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del Lazio e della Toscana *M. Aleandri*

Valutazione del Rischio in ambito di sicurezza alimentare

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Gruppo Aziendale di Valutazione
del Rischio (GAVR)

Roma, 05/05/22

Hazard (Pericolo) vs Risk (Rischio)

You think Hazard and Risk is supposed to mean the same thing?

It is not.

The following slides shall explain the difference betweend a hazard and a risk.

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Concepts: Hazards

- Hazards:

Something that has the potential to have negative effect on our health. We call that negative effect unwanted outcome.

- Hazards:

A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect (*Codex Alimentarius Commission*)

Un agente biologico, chimico o fisico, o una condizione, presenti in un alimento e che possiede il potenziale per causare un effetto avverso alla salute

A condition or physical situation with a potential for an undesirable consequence (*Society for Risk Analysis*)

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Pericolo -esempi

- *Listeria monocytogenes* in formaggi erborinati
- Virus Epatite E in carni di cinghiale
- Prione BSE in carni bovine
- Tossina enterococcica in alimenti a base di riso
- Anisakis in prodotti ittici marinati
- Mercurio in prodotti ittici
- Sostanze chimiche derivanti da incendi in verdure
- Allergeni di latte e uova in prodotti carnei

Concepts: Risk

Risk:

- a situation involving exposure to danger
- the possibility that something unpleasant will happen

(*Compact Oxford English Dictionary of Current English*)

Risk:

- A function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard(s) in food.

(*Codex Alimentarius Commission –CAC*)

Una funzione della probabilità che un evento dannoso per la salute accada e la gravità dell'evento stesso, conseguente ad un pericolo alimentare

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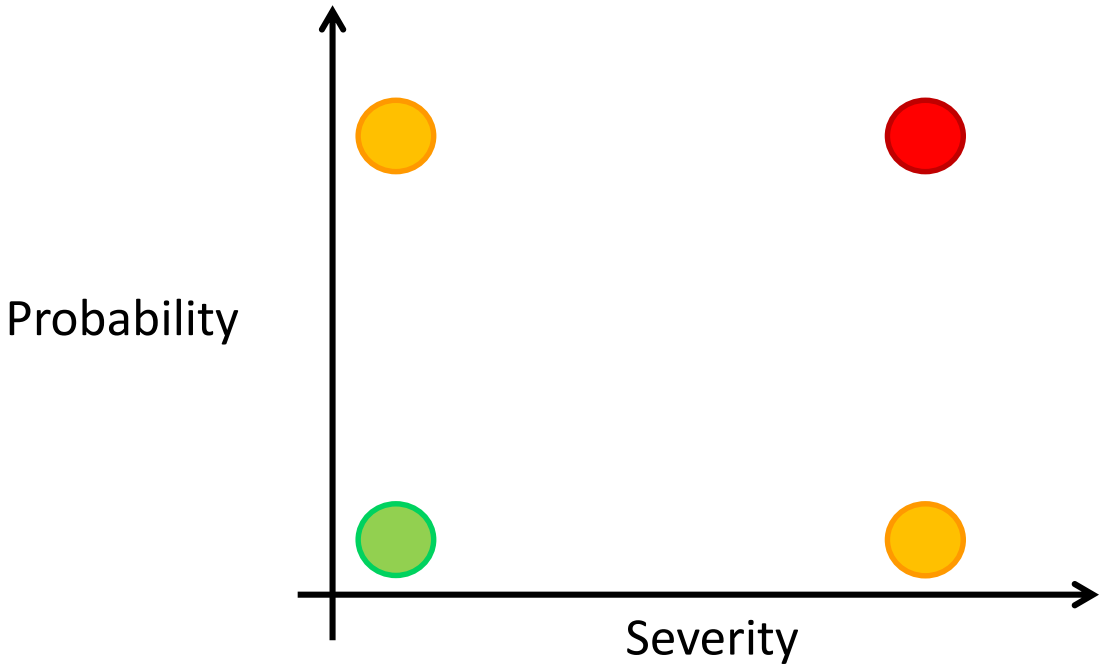
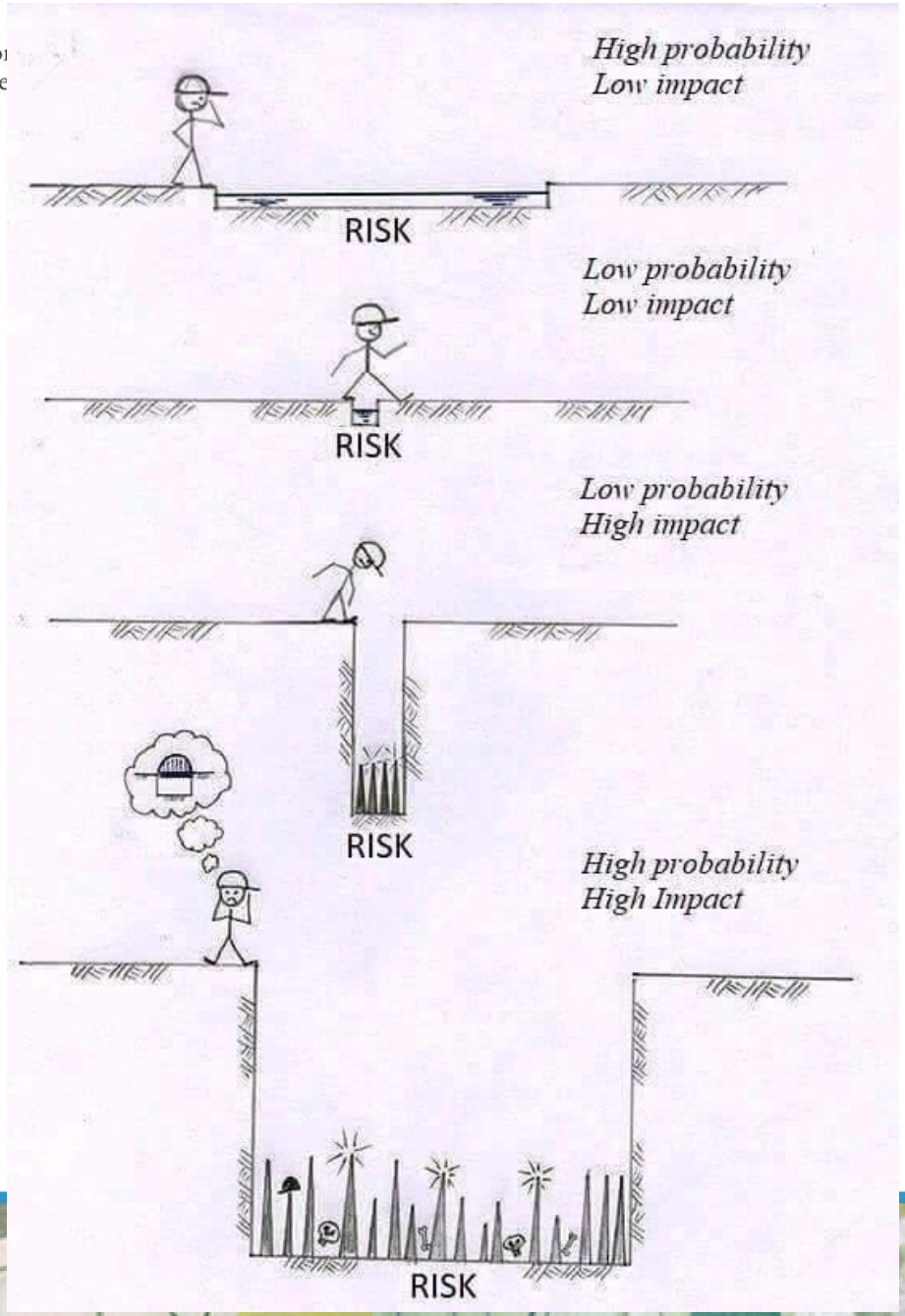
What is a risk?

Every risk is a combination of the probability to cause harm and the severity of the harm.



Risk estimation:
- low
- moderate
- high



source: www.tes.com

source: www.tes.com

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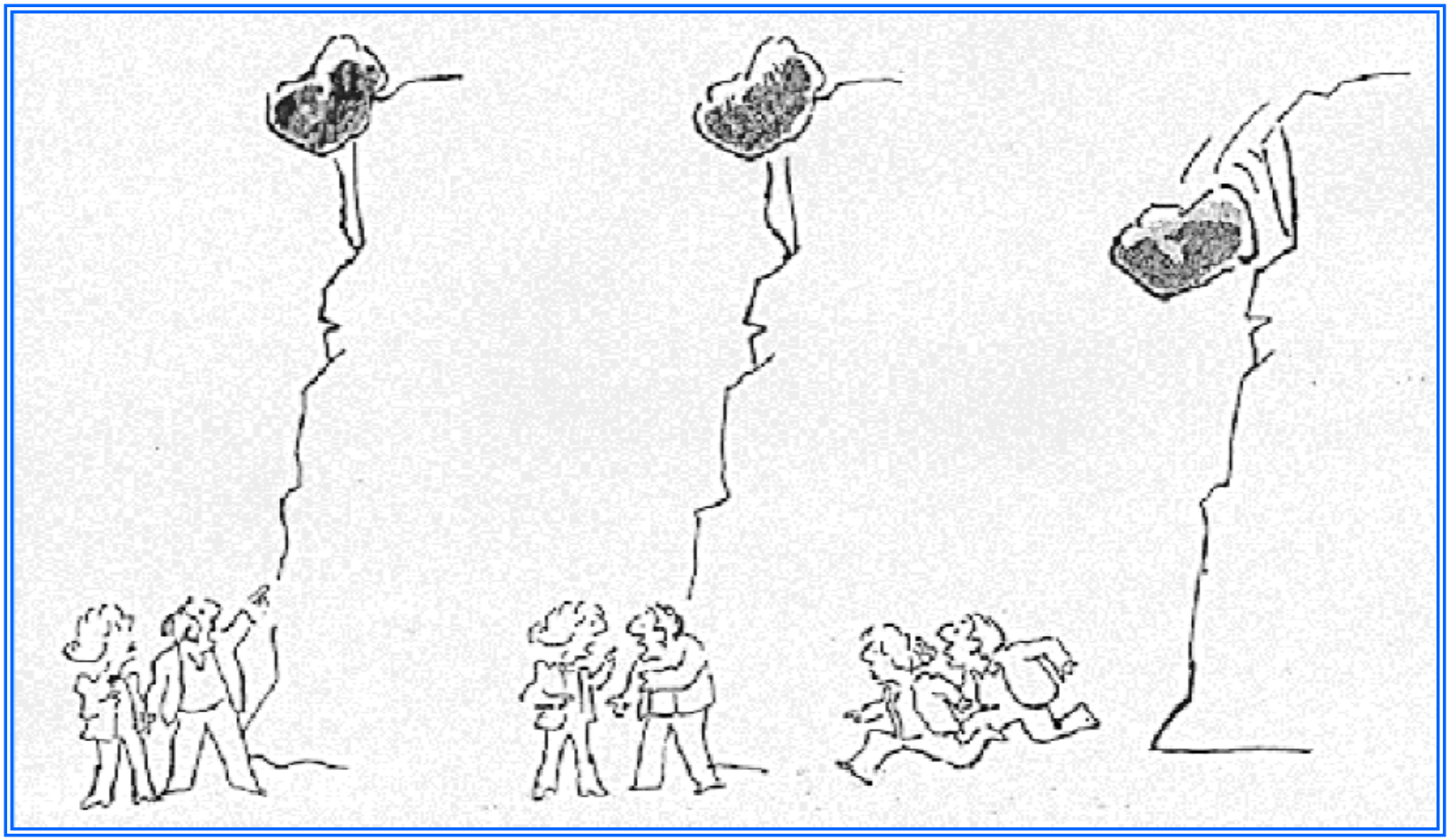
Componenti dell'Analisi del Rischio

