PESTICIDES LABORATORY DIAGNOSIS AND TESTING

WHAT IS AVAILABLE AND WHAT'S TO COME

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Ministerial Advisory Committee on Foodborne Illnesses (MAC FBI)
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ROADMAP

Why laboratory testing matters in pesticide exposure

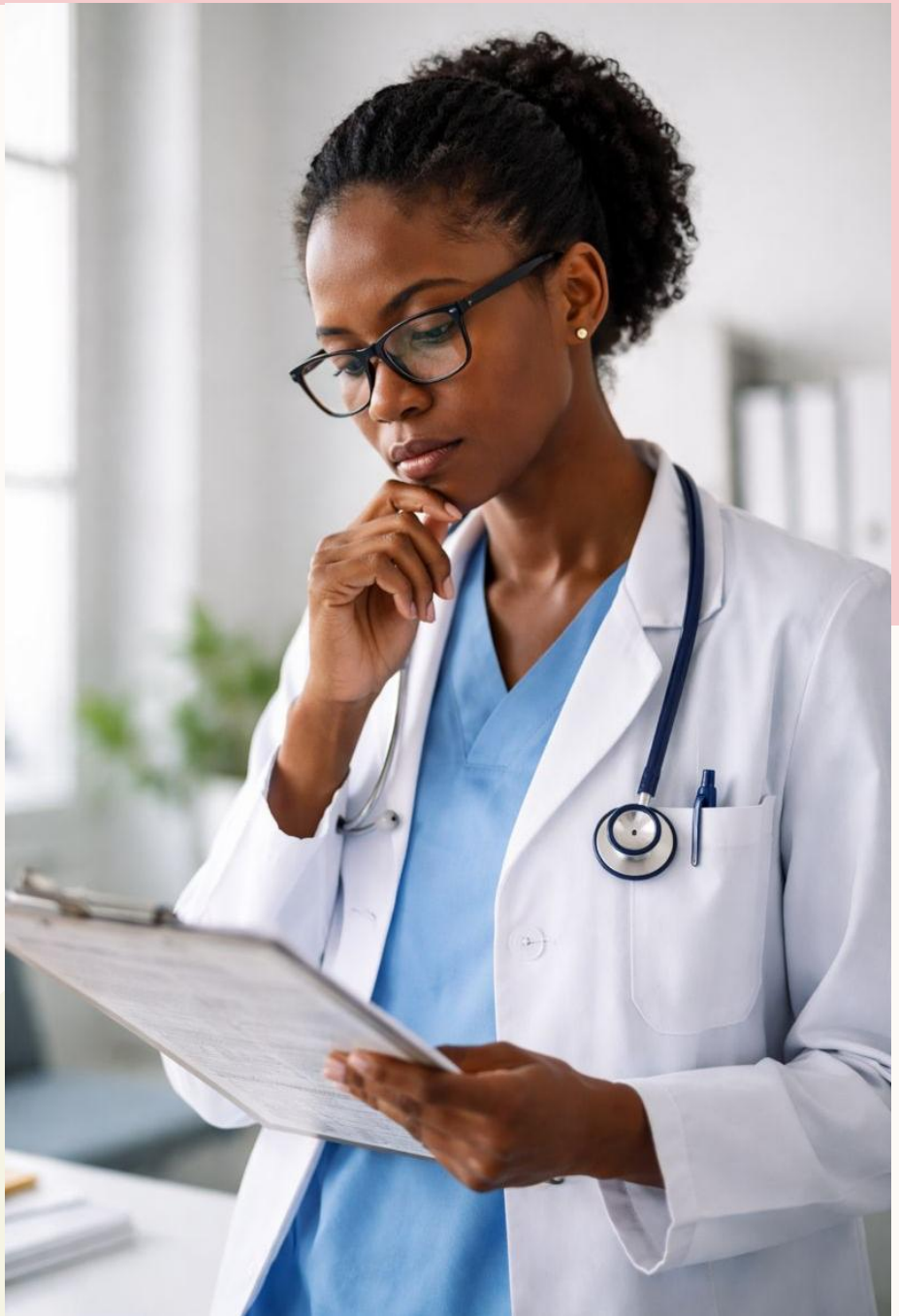
How pesticides are classified and named

Diagnosing pesticide poisoning

- Clinical diagnosis and routine lab tests
- Identifying pesticide groups (mechanism-based testing)
- Identifying specific pesticides (advanced toxicology)

WHAT QUESTION IS THE CLINICIAN ASKING?

