Using Data Trends to Improve Microbial Risk Detection in Food Safety Systems
May 28, 2026

Moderator: MAVIS OKAFOR, Case Western Reserve University

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Todays Panelists

•Mavis Okafor- Food Safety and Quality System Analyst (MBA Full time Student)- **Explain how trend analysis of routine monitoring data can identify emerging contamination risks.**

•Michael Ikele - Lecturer Food and Fermentation Microbiology- **Describing the common challenges in detecting microbial risks in Food Processing environments'.**

•Cole Calbaugh- Food Safety and Microbiology Specialist - **Applying risk-based thinking to prioritize corrective actions in food safety systems. (Still awaiting decision)**

USING DATA TRENDS TO IMPROVE MICROBIAL RISK DETECTION IN FOOD SAFETY SYSTEMS

IAFP WEBINAR

SPEAKERS : MAVIS OKAFOR

MICHAEL IKELE

COLE CALBAUGH

USING TREND ANALYSIS TO IDENTIFY EMERGING CONTAMINATION RISKS

SPEAKER: MAVIS OKAFOR

WHY MONITORING

- Food contamination often develops gradually
- Single test results may not show the full risk
- Repeated small deviations may signal larger problems
- Trend analysis supports earlier intervention

TREND ANALYSIS MEANING

Reviewing routine monitoring data over time to identify:

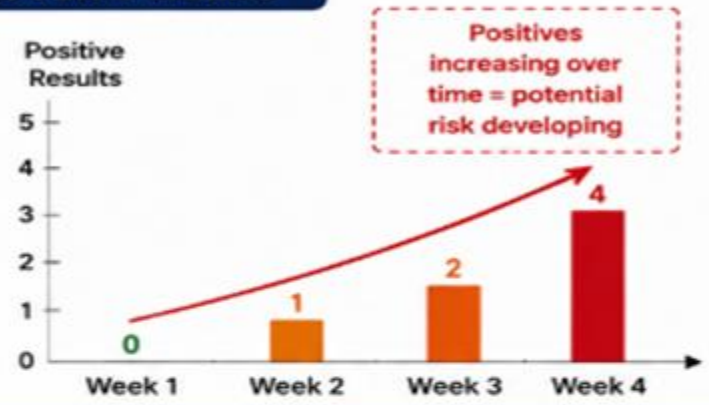
- recurring patterns
- increasing deviations
- contamination signals

PRACTICAL EXAMPLE: ENVIRONMENTAL MONITORING TREND

Drain Area – Increasing Positives Over 4 Weeks

TREND OVER 4 WEEKS

Week	Drain Positives
Week 1	0
Week 2	1
Week 3	2
Week 4	4



DRAIN AREA (EXAMPLE)

WHAT THIS MEANS

Looking at Week 2 alone, it may look like an isolated result. But the pattern over 4 weeks shows an increasing trend.

This may indicate:

- Persistent contamination source
- Poor sanitation effectiveness
- Biofilm formation
- Drainage issues
- Poor equipment design

WHY THIS MATTERS IN FOOD PROCESSING ENVIRONMENTS

Contamination often hides in hard-to-clean areas such as:

- Drains
- Floors
- Equipment joints
- Conveyor belts
- Hard-to-clean surfaces

CONTEXT (Example Facility in Nigeria / West Africa)

In many facilities, records are written manually. If data is not reviewed, recurring problems may be missed and the same area keeps getting contaminated.

CORRECTIVE ACTIONS (INDUSTRY STEPS)

1. **DEEP CLEANING**

Thoroughly clean drain and surrounding area.

2. **REVIEW SANITATION CHEMICALS**

Check concentration, foam, contact time and effectiveness.

3. **RETRAIN WORKERS**

Reinforce proper cleaning techniques and hygiene practices.

4. **REPAIR DRAINAGE**

Fix leakages, slope issues or damaged drain fittings.

5. **INCREASE SWAB FREQUENCY**

Swab more frequently to monitor improvement.

6. **INVESTIGATE SOURCE**

Check raw materials, water quality and equipment condition.

EXPECTED OUTCOME

Identify the source, control the risk and prevent future contamination.

