



Global commodity chains from a risk assessment perspective

Food Defense – More than secure supply chains

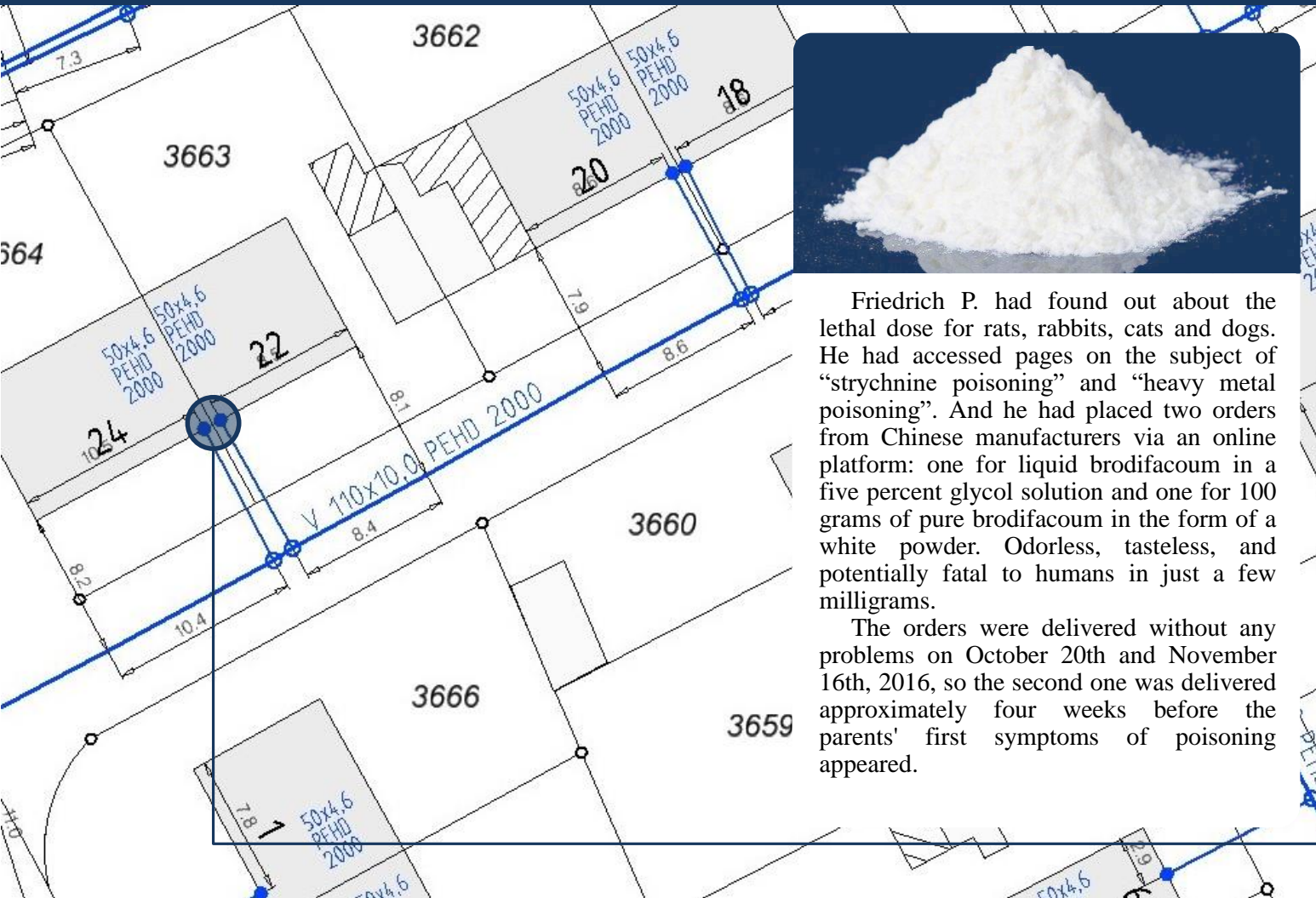
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May 28, 2024

