

Novel Predictive Analytic Tools to Inform Food Safety Decisions

Division of Risk and Decision Analysis, Office of Analytics and Outreach
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Overview

The Division of Risk and Decision Analysis, within CFSAN's Office of Analytics and Outreach, develops novel predictive analytical tools that can integrate data and information from a wide diversity of sources, sectors, and disciplines to derive new insights into particularly challenging food safety problems. These tools are virtual laboratories where scientists, stakeholders, and risk managers can explore the impact of different policies, practices, and events on the risk of illness to the consumer or population. Working with partners throughout the Agency, a suite of predictive models were developed to increase understanding of food safety and contamination pathways at various events in the food supply including restaurants, delicatessens, and production of a variety of commodities including tree nuts, cheese, fresh-cut produce, sprouts. These predictive tools have been used to investigate root cause and identify prevention strategies that inform policies, guidance, and messaging that reduce contamination of food and illness of consumers. Prioritization tools help to optimize resource allocations by ranking options, generally on the basis of risk or public health impact. The Risk Ranking Model for Food Tracing (RRM-FT) is an example of a prioritization tool used to inform the development of a Food Traceability List for the FSMA Proposed Rule on Food Traceability

Making Science useful and accessible to maximize public health impact

- What could go wrong?
- How likely is it?
- What are the consequences?
- How can we prevent/mitigate it?

Decision Analysis Tools

Risk Ranking Model for Food Tracing (RRM-FT)

Available at: <https://www.cfsanapposternal.fda.gov/scripts/FDA/RiskRankingModelForFoodTracing/>

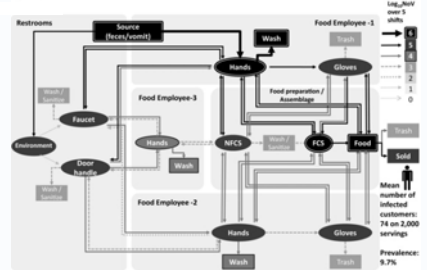
The RRM-FT tool is a web-based application that allows users to input data for various food categories and receive a risk ranking. The interface includes a search bar, a list of food categories, and a risk ranking matrix. The matrix shows risk levels (Low, Medium, High) for different food categories. The tool is designed to be user-friendly and accessible to a wide range of users.

Acknowledgements

The research presented in this poster benefited from the support of a number of individuals, organizations, and contracts. Full acknowledgements for each project is provided in the referenced manuscript/report.

Creating Virtual Worlds/Quantifying Public Health Impact

Quantitative Risk Assessment of Norovirus Transmission in Food Establishments: Evaluating the Impact of Intervention Strategies and Food Employee Behavior on the Risk Associated with Norovirus in Foods



Duret S, Pouillot R, Faniello W, Papadogiorgaki E, Liggins G, Williams L, Van Dorem JIM. Quantitative Risk Assessment of Norovirus Transmission in Food Establishments: Evaluating the Impact of Intervention Strategies and Food Employee Behavior on the Risk Associated with Norovirus in Foods. Risk Anal. 2017 Nov;37(11):2080-2106. doi: 10.1111/risa.12758. Epub 2017 Mar 1. PMID: 28475943. PMCID: PMC6023284

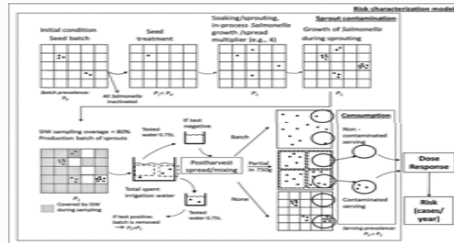
Cadmium: Mitigation Strategies to Reduce Dietary Exposure

The infographic details the sources of cadmium in the food supply and provides mitigation strategies for different food categories. It includes a flowchart of cadmium entry into the food supply, a table of cadmium entry into the food supply, and a table of mitigation strategies. The strategies are categorized into steps that can be taken by manufacturers and steps that can be taken by consumers.

Cadmium entry into the food supply	Steps that can be taken by Manufacturers	Steps that can be taken by Consumers
Mineral fertilizers	Discontinuing the use of cadmium plated ureters and granulated equipment for food production can minimize excess cadmium in food.	Eating a variety of foods can ensure a healthy diet.
Animal feed	Reducing cadmium-bearing stabilizers in plastics can minimize cadmium exposure.	Getting the proper amount of micronutrients (Zn, Fe, Ca) can prevent against cadmium absorption and toxicity.
Food processing	Removing cadmium-based pottery glazes on cookware can reduce cadmium exposure.	

Schaefer, H.R., Dennis, S. and Fitzpatrick, S. (2020). Cadmium: Mitigation strategies to reduce dietary exposure. Journal of Food Science, 95: 260-267. <https://doi.org/10.1111/1750-3841.14997>

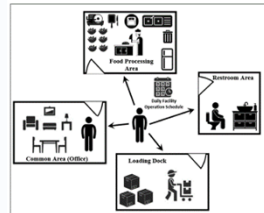
Salmonella – Sprouts Risk Assessment



Chen, Y., Pouillot, R., Santolana Farakos, S.M., Duret, S., Spangenberg, J., Fu, T., Shahr, F., Homola, P.A., Dennis, S. and Van Dorem, J.M. 2020. Risk Assessment of Salmonellosis from Consumption of Alfalfa Sprouts and Evaluation of the Public Health Impact of Sprout Seed Treatment and Sprout Irrigation Water. Risk Analysis, 38: 1738-1757. <https://doi.org/10.1111/risa.12864>

Quantitative Microbial Risk Assessment Model for Food Facilities (P²-QMRA)

An Agent-based model for microbial persistence and cross contamination dynamics in a food facility