Power BI

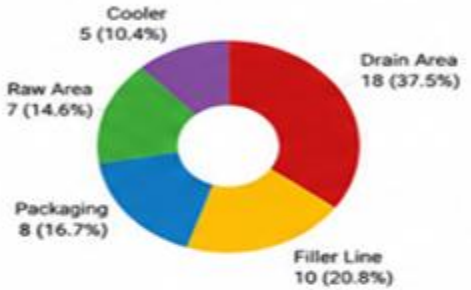
FOOD SAFETY ENVIRONMENTAL MONITORING DASHBOARD

Area: All | Date: Last 12 Weeks

Total Samples	Positive Samples	Normal Variation	Abnormal Variation	Areas Monitored
612	48	563	49	12
Last 12 Weeks	7.84%	91.99%	8.01%	Production Areas

Environmental Positives Over Time

Positives by Area (Top 5)

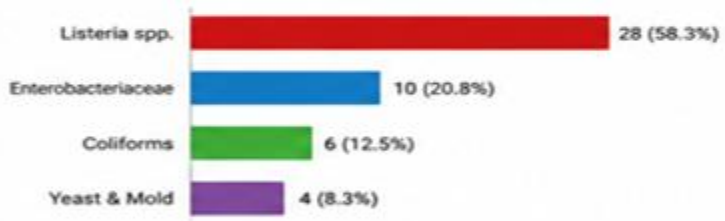


Recent Abnormal Results

Date	Area	Location	Organism	Result	Status
May 12, 2024	Filler Line	Filler Nozzle 3	Listeria spp.	Positive	Abnormal
May 11, 2024	Drain Area	Floor Drain 2	Listeria spp.	Positive	Abnormal
May 10, 2024	Drain Area	Floor Drain 2	Listeria spp.	Positive	Abnormal
May 10, 2024	Filler Line	Conveyor Belt	Listeria spp.	Positive	Abnormal
May 9, 2024	Cooler	Cooler Drain	Listeria spp.	Positive	Abnormal

* Abnormal variation detected from Week 9 – immediate investigation recommended.

Positives by Organism



Key Insights

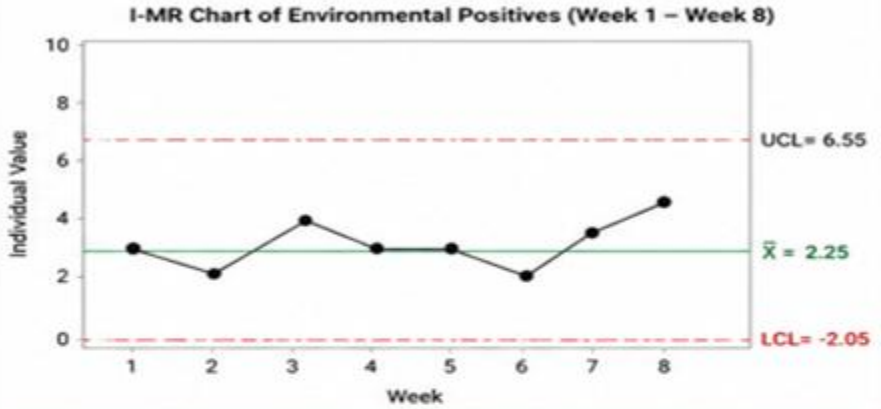
- ✓ Abnormal increase in positives detected from Week 9.
- ✓ Drain Area and Filler Line are the top contributors.
- ✓ Immediate corrective action and intensified cleaning recommended.

Recommended Actions

- Investigate Drain Area (Floor Drain 2).
- Sanitize and verify Filler Nozzle 3 and Conveyor Belt.
- Increase swab frequency in high-risk areas.
- Review sanitation effectiveness and employee practices.

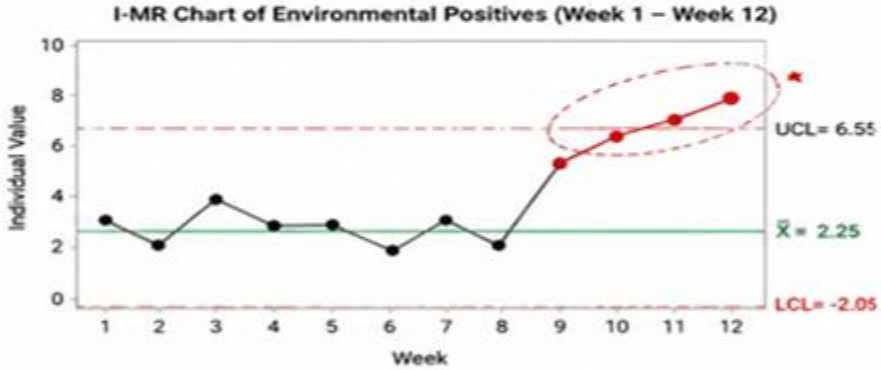
MINITAB CONTROL CHART EXAMPLE

1. NORMAL VARIATION (Process in Control)



All points are within control limits and show no special cause variation.
Process is stable.