VALUTAZIONE DEL RISCHIO GESTIONE DEL RISCHIO COMUNICAZIONE DEL RISCHIO



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SPECIAL ISSUE: **Advances in Terrorism Risk Analysis**

Risk Analysis

Bjoern Hagendorff,[1] Jens Hagendorff,[2,*] and Kevin Keasey[1]

The Impact of Mega-Catastrophes on Insurers: An Exposure-Based Analysis of the U.S. Homeowners' Insurance Market

Risk Analysis, Vol. 35, No. 1, 2015

Rob P. Rechard[1]

Historical Relationship Between Performance Assessment for Radioactive Waste Disposal and Other Types of Risk Assessment

Risk Analysis, Vol. 19, No. 5, 1999

Roberto Condoleo,[1] Laura Rinaldi,[2] Stefania Sette,[3] and Ziad Mezher[1,*]

Risk Assessment of Human Toxoplasmosis Associated with the Consumption of Pork Meat in Italy

Risk Analysis, Vol. 38, No. 6, 2018

Inizio anni 90: applicazione in campo veterinario e agri-zootecnico

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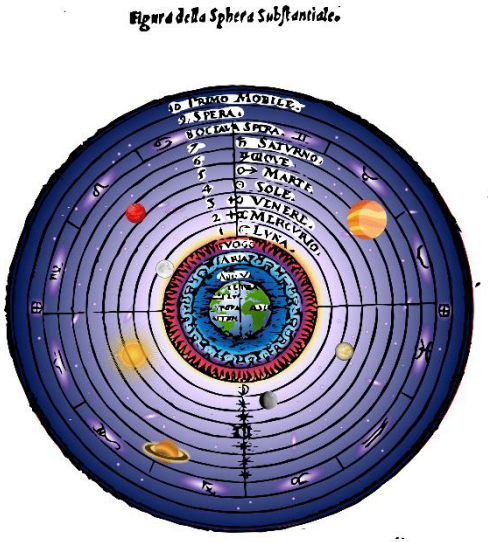
Risk assessment areas

- Food Safety → Microbial, Chemical
- Animal health → Import diseases, Transmission
- Plant Pest
- Environmental
- GMO
- Animal welfare

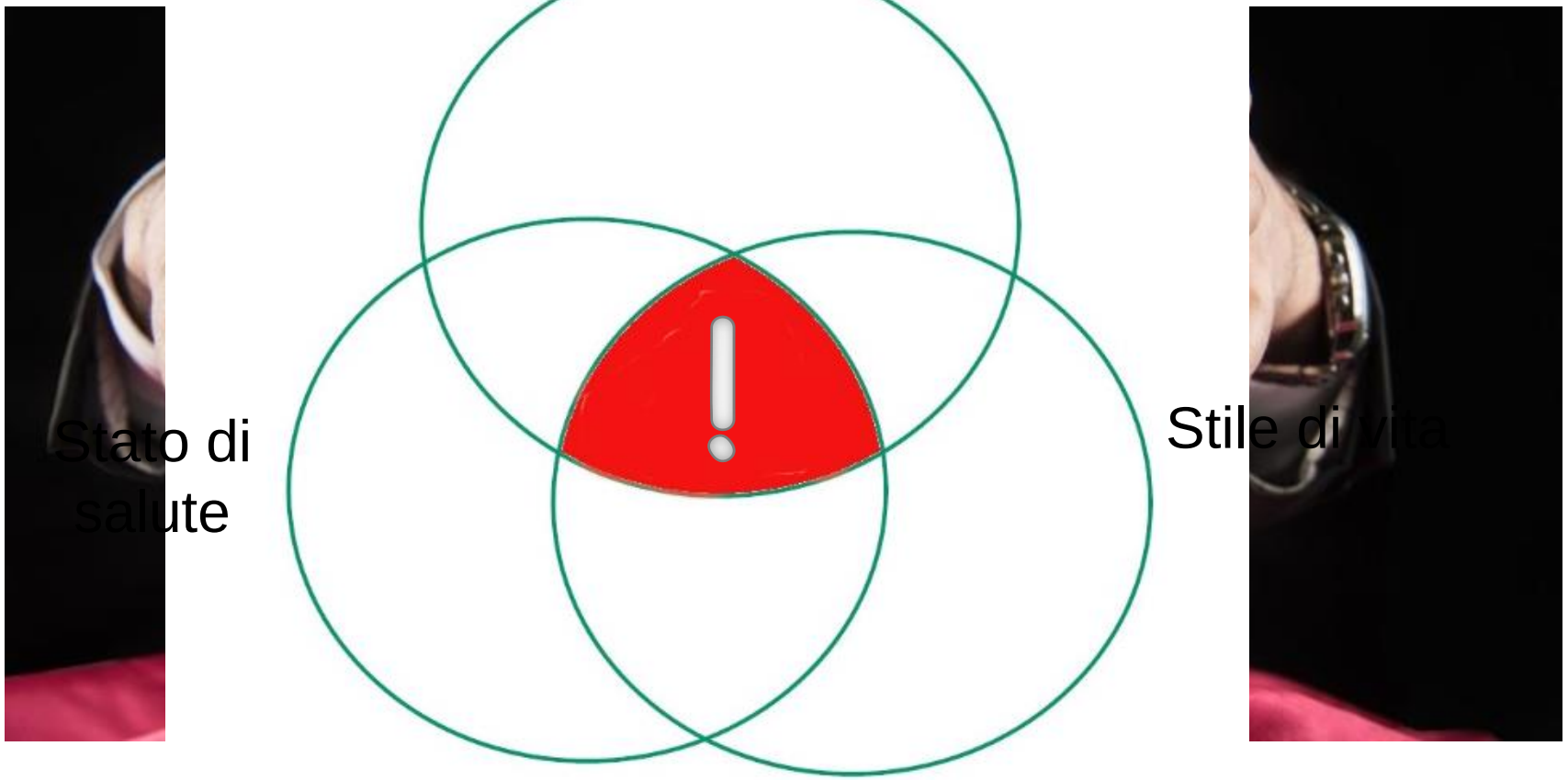
Valutazione del rischio

- Parte tecnica che si avvale di metodologie scientifiche
- La maggior parte delle valutazioni del rischio si avvalgono di modelli



https://www.youtube.com/watch?v=uWuNfhDvZz8&index=2&list=PL77B6F5984D1D92AE

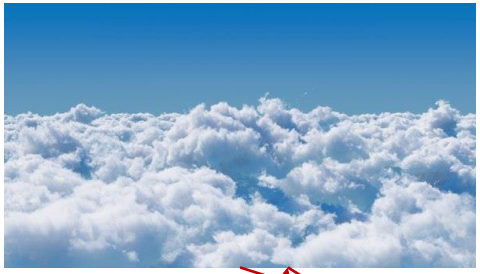
Modelli in Valutazione del Rischio



https://www.youtube.com/watch?v=uWuNfhDvZz8&index=2&list=PL77B6F5984D1D92AE

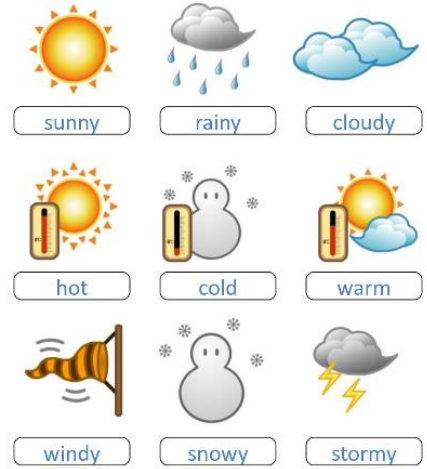
Modelling

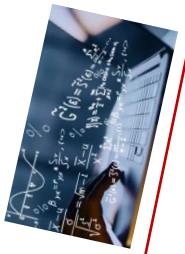
Come sarà il tempo a Roma nei prossimi giorni?