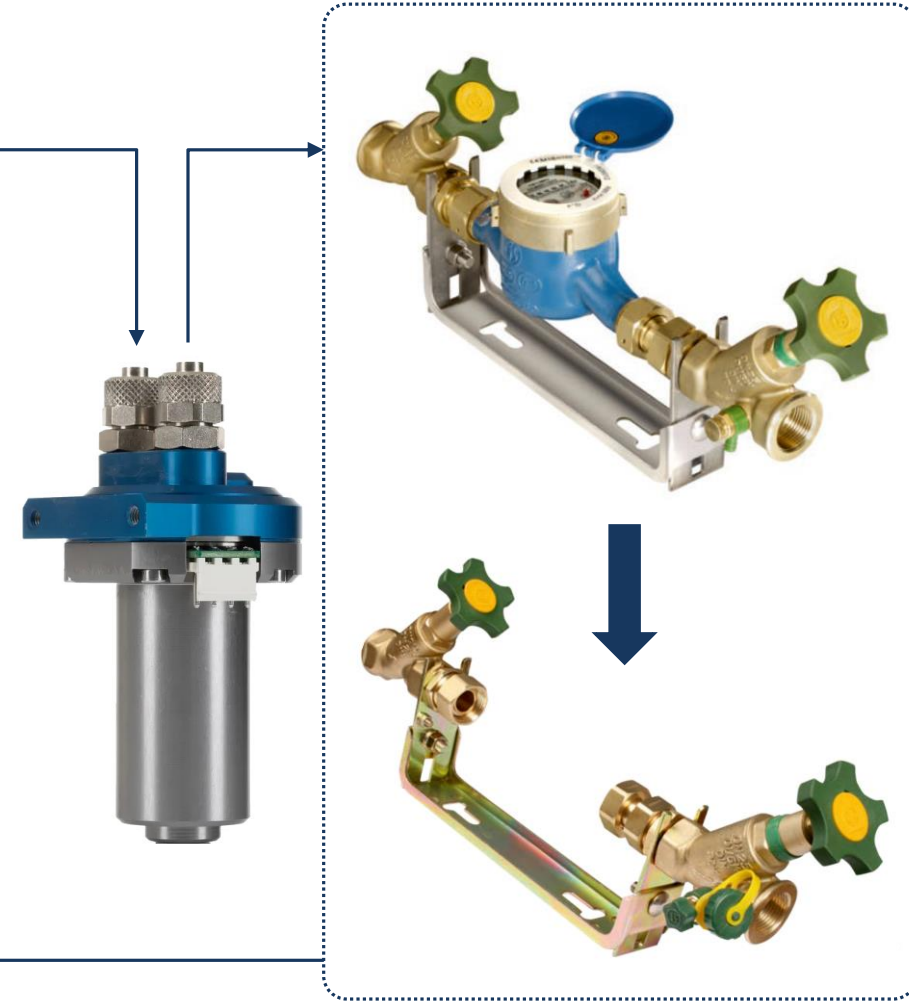


what if...



Friedrich P. had found out about the lethal dose for rats, rabbits, cats and dogs. He had accessed pages on the subject of “strychnine poisoning” and “heavy metal poisoning”. And he had placed two orders from Chinese manufacturers via an online platform: one for liquid brodifacoum in a five percent glycol solution and one for 100 grams of pure brodifacoum in the form of a white powder. Odorless, tasteless, and potentially fatal to humans in just a few milligrams.

The orders were delivered without any problems on October 20th and November 16th, 2016, so the second one was delivered approximately four weeks before the parents' first symptoms of poisoning appeared.