- Is this a poisoning?
- Is this a pesticide?
- What class of pesticide?
- Which specific pesticide?
- How severe is the exposure?
- Is there ongoing risk?
- Is this occupational or accidental?



Acute pesticide exposure

Occupational exposure

THE PURPOSE OF LAB TESTING IN PESTICIDE EXPOSURE

Acute setting

- Support clinical decision-making in acute poisoning
- Confirm pesticide exposure
- Identify the mechanism of toxicity

Public health and prevention

- Enable surveillance, notification, and outbreak detection
- Support occupational health monitoring and risk assessment
- Generate data to inform policy and regulatory decisions

CLASSIFYING THE CHEMICAL

Target “pest” (primary use)

- Insecticides, herbicides, fungicides, rodenticides, etc.

Chemical type

- organophosphates, carbamates, pyrethroids, etc.

Toxicity level

- WHO categories

Physical state

- Solid, liquid, gas

Mode of action/entry

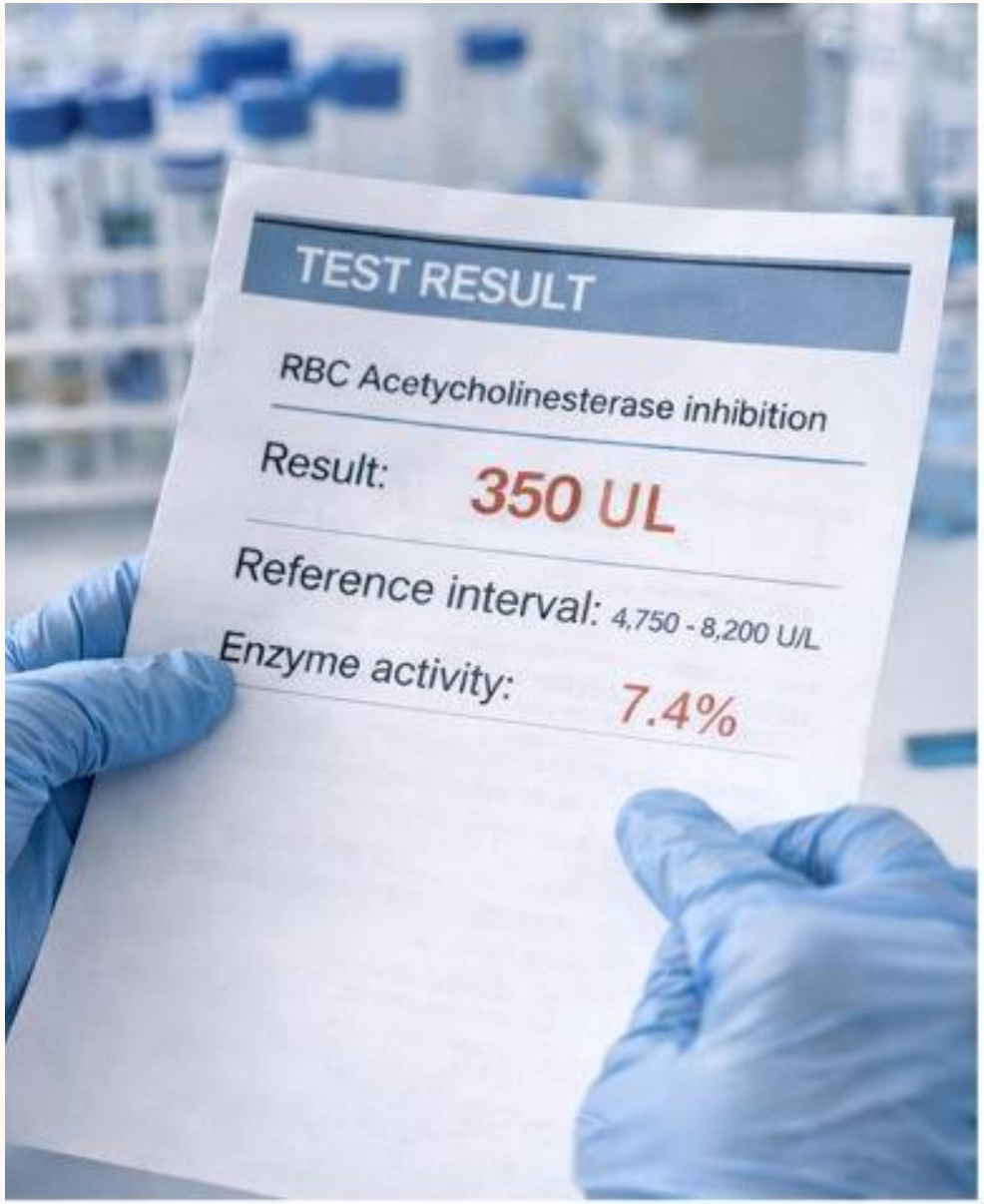
- Systemic, contact, stomach

ACUTE TOXIC HAZARD CATEGORY

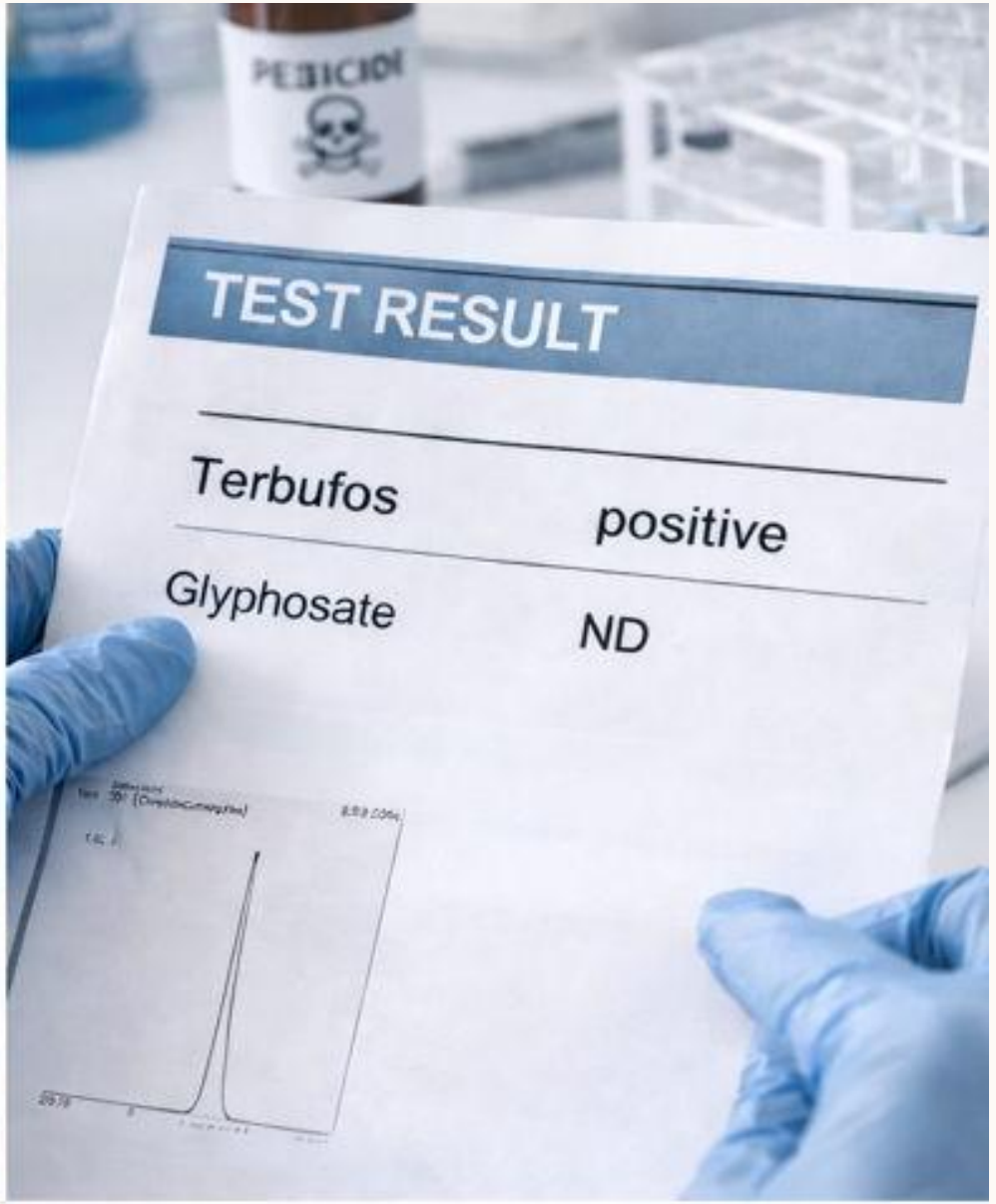
Class		LD_{50} for the rat (mg/kg body weight)	
		Oral	Dermal
Ia	Extremely hazardous	< 5	< 50
Ib	Highly hazardous	5–50	50–200
II	Moderately hazardous	50–2000	200–2000
III	Slightly hazardous	Over 2000	Over 2000
U	Unlikely to present acute hazard	5000 or higher	