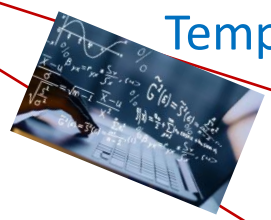


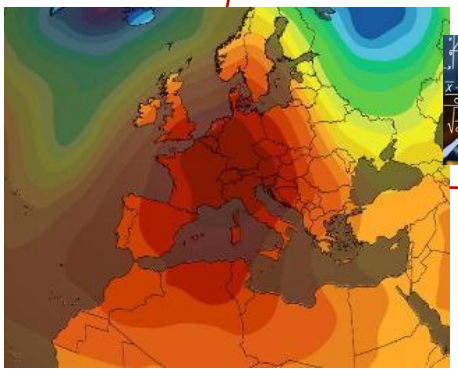
Masse d'aria = *M*

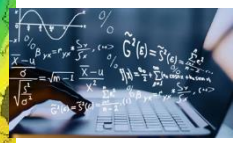
Temperatura = *T*

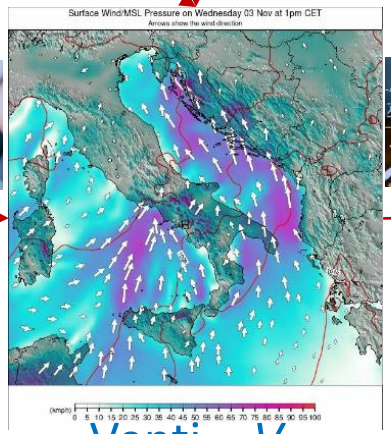










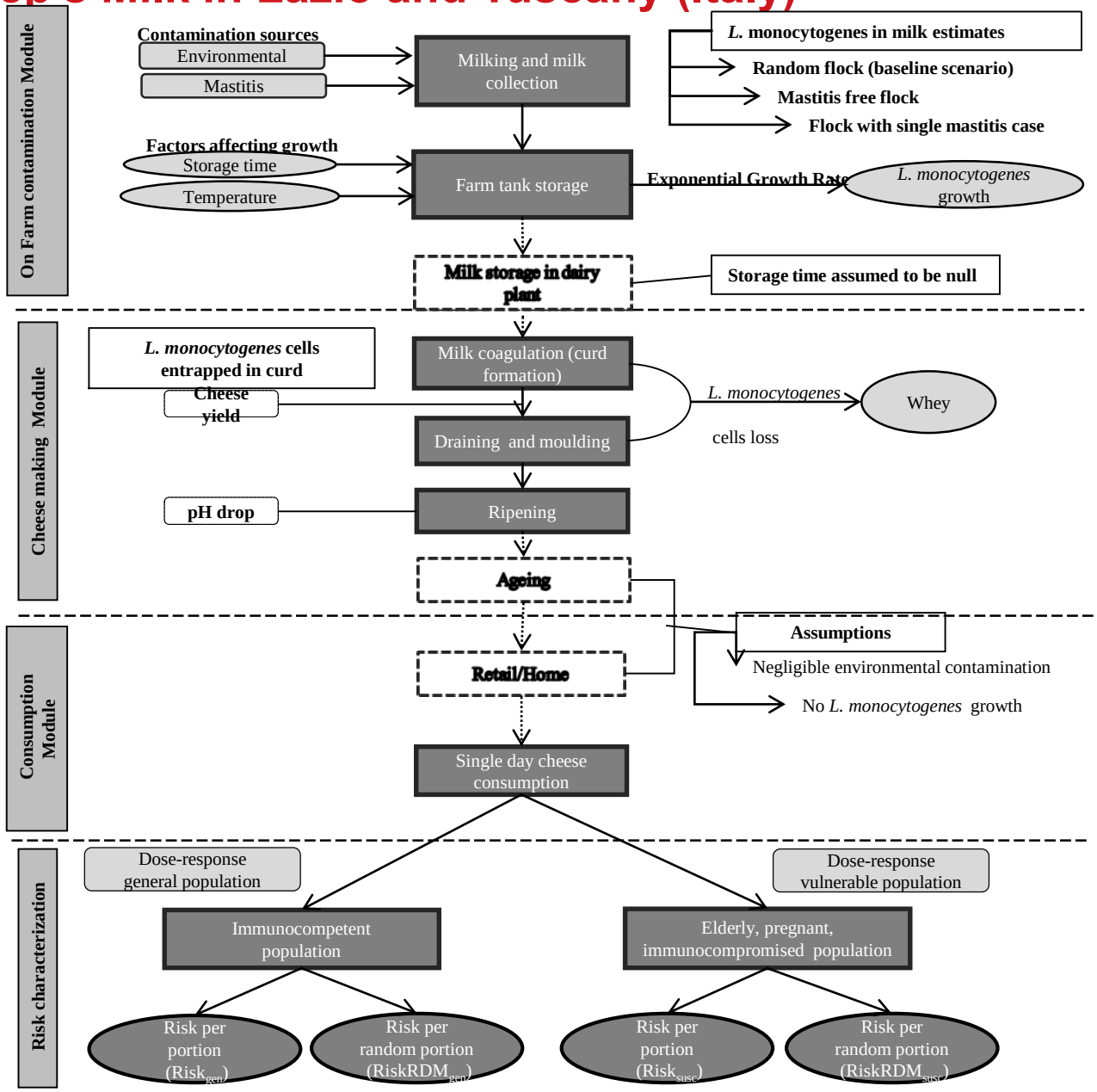


Pressione atmosferica *P*

Venti = *V*

Elementi naturali = *E*

Risk Assessment of Human Listeriosis from Semisoft Cheeses Made from Raw Sheep's Milk in Lazio and Tuscany (Italy)



EFSA Video [3:36 min]

https://www.youtube.com/watch?v=uWuNfhDvZz8&index=2&list=PL77B6F5984D1D92AE

Modellizzazione in Valutazione del Rischio

- Obiettivi della valutazione del rischio
  - spiegare e predire i rischi in sicurezza alimentare
  - Informare sulle possibili azioni da intraprendere e fornire raccomandazioni
- Differenti scenari di gestione del rischio possono essere esplorati
- Modelli
  - Sono semplificazioni della realtà
  - Necessitano di dati per essere creati
  - Hanno sempre delle limitazioni…
  - Ma rappresentano il meglio della nostra conoscenza e possono essere utili se “maneggiati con cura”

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TIPOLOGIE VALUTAZIONE DEL RISCHIO

QUALITATIVA

Risk level	Definition
Negligible	Event is so rare, does not merit consideration
Very low	Event is very rare, but cannot be excluded
Low	Event is rare, but does occur
Medium	Event occurs regularly
High	Event occurs very often
Very high	Event occurs almost certainly

QUANTITIVA

DETERMINISTICA

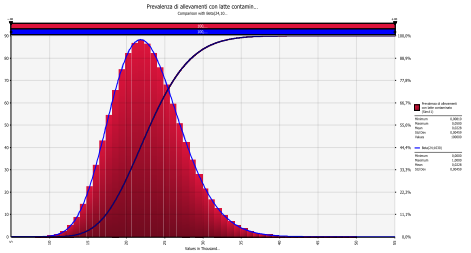
10^{-5}

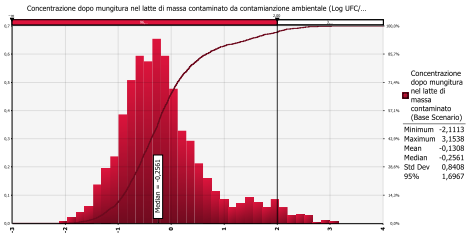
1/100,000

0.00001

0.001%

PROBABILISTICA STOCASTICA





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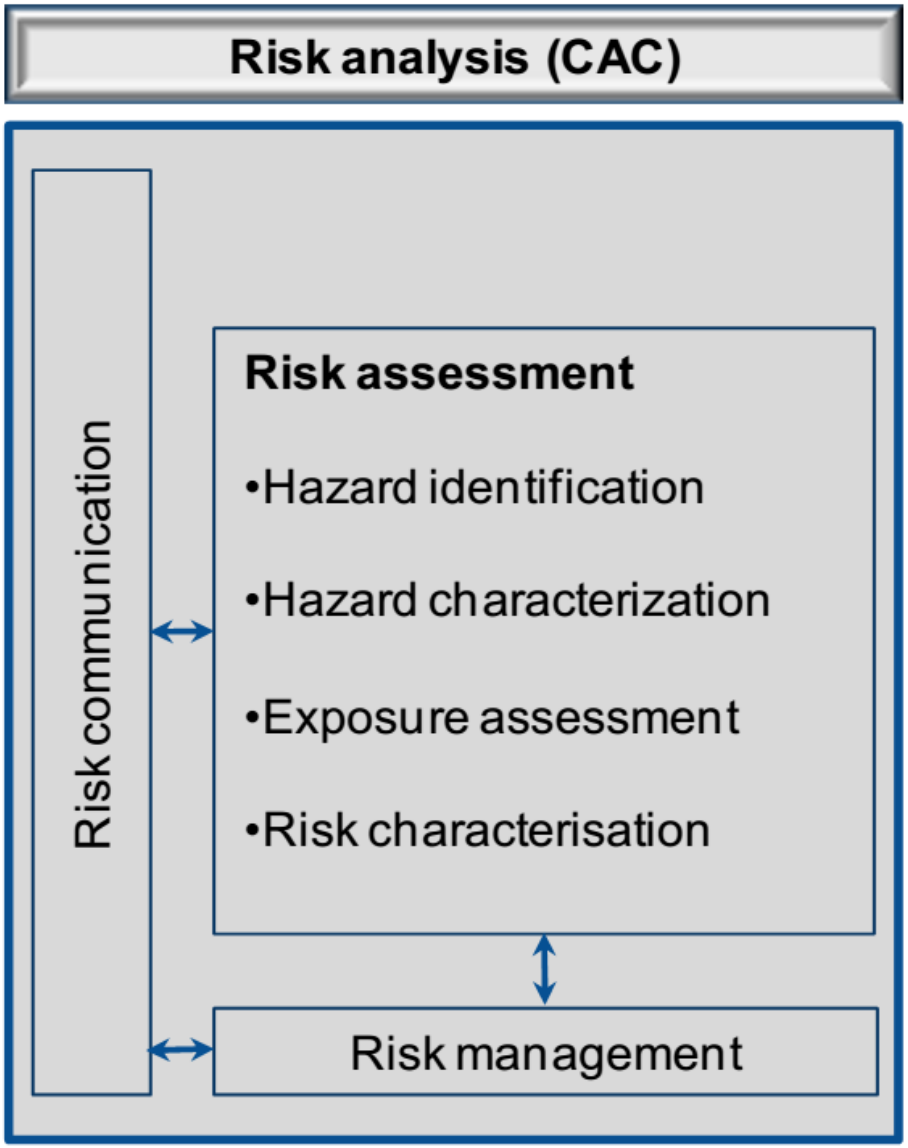
METODOLOGIE VALUTAZIONE DEL RISCHIO

Microbial Risk Assessment



IDENTIFICAZIONE DEL PERICOLO

CARATTERIZZAZIONE DEL PERICOLO

VALUTAZIONE DELL'ESPOSIZIONE

CARATTERIZZAZIONE DEL RISCHIO

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IDENTIFICAZIONE DEL PERICOLO

MATRIX

DISEASE

PATHOGEN

HOST

Valutazione dell'esposizione

Exposure assessment

Which is the exposure?
(frequency-amount)

Valutazione qualitativa e/or quantitativa della probabilità (e grado) di intake dell'agente biologico attraverso l'alimento come anche da altre fonti se rilevanti

The qualitative and/or quantitative evaluation of the likely intake of biological agent(s) via food as well as exposures from other sources, if relevant.