safe(r) food

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food quality



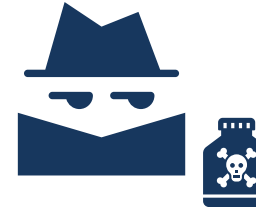
food safety

- preventing unintentional contamination of foodstuffs (official food monitoring)
- safeguarding food supply (global supply chains and flows of goods)

food security



food fraud



food crime



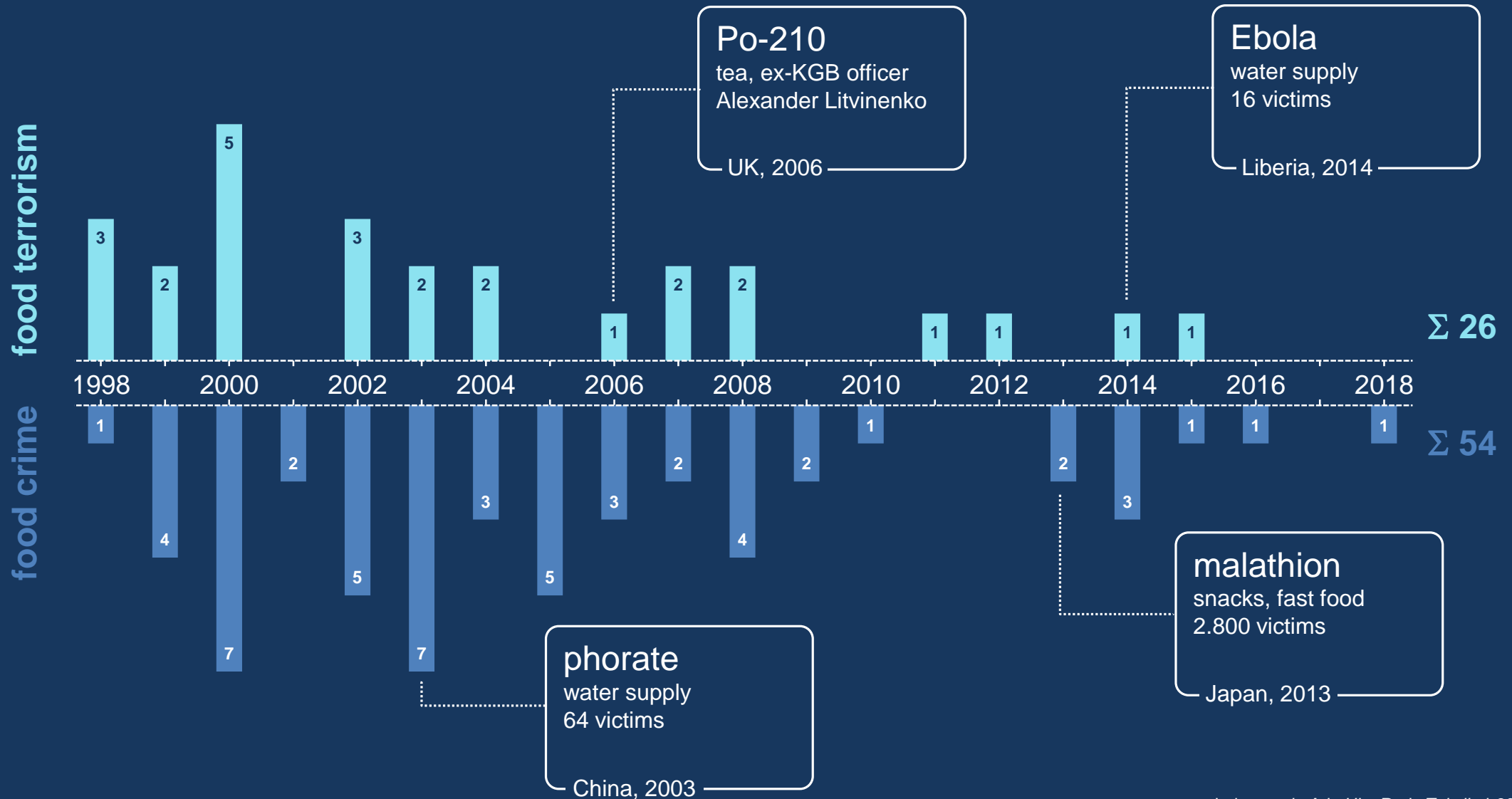
food terrorism

- preventing intentional contamination
- motivation
 - economical (food fraud)
 - personal (food crime)
 - political/ideological (food terrorism)
- food crime/terrorism: health threat, fear!

food defense



food defense incidents 1998-2018





FCRA (Food Crime Risk Assessment)