2. ABNORMAL VARIATION (Process Out of Control)



Points above the upper control limit from Week 9 – Week 12 indicate special cause variation.
Process is out of control – investigation required.

AI-POWERED PREDICTIVE ANALYTICS FOR FOOD SAFETY

From Historical Data to Future Contamination Risk Prediction

1. HISTORICAL DATA

Environmental positives, ATP, Sanitation, Temperature, Humidity, Production data, etc.

2. AI MODEL

AI learns patterns and relationships from historical data

3. PREDICT FUTURE RISK

AI predicts contamination risk for the next 7 days

4. EARLY ACTION

Take preventive actions before contamination escalates

INPUTS TO AI MODEL

- Listeria Positives (History)
- ATP (RLU)
- Temperature (°C)
- Humidity (%)
- Sanitation Score (%)
- Area / Location
- Production Volume
- Day of Week / Shift

...and more

AI MODEL

Machine Learning Model (Gradient Boosting)

AI analyzes multiple factors together and generates a risk score (0 – 100)

PREDICTED CONTAMINATION RISK (NEXT 7 DAYS)

Area	Predicted Risk Score (0-100)	Risk Level	Recommended Action
Drain Area	82	High	Immediate Action Required
Filler Line	71	High	Intensify Sanitation & Monitoring
Cooler Area	48	Moderate	Increase Monitoring
Packaging Area	32	Low	No Action Needed
Conveyor Belt	65	Moderate	Intensify Cleaning

Low (<40) Moderate (40-70) High (>70)

FUTURE DIRECTION/CONCLUSION

- Digital food safety systems
- Real-time dashboards
- Predictive analytics
- AI-supported monitoring

Conclusion:

Trend analysis transforms routine monitoring data into proactive food safety decisions.

Common Challenges in Detecting Microbial Risks in Food Process Environments

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Food and Fermentation Microbiology

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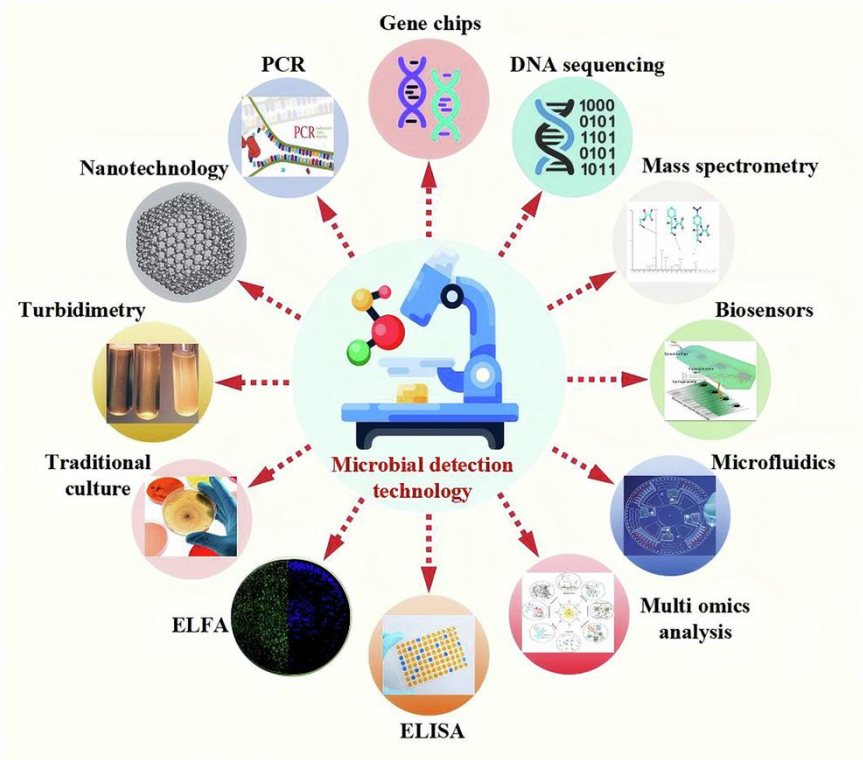

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Microbial Risks in Food Processing

- Microbial contamination is a major food safety concern.
- Food processing environments can harbor harmful microorganisms.
- Early detection is essential to protect consumer health and product quality.
- Effective monitoring supports regulatory compliance and brand reputation.