- Prevalence and/or Concentration at the time of consumption
- Consumption – Quantity and frequency

DELINEARE LA PATHWAY DI ESPOSIZIONE!

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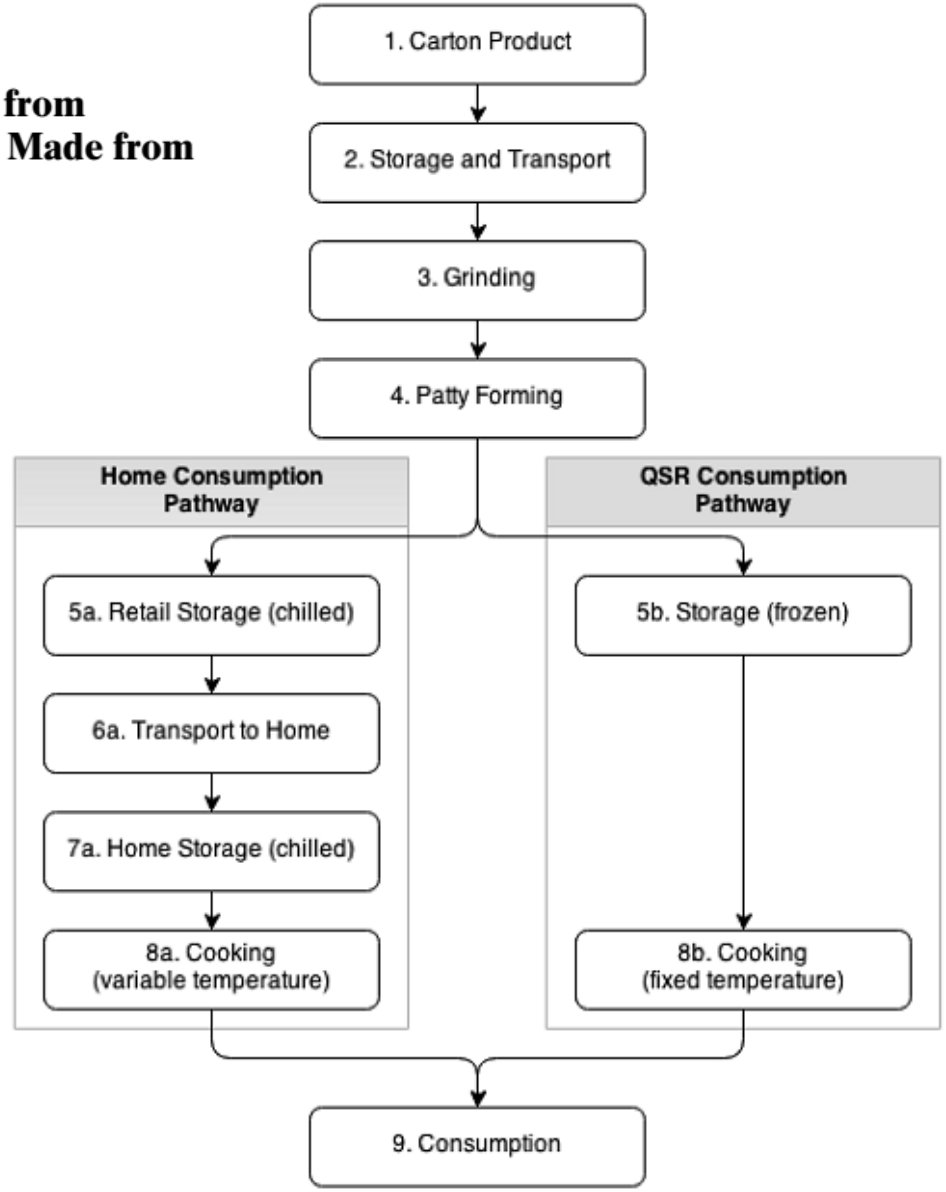
Exposure Assessment

Risk Assessment of *Escherichia coli* O157 Illness from Consumption of Hamburgers in the United States Made from Australian Manufacturing Beef

Risk Analysis, Vol. 35, No. 1, 2015



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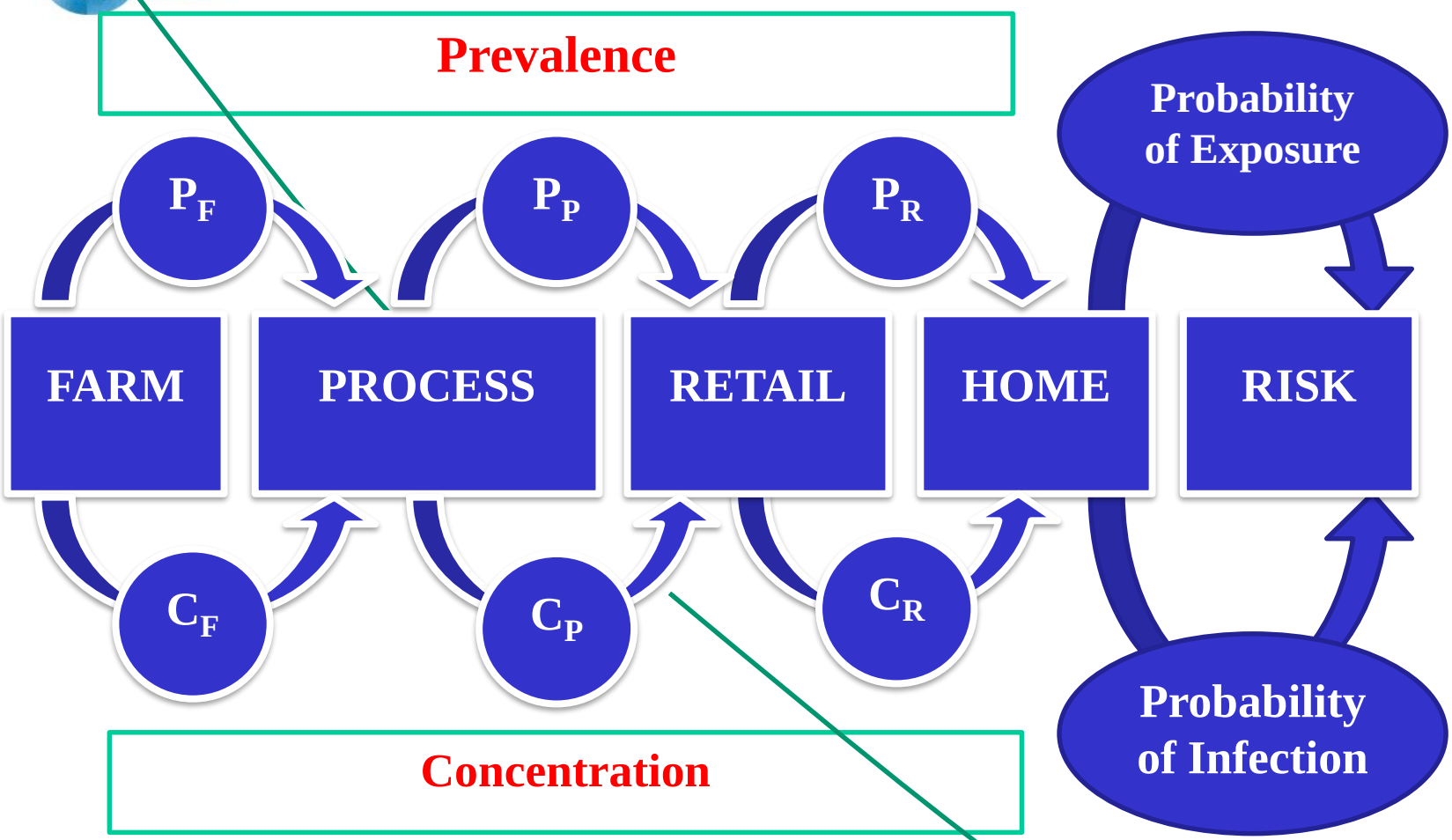
Exposure Assessment

Exposure Assessment



Source: Lammerding and Fazil, 2000

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Risk Assessment Infograph

Primary Production | Processing | Distribution | Retail Storage | Domestic Storage | Consumption

Exposure Assessment

N (LogCFU/g)

$N_{consumption}$ (LogCFU/g)

I_1

H_0 Starting Point

R_1

I_2

I_3

I_4

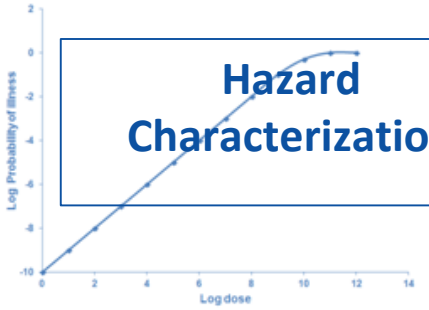
Hazard Identification

Exposure

(X) Serving

(X) No of Annual Servings in a population

Hazard Characterization



$P_{illness}$/serving

No of illnesses in the population per year

Risk Characterization

Dose-Response

Hazard characterisation / dose response (Caratterizzazine del pericolo)

Dose-Response-Relationship of microbial risks:

- the relationship between the amount of bacteria / toxin that people ingest and the likelihood that they will become ill;
- based on
  - observations in controlled clinical studies
  - disease outbreaks or
  - animal trails;

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Hazard characterisation / dose response