- standards & specifications
 - ISO 22000:2018
 - BSI PAS 96:2017
 - NATO AMedP-4.12:2019
- certification systems
 - GFSI, e.g. IFS Food 8, BRCGS Food Safety 9, FSSC 22000 Food Safety
- legislation
 - USA „Mitigation Strategies To Protect Food Against Intentional Adulteration“ (21 CFR 121)

requirements

VACCP

food fraud

- VACCP: vulnerability assessment and critical control points (focus: weaknesses)
- TACCP: threat assessment and critical control points (focus: threats)
- CARVER: criticality, accessibility, recuperability, vulnerability, effect, recognizability, (shock)
- FDA Food Defense Plan Builder
- CVUA Stuttgart VoLT checklist

TACCP, CARVER

food crime / terrorism



concepts, tools



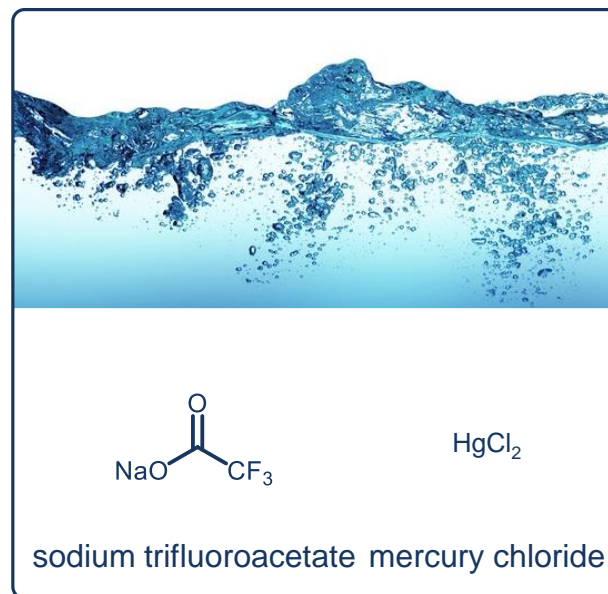
weak spot: detection



project EDEN – End-user driven DEMo for cbrNe

(chemical, biological, radiological, nuclear, explosive)

- development of rapid detection methods for shorter reaction times
- increasing resilience of the food supply chain





weak spot: detection



project EDEN – End-user driven DEMo for cbrNe

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- pH value
- water, protein, fat content
- hydroxyproline (connective tissue, BEFFE)
- salt, ash



- free selection of parameters (process/production water)



- arsenic
- lead
- copper
- pesticide screening (> 380)

lab analysis



weak spot: detection



project EDEN – End-user driven DEMo for cbrNe

(chemical, biological, radiological, nuclear, explosive)

- development of rapid detection methods for shorter reaction times
 - increasing resilience of the food supply chain
- none of the involved food industries/laboratories detected any contamination
 - focus on common and/or legally regulated parameters
- **Our “food defense” eye is blind!**



developing suitable detection methods

targeted analytics

Arsenic	Metalloid	LD: 70-180 mg	Vomiting, diarrhoea, dehydration, multisystem organ failure
Barium	Metal	LD ₅₀ : 132 mg/kg (rat)	Vomiting, abdominal pain, and watery diarrhoea, hypokalaemia, paralysis
Chromium VI	Metal	LD: 4.1 mg/kg	Irritation, ulceration and non-neoplastic lesions of the stomach and small intestine
Cyanide	Salts (sodium or potassium)	LD: 1.52 mg/kg	Headache, nausea/vomiting, cardiovascular collapse
Digoxin	Cardiac glycoside	LD: 10 mg	Nausea, vomiting, hyperkalaemia, and dysrhythmias
Dioxin	Industrial by-product	LD ₅₀ : 22 µg/kg (rat)	Chloracne
Ethylene glycol	Antifreeze agent	LD: 1,400-1,600 mg/kg	Vomiting, metabolic acidosis, renal failure
Fentanyl	Opioid	LD: 2 mg	Lethargy or coma, decreased respiratory rate, miosis, bradypnea, and possibly apnea
Lewisite	Chemical warfare agent	LD: 50mg/kg (rat)	burn of mouth and throat, severe stomach pain, nausea, vomiting, and bloody stools
Phosphorus white	Chemical warfare agent	LD: 100 mg/kg (rat)	Sweating, rapid heartbeat, tremor