Hidden Sources of Contamination

- Microorganisms are unevenly distributed in processing facilities.
- Common contamination hotspots are:
- Equipment crevices
- Drains
- Biofilms
- Air handling systems
- Routine cleaning may not fully remove microbial buildup

Limitations of Detection Methods

- Traditional microbial testing requires long incubation times.
- Some microorganisms become viable but non-culturable (VBNC).
- Rapid detection technologies improve response time but:
- Are expensive
- Require specialized expertise
- Need validation before implementation

Environmental and Operational Challenges

- Temperature and humidity affect microbial growth.
- Cross-contamination can occur through:
- Personnel
- Raw materials
- Equipment movement
- Frequent production changes complicate monitoring and control

Improving Microbial Risk Detection

- Develop strong sanitation and hygiene programs.
- Implement continuous environmental monitoring.
- Train employees on contamination prevention practices.
- Use advanced detection technologies where possible.
- Maintain accurate documentation for regulatory compliance.

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Using Data Trends to Drive Risk-Based Decisions and Prevent Contamination

Cole Calbaugh, MS
Microbiology and Food Safety Specialist

Making Data Operational

From Signals to Risk-Based Decisions

Turning Data into Action

1

Large Volumes of Data Exist

Generated daily across environmental monitoring, process controls, and product testing.

2

Trends are Often Visible

Data can reveal early signals before a lapse or incident occurs.

3

Response Proportional to Actual Risk?

Many systems respond too late, inconsistently, or not in line with the level of risk.

4

Our Focus

Turn signals into risk-based decisions to prevent contamination—not just react to it.

Outcome

Better decisions. Targeted actions. Lower risk.

Prevent contamination events—don't just respond to them.

Traditional Risk-Based Thinking

Risk = Probability x Severity

Methods

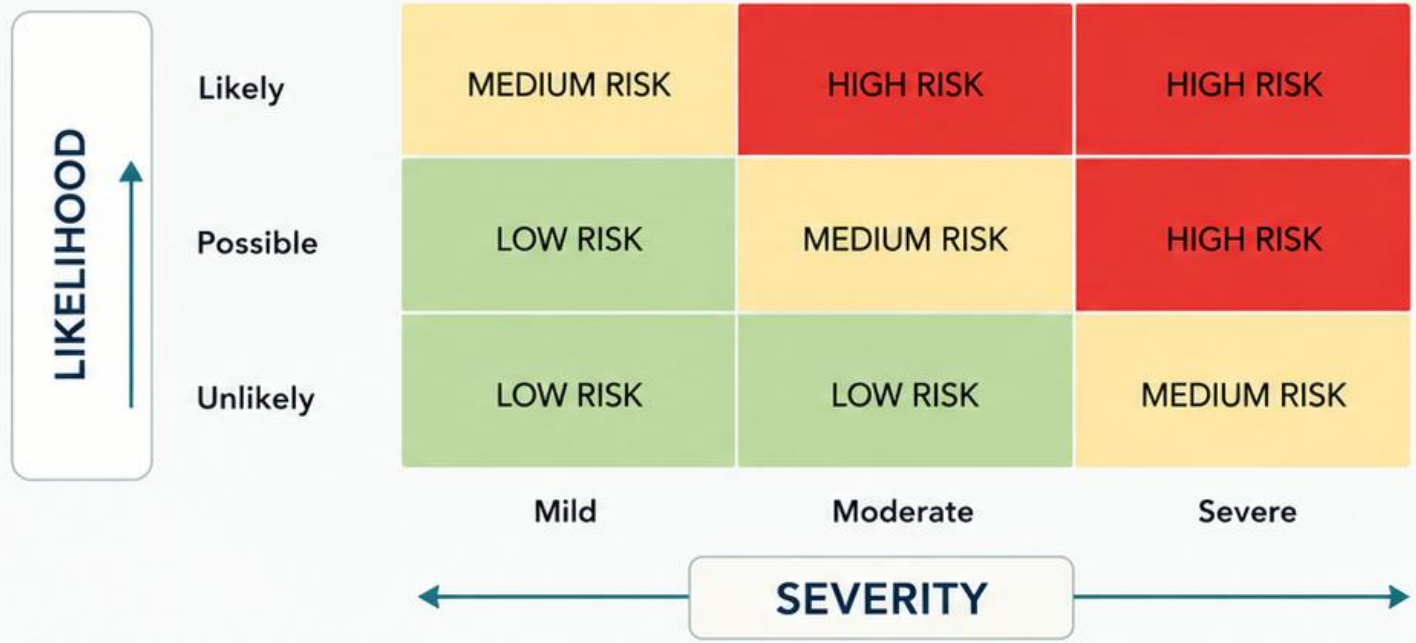
- Hazard analysis aligned with HARPC and Codex risk analysis principles
- Controls, critical limits, corrective actions