Table III. Mathematical Models Used for Dose-Response Curve Fitting

Model	Equation	Description	Reference
Exponential	$P(d) = 1–\exp(–rd)$	$P(d)$: probability of infection at dose d; d: dose; r: model parameter, interpret as the probability for one cell to successfully initiate a response	Haas *et al.* (1983)[49]
beta-Poisson	$P(d) = 1–(1 + d/\beta)^{-\alpha}$	$P(d)$: probability of infection at dose d; d: dose; α: model parameter (infectivity); β: model parameter (shape)	Haas *et al.* (1983)[49]
Weibull	$P\,(d) = 1–\exp(–q_1 d^{q}{}_2)$	$P(d)$: probability of infection at dose d; d: dose; q_1: model parameter (infectivity); q_2: model parameter (shape)	Krewski *et al.* (1981)[50]
Log-logistic	$P\,(d) = \frac{1}{1+\exp[q_1 - q_2 \ln(d)]}$	$P(d)$: probability of infection at dose d; d: dose; q_1: model parameter (infectivity); q_2: model parameter (shape)	Prentice *et al.* (1976)[51]

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Hazard characterisation / dose response

Table II. Parameters of the Lognormal-Poisson Dose-response Model for Invasive Listeriosis Following the Ingestion of *L. monocytogenes* in Different Population Subgroups and Resulting Statistics for *r*, the Probability of Illness Following the Ingestion of One Cell of *L. monocytogenes*; The Distribution of *r* Includes the Individual Within-Group and the Strain Variability

	Estimates of a Log_{10} Normal Distribution[a] of *r*		Estimates of *r*			
Population Subgroup	μ	σ	Mean	50th Percentile	99th Percentile	99.9th Percentile
Less than 65 years old, no known underlying condition (i.e., "healthy adult")	−14.11	1.62	7.90×10^{-12}	7.82×10^{-15}	4.48×10^{-11}	7.68×10^{-10}
More than 65 years old, no known underlying condition	−12.83	1.62	1.49×10^{-10}	1.47×10^{-13}	8.44×10^{-10}	1.45×10^{-8}
Pregnancy	−11.70	1.62	2.01×10^{-9}	1.99×10^{-12}	1.14×10^{-8}	1.95×10^{-7}
Nonhematological cancer	−12.11	1.62	7.76×10^{-10}	7.68×10^{-13}	4.40×10^{-9}	7.54×10^{-8}
Hematological cancer	−11.02	1.62	9.60×10^{-9}	9.51×10^{-12}	5.44×10^{-8}	9.33×10^{-7}
Renal or liver failure (dialysis, cirrhosis)	−11.56	1.62	2.79×10^{-9}	2.76×10^{-12}	1.58×10^{-8}	2.71×10^{-7}
Solid organ transplant	−11.51	1.62	3.14×10^{-9}	3.11×10^{-12}	1.78×10^{-8}	3.06×10^{-7}
Inflammatory diseases (rheumatoid arthritis, ulcerative colitis, giant cell arteritis, Crohn's disease)	−12.08	1.62	8.43×10^{-10}	8.35×10^{-13}	4.78×10^{-9}	8.19×10^{-8}
HIV/AIDS	−12.19	1.62	6.50×10^{-10}	6.44×10^{-13}	3.69×10^{-9}	6.32×10^{-8}
Diabetes (type I or type II)	−13.13	1.62	7.47×10^{-11}	7.39×10^{-14}	4.23×10^{-10}	7.26×10^{-9}
Heart diseases	−13.30	1.62	5.01×10^{-11}	4.96×10^{-14}	2.84×10^{-10}	4.86×10^{-9}
Whole population	N/A[b]	N/A	1.19×10^{-10}	1.56×10^{-14}	2.47×10^{-10}	6.87×10^{-9}

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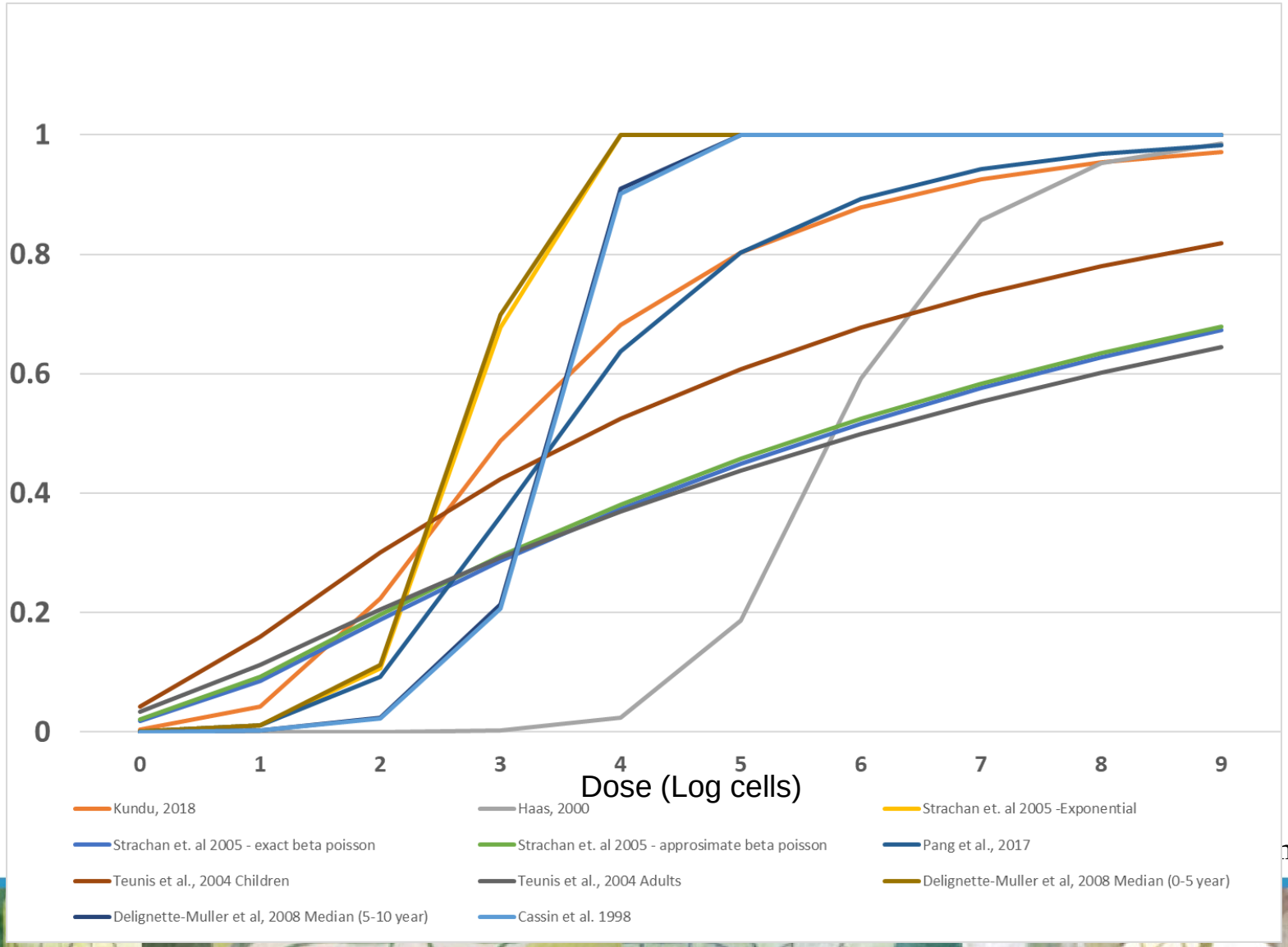
Shigatoxin-producing Escherichia coli (STEC) dose response



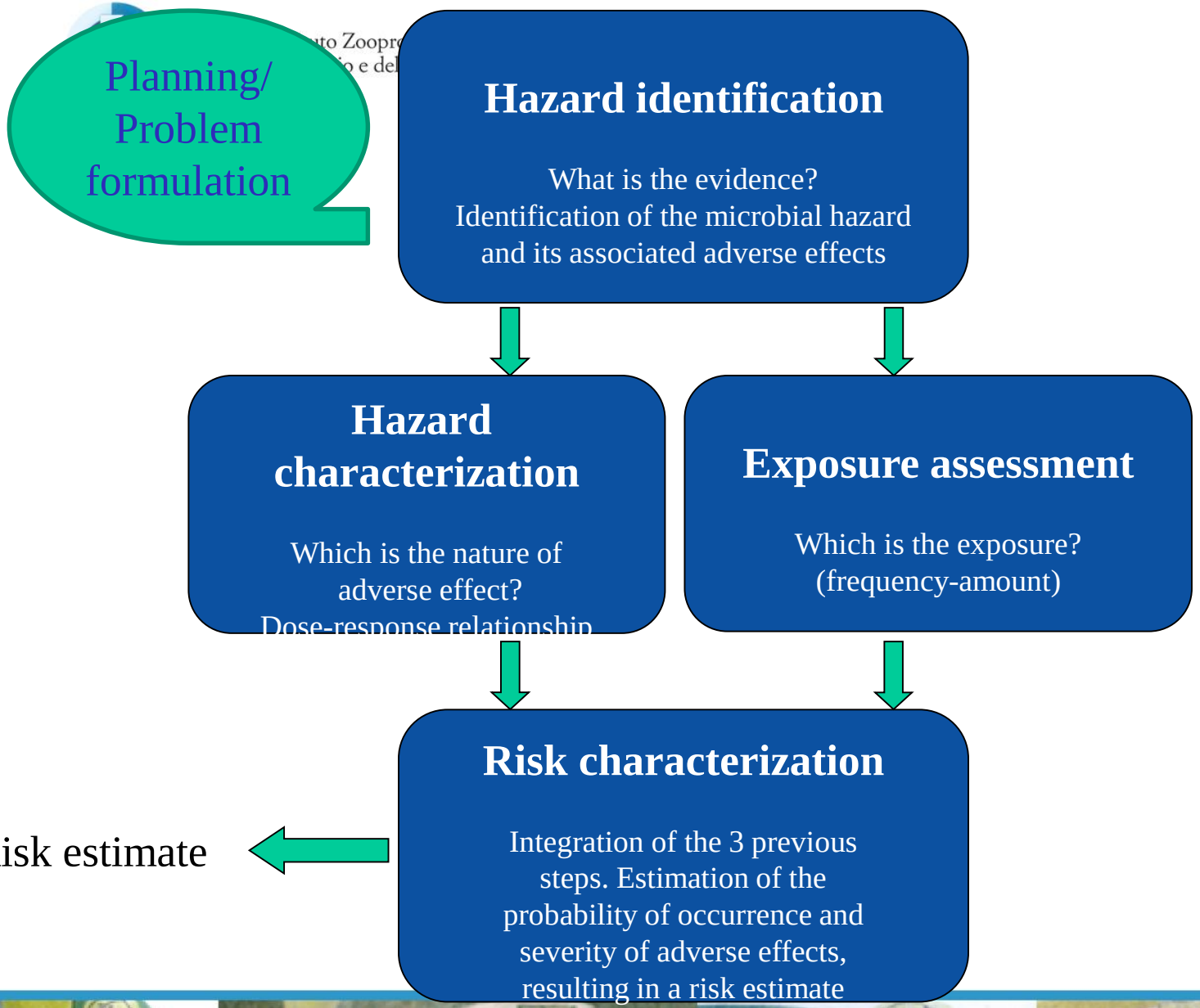

Planning/
Problem
formulation
Hazard identification
What is the evidence?
Identification of the microbial hazard
and its associated adverse effects
Hazard
characterization
Which is the nature of
adverse effect?
Dose-response relationship
Exposure assessment
Which is the exposure?
(frequency-amount)
Risk characterization
Integration of the 3 previous
steps. Estimation of the
probability of occurrence and
severity of adverse effects,
resulting in a risk estimate
Risk estimate