- database development for relevant substances (toxicity, availability, manageability)
- consideration of intelligence information
- development of robust screening methods (e.g. EU FP7 SNIFFER)

non-targeted analytics

IRMS

NMR

LC-Q-TOF-MS

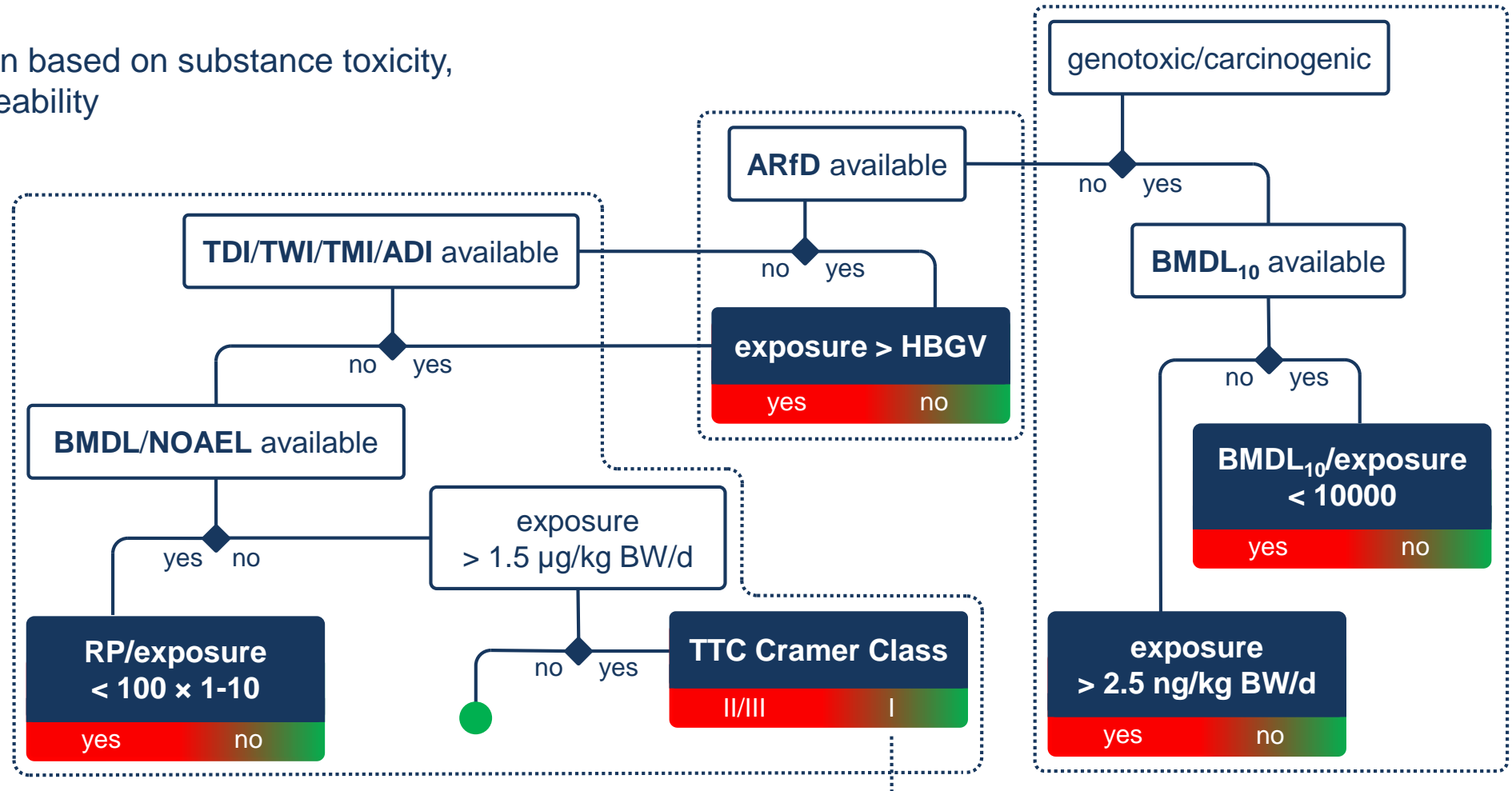
SORS

- “fingerprint” techniques are already established in the field of authenticity testing
- sensitivity may be insufficient
- lack of predicting toxicity
- alternatives: effect-related analysis, e.g. bioautography