Goal

- Ensure results remain within established specifications

Potential Shortcomings

- Overreliance on pass/fail over trends
- Reactive decision-making
- Individual events instead of patterns over time
- Lacks larger context



Assessed Upfront
Risk assessed during plan development.

Managed by Controls
Preventive measures, critical limits, and corrective actions.

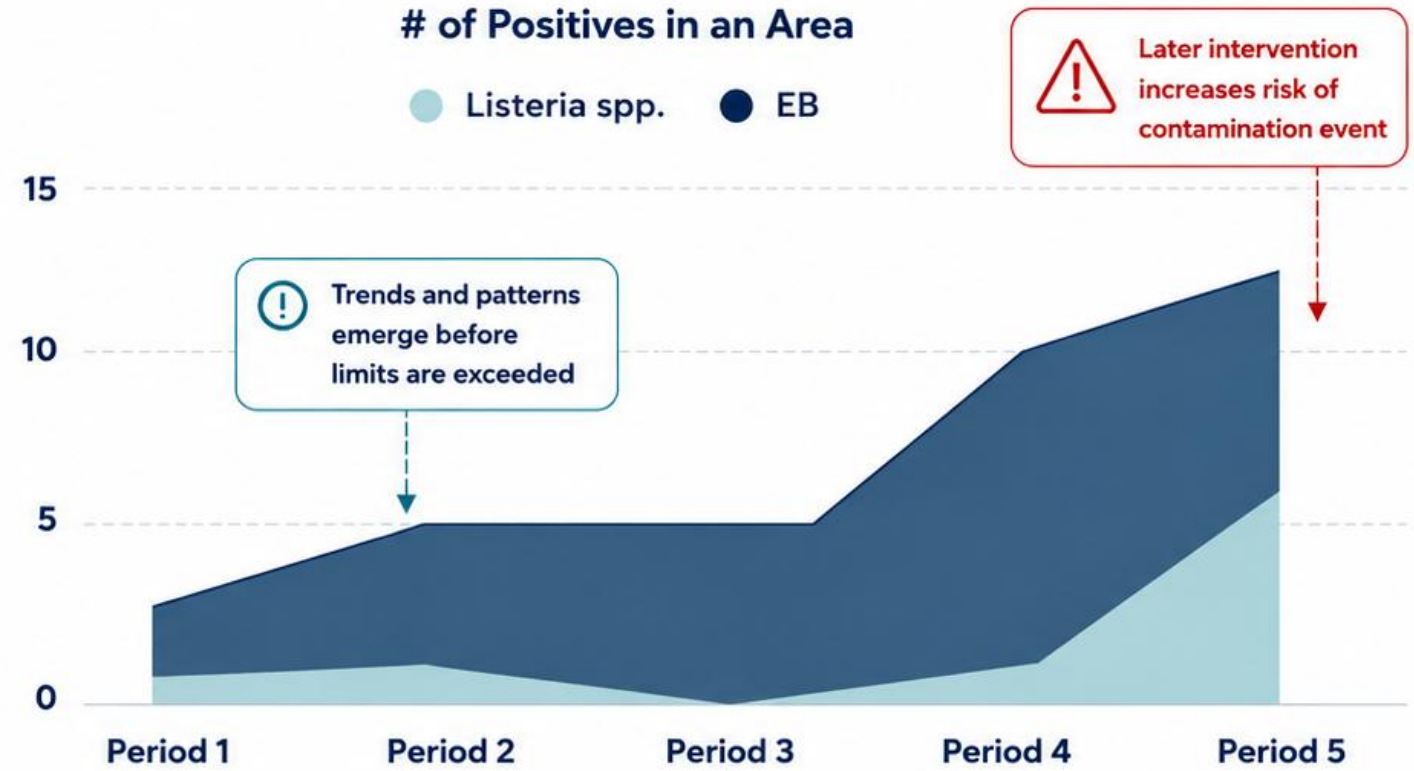
Verify & Monitor
Focus shifts to verifying controls and results within specifications.