Table III. Estimated Risk per Portion (Contaminated or Random) and Annual Number of New Infections Associated with the Consumption of Pork Products in Italy (Baseline Scenario)

Category	Product	Risk per Contaminated Portion, Mean (5th, 95th, 99th Percentiles)	Risk per Random Portion, Mean (5th, 95th, 99th Percentiles)	New Infections per Year—Adults, Mean (5th, 95th, 99th Percentiles)	New Infections per Year—Pregnant Women, Mean (5th, 95th, 99th Percentiles)
Fresh meat	Fresh pork meat (generic)	5.5×10^{-5} (0, 9.4×10^{-5}, 1.4×10^{-3})	7.2×10^{-6} (0, 1.2×10^{-5}, 1.8×10^{-4})	5,737 (0, 9,848, 146,149)	42 (0, 73, 956)
	Fresh pork meat (steak)	4.7×10^{-5} (0, 8.2×10^{-5}, 1.2×10^{-3})	6.1×10^{-6} (0, 1.1×10^{-5}, 1.5×10^{-4})	2,354 (0, 4,138, 59,347)	17 (0, 30, 321)
	Fresh pork meat (leg)	5.5×10^{-5} (0, 9.4×10^{-5}, 1.4×10^{-3})	7.2×10^{-6} (0, 1.2×10^{-5}, 1.8×10^{-4})	641 (0, 1,097, 11,874)	5 (0, 8, 87)
	Fresh wild boar meat	5.5×10^{-5} (0, 9.5×10^{-5}, 1.4×10^{-3})	7.7×10^{-6} (0, 1.3×10^{-5}, 1.9×10^{-4})	75 (0, 128, 1,393)	1 (0, 1, 10)
	Fresh sausages	4.5×10^{-5} (0, 8.8×10^{-5}, 6.3×10^{-3})	5.9×10^{-6} (0, 1.2×10^{-5}, 1.5×10^{-4})	3,692 (0, 7,208, 92,545)	27 (0, 53, 680)
Salt-cured meat	Bacon	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)
	"Capocollo"—traditional meat product	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)
	Dry-cured ham	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)
	Dry-cured ham, light	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)
	Speck	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)
Fermented sausages/salami	Generic salami	4.1×10^{-6} (0, 1.7×10^{-5}, 9.6×10^{-5})	4.3×10^{-7} (0, 1.7×10^{-6}, 1.0×10^{-5})	14 (0, 57, 331)	0 (0, 0, 1)
	Salami with beef meat	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)
	Salami, Napoli type	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)
	Salami, Hungarian type	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)
	Salami, Milano type	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)
	Salami, Soppressata type	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)	0 (0, 0, 0)
All products				12,513 (0, 32,203, 318,854)	92 (0, 237, 2,343)

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EFSA Quantitative Microbiological Risk Assessment on *Salmonella* in Slaughter and Breeder pigs: Final Report

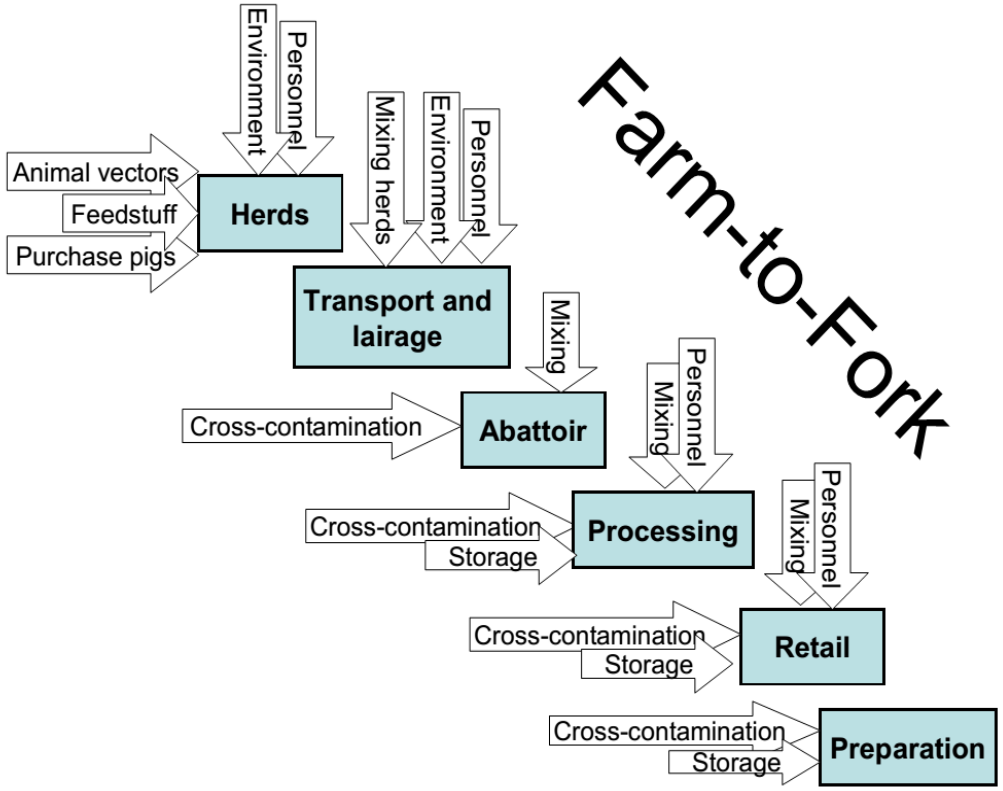

Figure 3.2: The farm-to-consumption chain of the pork production. Arrows indicate sources of introduction of *Salmonella* into the production chain.

- "Farm-to-consumption" simulation
- Concerns four different ("mysterious") European countries
- Main output: risk of human salmonellosis associated with 1) fresh meat pork cuts, 2) minced meat and 3) fermented sausages.

Esempi – Valutazione del rischio microbiologica

Qualitative risk assessment of cricket powder to be used to treat undernutrition in infants and children in Cambodia

K. Walia et al. / Food Control 92 (2018) 169–182

Table 5
Overall qualitative health hazard risk assessment for cricket powder that has been added to porridge and boiled prior to consumption by infants and children 6–23 months of age.

Organism	D-kill step (i.e., a rolling boil for 5 min)	Likelihood of occurrence[a]	Severity or Consequence	Risk rating
Bacillus cereus	Yes	Very Low to Low	Moderate	Low to Moderate
Clostridium perfringens Type A	Yes	Very Low to Low	Moderate	Low to Moderate
Clostridium perfringens Type C	Yes	Very Low to Low	Critical	Moderate to Serious
Cronobacter sakazakii	Yes	Negligible to Very Low	Critical	Low to Moderate
Enterohemorrhagic *Escherichia coli* (EHEC)	Yes	Negligible to Very Low	Critical	Low to Moderate
Listeria monocytogenes	Yes	Negligible to Very Low	Critical	Low to Moderate
Salmonella spp.	Yes	Negligible to Very Low	Major	Low to Moderate
Staphylococcus aureus	Yes	Negligible to Very Low	Moderate	Low

Risk Rating (R) = Likelihood (P) x Severity (I)*.

Table 3. Risk Rating (R) = Likelihood (P) x Severity (I)*

		Severity/Consequence (I)				
		Critical	Major	Moderate	Minor	Insignificant
Likelihood (P)		5	4	3	2	1
Very High	6	30 (Severe Risk)	24 (Severe Risk)	18 (Serious Risk)	12 (Moderate Risk)	6 (Low Risk)
High	5	25 (Severe Risk)	20 (Serious Risk)	15 (Serious Risk)	10 (Moderate Risk)	5 (Low Risk)
Medium	4	20 (Serious Risk)	16 (Serious Risk)	12 (Moderate Risk)	8 (Moderate Risk)	4 (Low Risk)
Low	3	15 (Serious Risk)	12 (Moderate Risk)	9 (Moderate Risk)	6 (Low Risk)	3 (Low Risk)
Very Low	2	10 (Moderate Risk)	8 (Moderate Risk)	6 (Low Risk)	4 (Low Risk)	2 (Low Risk)
Negligible	1	5 (Low Risk)	4 (Low Risk)	3 (Low Risk)	2 (Low Risk)	1 (Low Risk)

(Source: modified from ICMSF, 2002; FAO/WHO, 2009b; FAO, 2009; Monaghan et al., 2017).

*The risk ratings are classified into 4 categories: Low Risk (1-7), Moderate Risk (8-14), Serious Risk (15-21) and Severe Risk (22-30).