database / software solutions

- decision tree design based on substance toxicity, availability, manageability

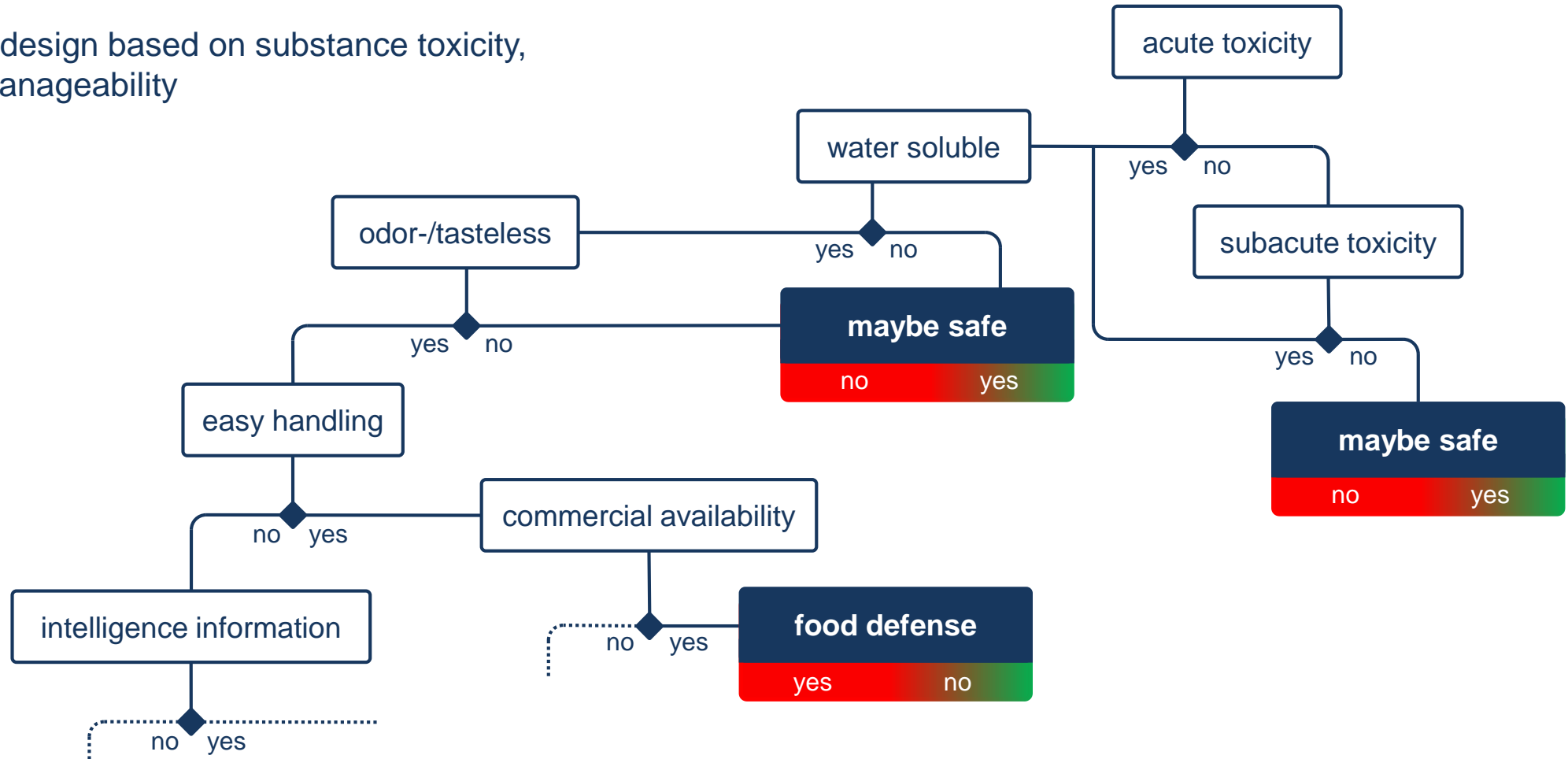


Fürst et al., EFSA J. 2019, 16, 1625



database / software solutions

- decision tree design based on substance toxicity, availability, manageability





effect-related analysis / “in vitro” taster



- a. acetylcholinesterase
- b. mitochondrial complexes (I-V)
- c. voltage-gated ion channels
- d. NMDA receptors
- e. cytochrome P450 enzymes
- f. DNA topoisomerases
- g. protein kinases (e.g., MAPKs, PKC)
- h. heat shock proteins
- i. ligand-gated ion channels
- j. sodium-potassium ATPase
- k. calcium channels and pumps
- l. cyclin-dependent kinases
- m. caspases
- n. glutamate receptors
- o. ryanodine receptors
- p. microtubules and tubulin
- q. glycolytic enzymes
- r. phospholipase A2
- s. caspase-8 and death receptors
- t. adrenergic receptors

ChatGPT

Based on substances listed in toxicity databases such as TOXNET that exhibit acute toxicity in humans, here are 20 prominent cellular targets:

- Acetylcholinesterase:** Inhibition leads to cholinergic toxicity, affecting neurotransmission.
- Mitochondrial Complexes (I-V):** Disruption affects ATP production and cellular respiration.
- Voltage-Gated Ion Channels:** Blockade alters cellular excitability and neurotransmission.
- NMDA Receptors:** Activation or blockade affects synaptic transmission and excitotoxicity.
- Cytochrome P450 Enzymes:** Inhibition affects metabolism of endogenous and exogenous compounds.
- DNA Topoisomerases:** Inhibition interferes with DNA replication and repair.
- Protein Kinases (e.g., MAPKs, PKC):** Dysregulation affects cellular signaling and responses.
- Heat Shock Proteins:** Disruption leads to impaired protein folding and cellular stress responses.