WHO 2019


PESTICIDE
Classify the chemical
Organophosphate
Chlorpyrifos
Diazinon
Terbufos
Carbamate
Aldicarb
Carbaryl
Herbicide
Glyphosate
Paraquat
Rodenticide
Brodifacoum
Zinc phosphide
Pyrethroid



Identify a group of chemicals



Identify a specific pesticide

CONFUSION

Why chemical identification is difficult

- Brand, chemical, and colloquial names differ
- Products often removed from original packaging
- History is frequently incomplete or unreliable
- Clinical features overlap across pesticide classes
- Many pesticides have no routine laboratory marker

ORGANOPHOSPHATES

MOA: Irreversible inhibition of acetylcholinesterase

Terbufos – Counter, Contraven, Aragan

Malathion – Mercaptothion, Malasol, Carbophos, Maldison

Chlorpyrifos – Brodan, Dursban, Lorsban

CARBAMATES

MOA: Reversible inhibition of acetylcholinesterase

Aldicarb – Galephirimi, “two step”, Temik

Carbaryl – Sevin, naphthalen-1-yl methylcarbamate

Carbofuran – Furadan, 2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate

DIAGNOSING PESTICIDE POISONING

- History
- Physical examination
- Routine laboratory tests
- Toxicology tests

The diagnosis of acute pesticide poisoning is usually clinical, based on recognition of the toxidrome, with laboratory tests providing supportive or confirmatory information.

Drug- and toxin-associated odors

Odor	Agent(s)
Acetone (fruity)	Ethanol, isopropyl alcohol, chloroform, salicylates
Bitter almonds	Cyanide
Garlic	Arsenic, organophosphates, phosphorus, thallium, selenium
Mothballs	Naphthalene, paradichlorobenzene
Kerosene (petroleum distillate)	Organophosphates, parathion
Freshly mown hay	Phosgene
Rotten eggs	Hydrogen sulfide
Wintergreen	Methyl salicylate

ROUTINE LAB TESTS

- Urinalysis
- Kidney function – serum electrolytes, urea, and creatinine; anion gap
- Liver function
- Metabolic function – glucose, lactate, ketones
- Blood gas, co-oximetry
- Other – creatine kinase, lipase, ionized calcium and magnesium, serum osmolality
- Pregnancy test

Used to assess mechanism, severity, and complications and to support a clinical toxidrome, assess severity, and guide supportive care.

GENERAL TOX TESTS

Routinely / widely available:

- Cholinesterase enzyme activity
- Acetaminophen and salicylate
- Drugs of abuse – urine screen by immunoassay
- Therapeutic drug monitoring

Not routinely or widely available:

- General qualitative tox screening of urine, blood, stomach contents, or meconium
- Select quantitative assays
- Confirmatory testing for drugs of abuse or pesticides (or other poisons)