Can Miss the Bigger Picture
Pass/fail thinking can overlook early signals and evolving risk.

Modern Risk Based Framework

From Static Assumptions to Dynamic, Data-Driven Risk

- **Build on industry principles**
  - Anchored in HARPC (FSMA) and Codex risk analysis principles
- **Move from static to dynamic**
  - Continuously reassess likelihood using ongoing data streams
- **See the signal in the trends**
  - Patterns emerge before results exceed specifications
- **Early insight. Smarter action.**
  - Detect risk earlier, intervene sooner, and prioritize what matters most



The goal: Use data and context to focus resources on what is most likely to lead to a contamination event—not just what exceeds a limit.

Context Turns Data into Action

Example: Z3 Drain Positive Near Processing Equipment

1. Initial Positive

Z3 drain swab tests positive.

2. Add Context

2 months ago, nearby hard-to-clean equipment also tested positive.

3. More Meaningful Risk

The drain positive now has more context—suggesting a previous corrective action may not have been fully effective.

4. Informed Action

Escalate the risk: prioritize intensive vectoring and corrective action. Verify effectiveness with follow-up monitoring.

Hard-to-Clean Equipment

2 Months Ago: Positive

Z3 Drain

Today: Positive

Intensified Response

- Vectoring / Investigation
- Corrective Action
- Follow-up Monitoring
- Verify Effectiveness

The key takeaway:

Effective food safety systems are not driven by isolated data points—they're driven by trends and context. Risk-based thinking focuses our time and resources where they have the greatest impact and shifts us from reacting to problems to identifying and managing risk as it develops.