- Ligand-Gated Ion Channels (e.g., GABA receptors):** Modulation affects synaptic transmission and neuronal excitability.
- Sodium-Potassium ATPase:** Inhibition disrupts ion gradients and cellular homeostasis.



effect-related analysis / “in vitro” taster

- a. acetylcholinesterase
- b. mitochondrial complexes (I-V)

What substance would you use for an assault on the food supply chain, let's say the production of corn flakes?



Discussing or suggesting harmful actions, including assaults on the food supply chain, is against my use case policy. It's important to adhere to ethical and legal guidelines, ensuring the safety and integrity of the food supply chain. If you have any other questions related to food safety, security, or any other topic, I'd be happy to assist you.

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- p. microtubules and tubulin
- q. glycolytic enzymes
- r. phospholipase A2
- s. caspase-8 and death receptors
- t. adrenergic receptors

- 8. Heat Shock Proteins: Disruption leads to impaired protein folding and cellular stress responses.
- 9. Ligand-Gated Ion Channels (e.g., GABA receptors): Modulation affects synaptic transmission and neuronal excitability.
- 10. Sodium-Potassium ATPase: Inhibition disrupts ion gradients and cellular homeostasis.



immediate actions / targeted analysis

- heavy metals
- pharmaceuticals (opioids)
- rodenticides (superwarfarins)
- on-site detection techniques
- reach-back verification methods

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RESEARCH PAPER



Methods in food defence: a simple and robust screening for 16 rodenticides by LC-DAD/FLD following QuEChERS–based extraction

Georg Menacher¹  · Benedikt Masberg¹  · Paul W. Elsinghorst^{1,2,3} 

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Thank you for your attention

Stay alert!

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