Key Features

- Agent-based modeling (ABM)
- Explicit facility layout representation
- Dynamic schedule of events
- Spatial representation of contamination
- Persistence, survival, and growth
- Explicit definition of risk mitigation measures

Mukherji, A. and Van Dorem, J.M. (2019). An Agent-Based Model for Pathogen Persistence and Cross-Contamination Dynamics in a Food Facility. Risk Analysis, 39: 992-1021. <https://doi.org/10.1111/risa.12515>

FDA Interim Reference Level for lead

U.S. Food and Drug Administration's interim reference levels for dietary lead exposure in children and women of childbearing age

Brenna M. Flansbery*, Laurie C. Dolan, Dana Hoffman-Pemsel, Alexandra Gavelek, Olivia E. Jones, Richard Kanwal, Beverly Wolpert, Kathleen Gensheimer, Sherri Dennis, Suzanne Fitzpatrick

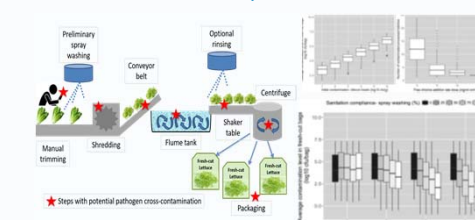
U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition, College Park, MD, USA

The infographic provides the FDA interim reference level for lead. It includes a table of reference levels for different food categories and a flowchart of the risk assessment process. The reference levels are based on the latest available data and are intended to protect children and women of childbearing age from lead exposure.

Food Category	Interim Reference Level (IRL) (ppm)
Infant formula	0.1
Infant cereal	0.1
Infant rice cereal	0.1
Infant rice cereal (with iron)	0.1
Infant rice cereal (without iron)	0.1
Infant rice cereal (with iron) (with iron)	0.1
Infant rice cereal (without iron) (with iron)	0.1
Infant rice cereal (with iron) (without iron)	0.1
Infant rice cereal (without iron) (without iron)	0.1

Flansbery, B.M., Dolan, L.C., Hoffman-Pemsel, D., Gavelek, A., Jones, O.E., Kanwal, R., Wolpert, B., Gensheimer, K., Dennis, S., Fitzpatrick, S., 2020. U.S. Food and Drug Administration's interim reference levels for dietary lead exposure in children and women of childbearing age. Regulatory Toxicology and Pharmacology, 110: 104616. <https://doi.org/10.1016/j.yrtph.2019.104616>

Pathogen Cross-Contamination Model for Postharvest Processing of Leafy Greens



Wolpert, B., Dolan, L.C., Flansbery, B.M., Gavelek, A., Jones, O.E., Kanwal, R., Gensheimer, K., Dennis, S., Fitzpatrick, S., 2020. Pathogen Cross-Contamination Model for Postharvest Processing of Leafy Greens. Risk Analysis, 40: 1000-1010. <https://doi.org/10.1111/risa.12864>

Revealing New Connections

Leveraging WGS Database to Enhance Risk Assessment, Attribution, and Large-scale Epidemiology Studies

The figure shows the use of Whole Genome Sequencing (WGS) data to enhance risk assessment and attribution. It includes a genomic graph, visualization and analysis tools, and categorizing isolates. The genomic graph shows the relationships between different isolates and their genetic makeup. The visualization and analysis tools allow users to explore the data and identify patterns. The categorizing isolates section shows how isolates are grouped based on their genetic characteristics.

Santa M. Pastore, K. Vagstad, S. Drake, E. Van Dorem, J.M., Gensheimer, K. A user-friendly open-source web application for foodborne pathogen whole genome sequencing data integration, analysis, and visualization. PLoS One. 2019 Feb;14(2):e0213039. doi: 10.1371/journal.pone.0213039

A Predictive Model for Survival of Escherichia coli O157:H7 and Generic E. coli in Soil Amended with Untreated Animal Manure

Use machine learning to:

- Quantify impact of environmental & agricultural factors
- Predict pathogen concentrations overtime under dynamic conditions

The figure shows the use of machine learning to predict the survival of E. coli in soil amended with untreated animal manure. It includes a table of environmental factors, a table of agricultural factors, and a series of predictive models. The environmental factors include precipitation, temperature, and soil moisture. The agricultural factors include manure type, soil management, and application method. The predictive models show the relationship between these factors and the survival of E. coli over time.

Pang, H., Mohitpour, A., Chen, Y., Oring, D., Ingram, D.T., Sharma, M., Miller, P.D. and Van Dorem, J.M. (2020). A Predictive Model for Survival of Escherichia coli O157:H7 and Generic E. coli in Soil Amended with Untreated Animal Manure. Risk Analysis, 40: 1387-1392. <https://doi.org/10.1111/risa.13491>

Implementing a Risk-risk Analysis Framework to Evaluate the Impact of Food Intake Shifts on Risk of Illness: A Case Study With Infant Cereal

Risk-Risk Framework: Dietary Shift

The figure shows the implementation of a risk-risk analysis framework to evaluate the impact of food intake shifts on the risk of illness. It includes a table of food additives and contaminants, and a graph showing the risk changes from infant rice cereal to infant oat cereal. The table lists various food additives and contaminants and their associated risks. The graph shows the risk of illness from different food intake shifts.

Sofia M. Santolana Farakos, Regis Poullet, Judith Spangenberg, Brenna Flansbery, Jane M. Van Dorem, and Sherri Dennis. 2021. Implementing a risk-risk analysis framework to evaluate the impact of food intake shifts on the risk of illness: a case study with infant cereal. Food Additives & Contaminants: Part A. <https://doi.org/10.1080/19448949.2021.1885152>