Targeted vs untargeted screening

CHOLINESTERASE INHIBITION

Identifying a group of pesticides by mechanism

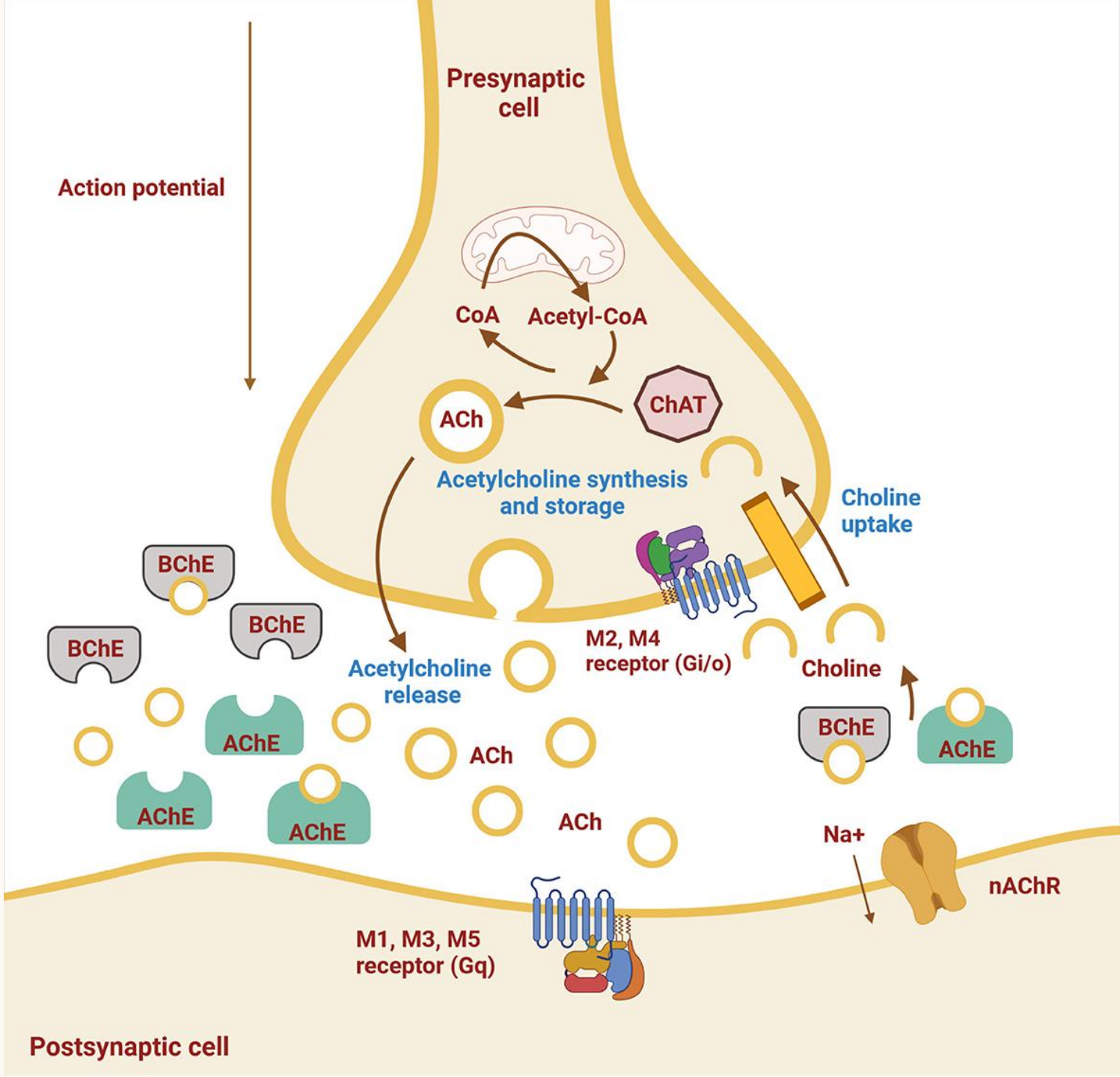
- Red blood cell acetylcholinesterase (AChE) [EDTA tube, purple top]

- Serum butyrylcholinesterase (BChE) aka pseudocholinesterase [SST tube, yellow top]

- Whole blood cholinesterase [EDTA tube, purple top] – terminology:
  - RBC AChE alone or
  - A calculated composite of plasma + RBC activity (method-specific)

Acetylcholinesterase (AChE)

Butyrylcholinesterase (BChE)



Žnidaršič et al.
Front Vet Sci
2023

Feature	RBC acetylcholinesterase (AChE)	Plasma butyrylcholinesterase (BChE)
Enzyme location	Erythrocyte membrane (neuronal surrogate)	Plasma (hepatic enzyme)
Best reflects	Neuronal cholinesterase inhibition	Recent exposure
Correlation with severity	Good	Poor
Sensitivity to exposure	Moderate	High
Recovery after exposure	Slow	More rapid (especially carbamates)
Usefulness for monitoring	Good (serial testing)	Limited
Influenced by non-toxic factors	Minimal	Significant (liver disease, pregnancy, genetics)
Sample type	EDTA whole blood	Serum or heparinised plasma
Availability / TAT	Limited / Slow	Widely available / Faster
Identifies specific pesticide	No	No

CHEMICAL TYPES

AS	Arsenic compound
BP	Bipyridylium derivative
C	Carbamate
CO	Coumarin derivative
CU	Copper compound
HG	Mercury compound
NP	Nitrophenol derivative
OC	Organochlorine compound
OP	Organophosphorus compound
OT	Organotin compound
PAA	Phenoxyacetic acid derivative
PZ	Pyrazole
PY	Pyrethroid
T	Triazine derivative
TC	Thiocarbamate

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SPECIFIC PESTICIDES

Advanced analytical testing

When is this needed?