Practical Strategies for Contamination Prevention

Using environmental and process data to intervene earlier

A practical data-to-prevention pathway

Connect

Unify EMP, process, sanitation, and maintenance context

Trend

Establish normal and detect drift before limits are exceeded

Prioritize

Rank signals by likelihood, severity, and proximity to exposure

Act + Verify

Take proportional action and confirm effectiveness

Strategy 1: Connect Results to Operational Context

A result becomes more useful when it is tied to where, when, and why it occurred

Minimum context to capture

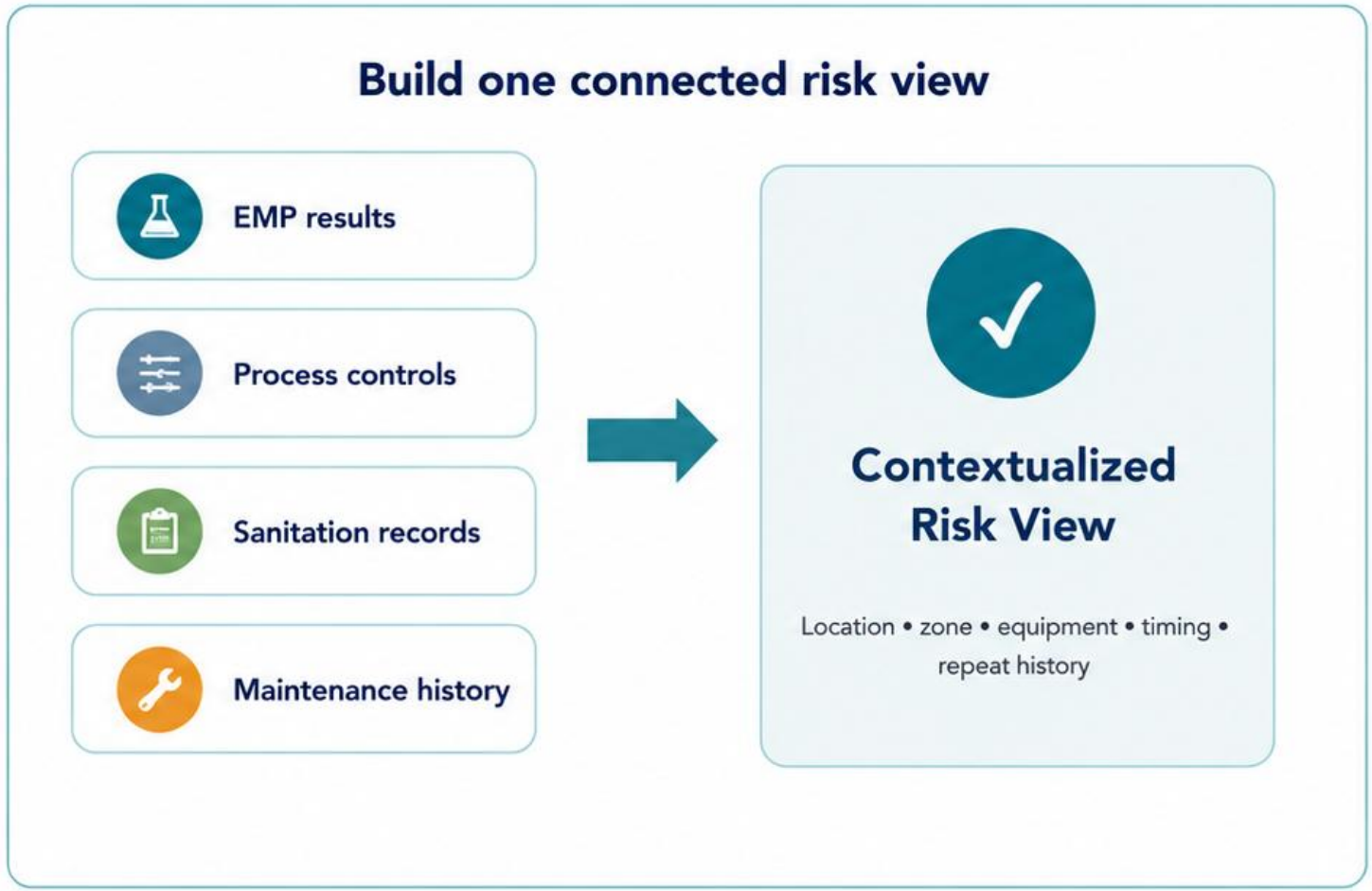
Location + zone
Line, room, zone, product exposure, and proximity to drains or equipment

Equipment + condition
Hard-to-clean design, recent repairs, downtime, or moisture history

Timing + operations
Shift, sanitation cycle, production schedule, and adjacent activities

Repeat history
Prior findings, recurring locations, and effectiveness of previous actions