Esempi – Valutazione del rischio microbiologica

SCIENTIFIC OPINION

Cadmium in food[1]

Scientific Opinion of the Panel on Contaminants in the Food Chain

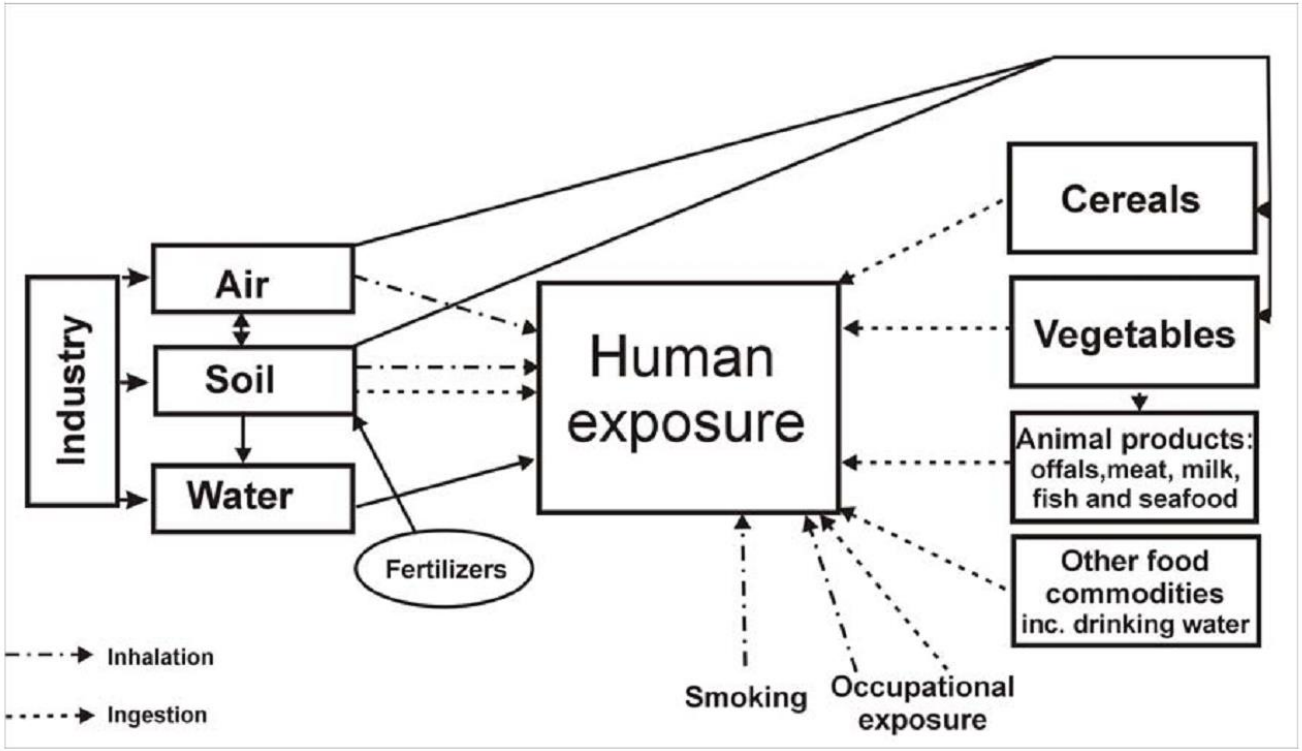

Figure 1. Sources of human exposure to cadmium

TERMS OF REFERENCE

contain an updated exposure assessment for cadmium, in particular addressing exposure from food (incl. drinking water) and indicate the relative importance from other non-dietary sources (e.g. air, cigarette smoke etc.);

Esempi – Valutazione del rischio chimico

Human campylobacteriosis related to the consumption of raw milk sold by vending machines in Italy: Quantitative risk assessment based on official controls over four years

		Percentage of young and adult consumers[a]				Percentage of young and adult consumers[b]				Percentage of young and adult consumers[c]			
		3.57% ≤5 years consumers		96.43% >5 years consumers		5.57% ≤5 years consumers		94.43% >5 years consumers		7.87% ≤6years consumers		92.13% >6 years consumers	
	% of consumers that do not boil raw milk before consumption	BS	WS	BS	WS	BS	WS	BS	WS	BS	WS	BS	WS
D–R-I	13.9[c]	82.1	62.7	107.7	82.3	128.1	97.9	105.4	80.6	150.6	115.2	103.9	79.4
	23[b]	135.8	103.8	178.2	136.2	211.8	162.0	174.5	133.4	249.2	190.5	171.9	131.4
	43[a]	253.9	194.1	333.1	254.7	396.1	302.9	326.2	249.4	465.8	356.2	321.4	245.7
D–R-II	13.9[c]	1428.8	1013.7	1874.6	1330.0	2229.2	1581.5	1835.7	1302.4	2621.7	1860.0	1808.7	1283.2
	23[b]	2364.2	1677.3	3101.9	2200.7	3688.6	2616.9	3037.6	2155.0	4338.1	3077.7	2992.9	2123.3
	43[a]	4419.9	3135.8	5799.2	4114.3	6896.1	4892.5	5678.9	4029.0	8110.3	5753.9	5595.3	3969.7

Federica Giacometti[a], Paolo Bonilauri[b], Simonetta Amatiste[c], Norma Arrigoni[d], Manila Bianchi[e], Marina Nadia Losio[f], Stefano Bilei[c], Giuseppe Cascone[g], Damiano Comin[h], Paolo Daminelli[f], Lucia Decastelli[e], Giuseppe Merialdi[i], Renzo Mioni[h], Angelo Peli[a], Annalisa Petruzzelli[k], Franco Tonucci[k], Silvia Piva[a], Andrea Serraino[a,*]

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GRAZIE PER L'ATTENZIONE...

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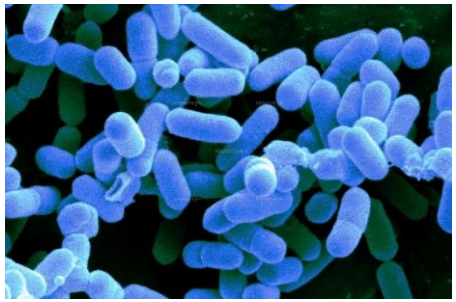
Risk Analysis, Vol. 37, No. 4, 2017

IDENTIFICAZIONE DEL PERICOLO

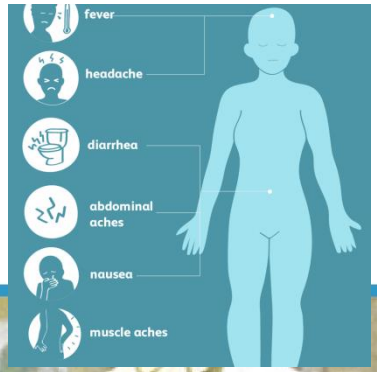
Risk Assessment of Human Listeriosis from Semisoft Cheeses Made from Raw Sheep's Milk in Lazio and Tuscany (Italy)

Roberto Condoleo,[1,*] Ziad Mezher,[1] Selene Marozzi,[1] Antonella Guzzon,[2] Roberto Fischetti,[1] Matteo Senese,[1] Stefania Sette,[3] and Luca Bucchini[2]



Pathogen: *Listeria monocytogenes*

Food product: Raw milk ovine's cheese produced by farmstead dairies in Lazio and Tuscany Region



Host: Humans

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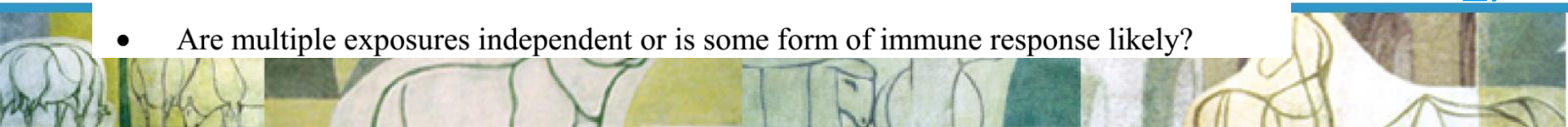
IDENTIFICAZIONE DEL PERICOLO

Addressing the following list of questions may help structure or refine the problem under consideration:

- What are the characteristics of the pathogen that affect its ability to cause disease in the host (e.g. infectivity, pathogenicity, virulence)?
- What adverse health effects may be associated with exposure to the pathogen (from mild and self-limiting symptoms, to life-threatening conditions)?
- Who is susceptible to infection (individual/subpopulation/population)?
- What are the characteristics of the exposed population that may affect its susceptibility (age, immune status, concurrent illness, medical treatment, genetic background, pregnancy, nutritional status, social status, behavioural traits)?
- How frequently does infection give rise to clinical disease?
- What are the short- and long-term consequences (morbidity, mortality, sequelae, years of life lost, impairment of quality of life)?
- What are the most important routes of transmission?
- How does the response of the organism to environmental stress (heat, drying, pH, etc.) affect its ability to cause infection and illness?
- How does the matrix (food or water) affect the ability of the organism to cause infection and illness?
- Are multiple exposures independent or is some form of immune response likely?

Diverse Guideline posso dare indicazioni per le informazioni da raccogliere



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Listeria monocytogenes- Description of the biological hazard

- Motile, Gram-positive non-sporeforming rods
- Family: Listeriaceae including 17 species
- Grows between -1^{o}C and 45^{o}C
- Ability to survive in a variety of foods under a range of environmental conditions
- The major human pathogen is *Listeria monocytogenes*.
- It is widely distributed in soil, stream water, sewage, plants, and food. Animals, including cattle, sheep and goats, can also carry the bacteria. Commonly found in food processing environments

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Listeria monocytogenes - Description of the adverse health effect

- Febrile gastroenteritis
- After invasion of intestinal tissue, *Listeria monocytogenes* may spread to blood, pregnant uterus or the central nervous system
- 2-3 weeks incubation time
- Major risk factor for immunocompromised, pregnant and elderly people.
- Fatal: septicemia, meningitis, abortion

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Listeria monocytogenes - Mode of transmission

- Mainly from foods
- Mother to child, zoonotically and hospital-acquired infections

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Listeria monocytogenes - Epidemiological data

Table 1: Reported hospitalisation and case fatality rates due to zoonoses in confirmed human cases in the EU, 2015

Disease	Number of confirmed[a]	Hospitalisation				Deaths			
	Human cases	Status available (%)	Number of reporting MS[b]	Reported hospitalised cases	Proportion hospitalised (%)	Outcome available (%)	Number of reporting MS[b]	Reported Deaths	Case Fatality (%)
Campylobacteriosis	229,213	27.0	17	19,302	31.2	73.7	16	59	0.03
Salmonellosis	94,625	34.0	16	12,353	38.4	55.6	16	126	0.24
Yersiniosis	7,202	23.9	14	530	30.9	59.8	14	0	0.0
STEC infections	5,901	39.4	14	853	36.3	56.2	15	8	0.24
Listeriosis	2,206	44.9	18	964	97.4	69.1	20	270	17.7
Tularaemia	1,079	14.9	9	89	55.6	15.6	10	0	0.0
Echinococcosis	872	20.5	13	107	59.8	23.5	13	1	0.49
Q fever	833	NA[c]	NA	NA	NA	47.7	12	3	0.36
Brucellosis	437	42.8	8	130	69.5	31.1	8	1	0.74
Trichinellosis	156	72.5	7	30	34.5	75.0	8	0	0.0
West Nile fever[a]	127	51.2	7	54	83.1	51.2	5	2	1.57
Rabies	0	NA[c]	NA	NA	NA	0.0	0	0	0.0

(a): Exception made for West Nile fever where the total number of cases was included.
(b): Not all countries observed cases for all diseases.
(c): NA-not applicable as the information is not collected for this disease.

