk and historical relationships requiring expert review.

Many companies are investing in Level 5 language while operating at Level 1 or 2. The correct sequence is architectural before algorithmic.

23. What Should Be Done Now

Food manufacturers and ingredient suppliers do not need to wait for another regulation. They can take several defensible steps now.

First, map where microbiological, traceability, supplier, complaint and process data are stored.

Second, create persistent identifiers linking significant isolates to samples, lots and locations.

Third, establish criteria for retaining isolates or sequence data in high-risk contexts.

Fourth, test whether a historical environmental positive can be traced forward to all potentially affected lots and backward to relevant raw materials.

Fifth, include historical pathogen events in supplier risk review.

Sixth, preserve process-change history so that investigators can distinguish conditions before and after corrective action.

Seventh, define who can interpret WGS results and how genomic evidence will be integrated with epidemiology and process data.

Eighth, run retrospective “cold case” exercises using old deviations or recalls.

Ninth, ensure that data governance protects confidential business information without making critical evidence inaccessible during an emergency.

Tenth, resist the temptation to automate before the data model is coherent.

24. Conclusions

FDA’s newly released CORE+EP report should be read as more than an annual list of outbreaks. Its most important cases show that food-safety evidence persists. A pathogen recovered during follow-up sampling can reveal a new outbreak. Historical clinical data can become meaningful years later. Multi-ingredient foods can require reconstruction across suppliers and regulatory jurisdictions. Old evidence becomes newly valuable when it can be connected.

Europe has reached the same transition from another direction. Since 23 August 2026, the new EU framework for outbreak-related WGS data has strengthened the legal infrastructure through which microbial fingerprints can be shared and compared across the One Health system. The combined lesson is clear. The future of food safety is not simply more testing. It is **memory with structure**.

Genomic data without traceability are incomplete. Traceability without process context is shallow. AI without persistent identifiers is cosmetic. Historical records without interoperability are archives, not intelligence. The next generation of food-safety systems should preserve relationships across time: organism, ingredient, lot, environment, process, supplier, customer and corrective action. When the next outbreak begins, the decisive evidence may already exist.

The question is whether the system will remember where it is.

Related Knowledge Areas

- Food Safety — outbreak reconstruction, environmental monitoring and preventive controls.
- Biotechnology — whole genome sequencing and microbial characterisation.
- AI & Food — knowledge graphs, graph analytics and evidence retrieval.
- Regulatory Affairs — EU WGS obligations, General Food Law and U.S. FSMA traceability.
- Functional Ingredients — ingredient-lot genealogy and supplier assurance.
- Processing Technologies — environmental persistence, sanitation and process-event metadata.
- Emerging Research — microbial passports and longitudinal food-safety intelligence.

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