Build one connected risk view



Strategy 2: Trend for Drift Before Limits Are Exceeded

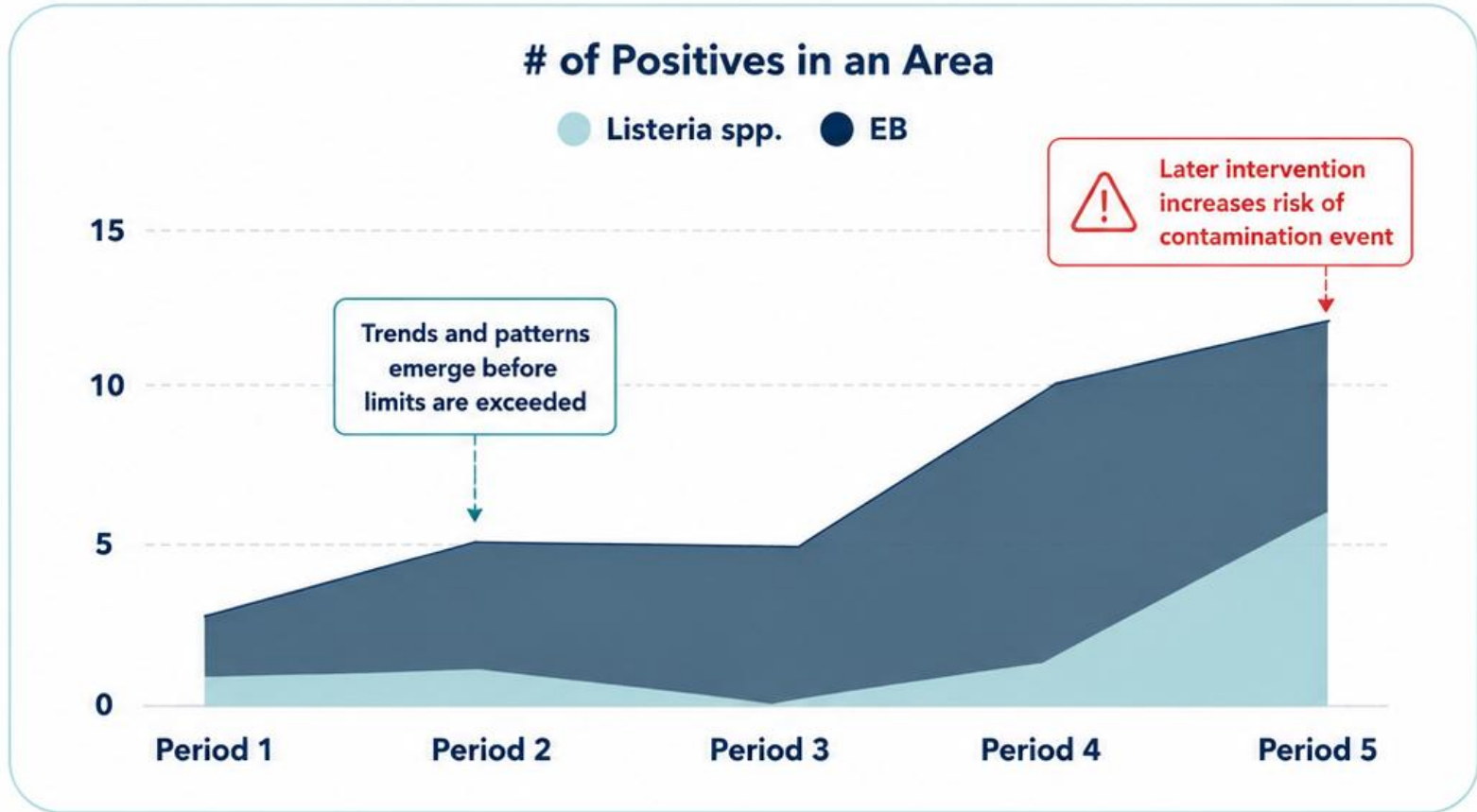
Use patterns to detect developing risk while there is still time to intervene

Practical tools

- Control charts
- Rolling averages
- Zone-based trends

Trigger investigation based on

- Drift
- Repeats
- Clustering—not only failed results



Example: A gradual Zone 2 indicator trend may justify investigation even while individual results remain within specification.

Strategy 3: Act Proportionally, Then Verify

Match the response to the risk signal and feed the learning back into the system

Risk-based response ladder

	Signal	Risk interpretation	Practical action	Verify
1	**Isolated finding in lower-risk area**	Important, but not part of a broader pattern	Routine resample and observation	**No recurrence**
2	**Repeat or clustered findings**	Pattern suggests a developing lapse	Targeted vectoring + sanitation adjustment	**Follow-up monitoring**
3	**Trend near exposure or hard-to-clean equipment**	Higher likelihood + higher potential impact	Cross-functional CAPA: maintenance, design, process	**Effectiveness confirmed**

Update baselines, action triggers, and preventive controls

Close the loop: an action is not complete until effectiveness is verified and the lesson improves future risk assessment.

Conclusion: Data-Driven, Risk-Based, Prevention-Focused

Turning environmental monitoring results into contamination prevention

A modern approach connects data to context, trends, and actions that matter.

1. Connect to Context

Link results to location, equipment, product exposure, timing, sanitation, maintenance, and history to understand the real risk.

2. Trend for Drift

Use patterns and trends to detect developing risk before limits are exceeded and before the event occurs.

3. Act Proportionally

Match the response to the risk signal—escalating actions as evidence and potential impact increase.

4. Verify & Learn

Verify effectiveness with follow-up monitoring and feed the learning back into baselines, triggers, and preventive controls.

The bottom line: When data is connected, patterns are visible, and actions are proportional and verified, environmental monitoring shifts from reacting to positives to preventing contamination events.

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