Source: EFSA (European Food Safety Authority) and ECDC (European Centre for Disease Prevention and Control), 2016. The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2015. EFSA Journal 2016;14(12)

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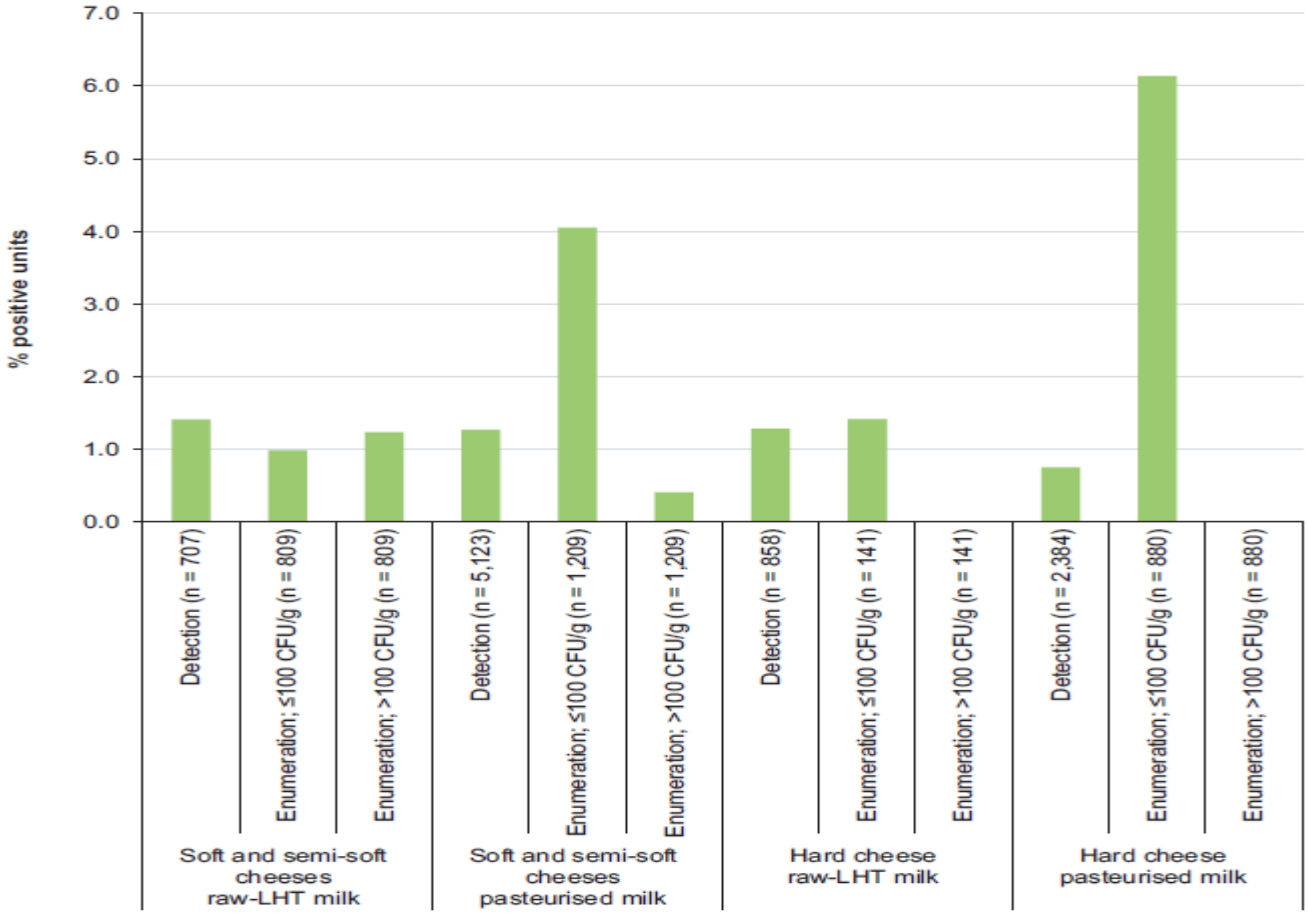
Occurrence/concentration data of *Listeria monocytogenes* in cheeses

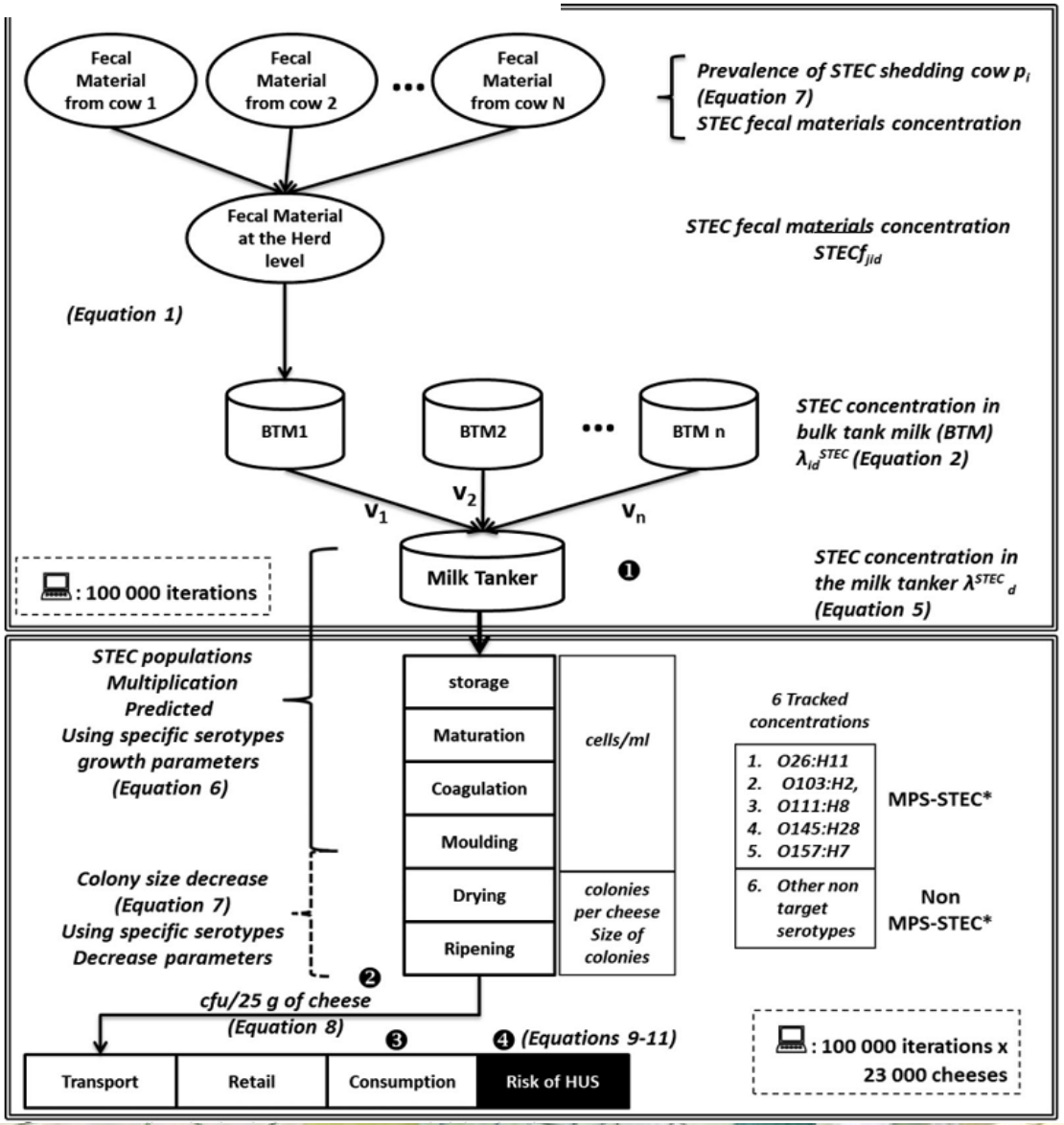


Source: EFSA (European Food Safety Authority) and ECDC (European Centre for Disease Prevention and Control), 2016. The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2015. EFSA Journal 2016;14(12)

Exposure Assessment

Quantitative Risk Assessment of Haemolytic and Uremic Syndrome Linked to O157:H7 and Non-O157:H7 Shiga-Toxin Producing *Escherichia coli* Strains in Raw Milk Soft Cheeses

Risk Analysis, Vol. 35, No. 1, 2015



Risk Assessment of Human Listeriosis from Semisoft Cheeses Made from Raw Sheep's Milk in Lazio and Tuscany (Italy)

On Farm contamination Module

Contamination sources
- Environmental
- Mastitis

→ Milking and milk collection

→ ***L.* monocytogenes in milk estimates**
- Random flock (baseline scenario)
- Mastitis free flock
- Flock with single mastitis case

Factors affecting growth
- Storage time
- Temperature

→ Farm tank storage → **Exponential Growth Rate** → *L. monocytogenes* growth

→ **Milk storage in dairy plant** → **Storage time assumed to be null**

Cheese making Module

***L. monocytogenes* cells entrapped in curd**

Cheese yield

Milk coagulation (curd formation) → Draining and moulding

L. monocytogenes cells loss → Whey

pH drop → Ripening → **Ageing**

Consumption Module

Assumptions
- Negligible environmental contamination
- No *L. monocytogenes* growth

Retail/Home → Single day cheese consumption

Risk characterization

Dose-response general population → Immunocompetent population → Risk per portion ($Risk_{gen}$); Risk per random portion ($RiskRDM_{gen}$)

Dose-response vulnerable population → Elderly, pregnant, immunocompromised population → Risk per portion ($Risk_{susc}$); Risk per random portion ($RiskRDM_{susc}$)