- Unknown or unusual exposure
- Severe poisoning with unclear mechanism
- Public health, forensic, or surveillance purposes
- Cluster or outbreak investigations

TARGETED ANALYSIS

What it is:

Looks for pre-specified pesticides

Technology

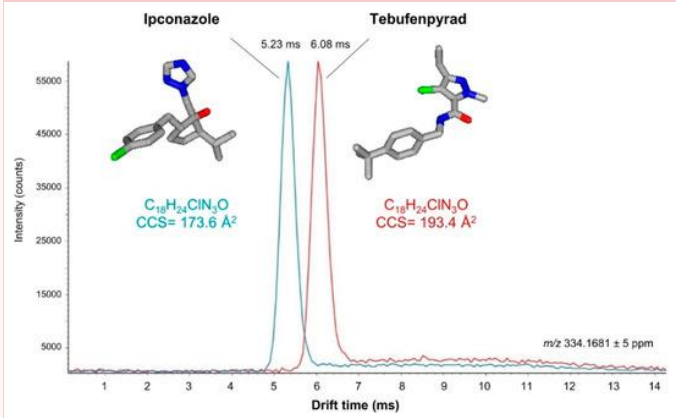
- LC-MS/MS
- GC-MS

Pros

- High sensitivity and specificity
- Clinically actionable when suspicion is strong

Cons

- Requires knowing *what to look for*
- Limited panels
- Turnaround time



UNTARGETED ANALYSIS

What it is

*Screens for **unknown or unexpected compounds***

Technology

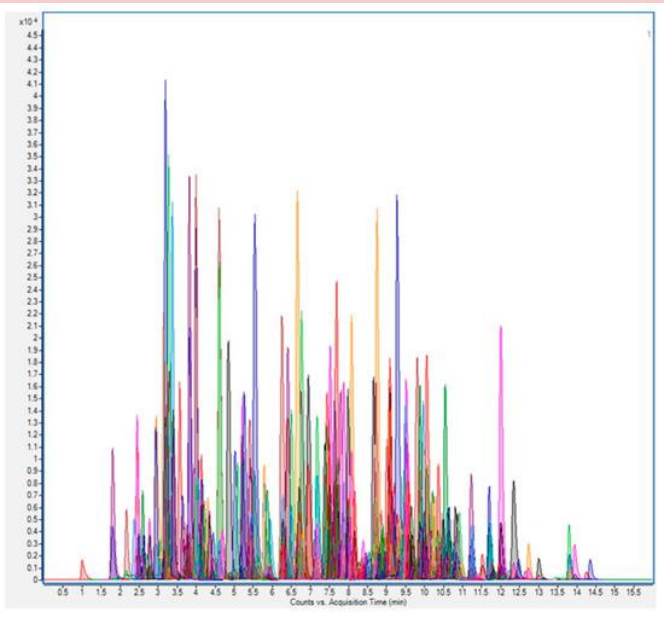
- High-resolution mass spectrometry

Pros

- Can identify unexpected agents
- Useful when history is absent

Cons

- Complex interpretation
- Resource intensive
- Rarely changes acute management

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KEY TAKEAWAYS

- Most acute pesticide poisonings are diagnosed clinically, using toxidrome recognition. Laboratory tests support, they rarely lead.
- Routine laboratory tests assess severity and complications, not the identity of specific pesticides.
- Only a few pesticide classes have group-level laboratory markers, most notably cholinesterase inhibition for organophosphates and carbamates.
- RBC acetylcholinesterase reflects toxicity severity; plasma butyrylcholinesterase reflects exposure; neither identifies the specific chemical.
- Identifying a specific pesticide usually requires advanced analytical techniques and is often retrospective.
- Laboratory data are critical for surveillance, prevention, and policy, even when they do not change acute management.

In high-burden settings such as South Africa, sustained investment in advanced analytical toxicology and thoughtful evaluation of point-of-care acetylcholinesterase testing are essential to improve diagnosis, surveillance, and prevention.

THANK YOU

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