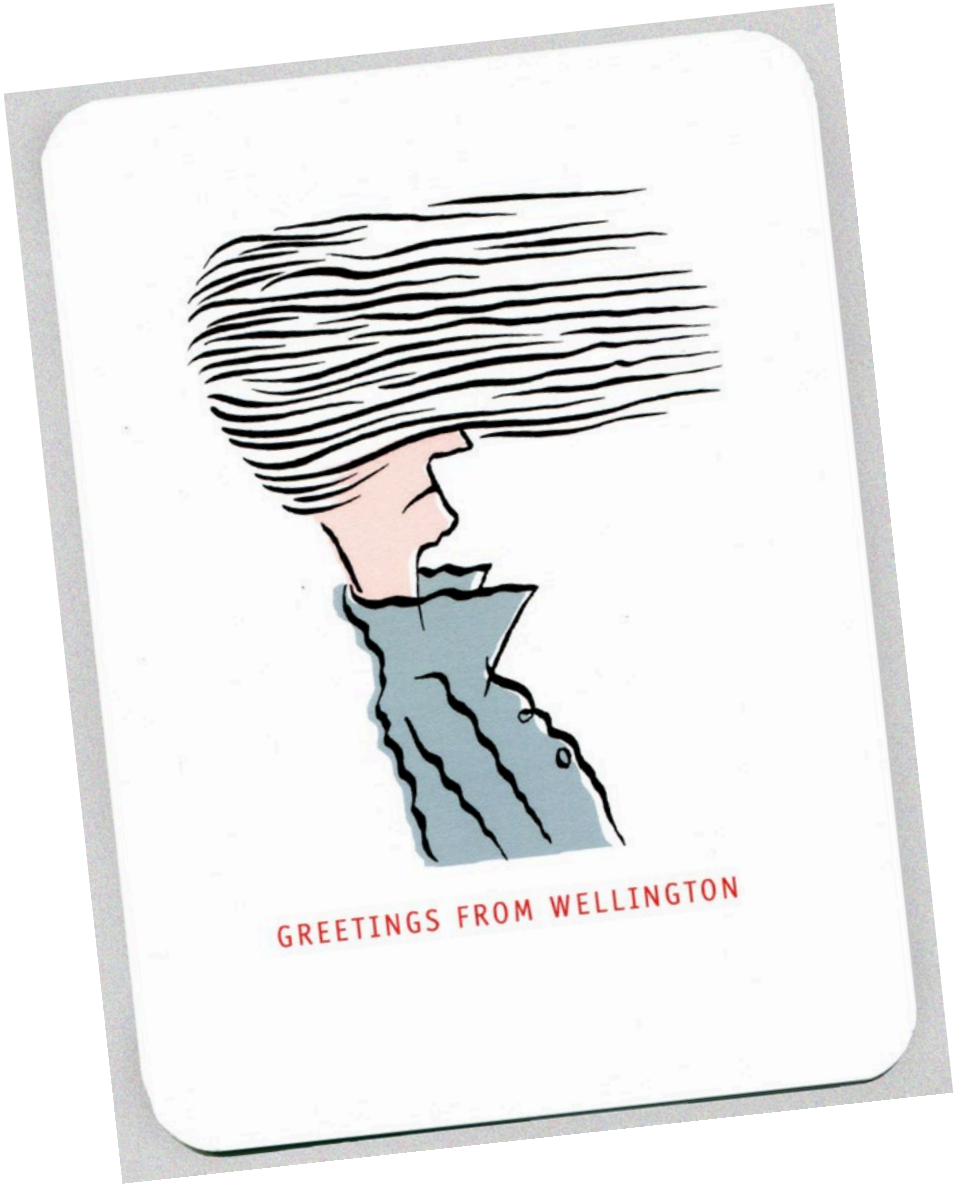

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Setting the right standards

A cautionary tale of standards

– Nick Kim, Massey University (Wellington)

Or.. It’s not the numbers; it’s how they’re implemented

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Methamphetamine testing of ordinary homes – how did New Zealand go mad?

…or, why do we always have to learn the hard way..?

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Testing football helmets, 1912

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Quick timeline

Numeric guideline for meth itself

2006-2010 local authorities finding increasing numbers of meth labs

2010 Ministry of Health guidelines for remediation of lab sites released

2010-2016 testing becomes embedded in the residential property market

2016 various central government shenanigans occur

- Standards New Zealand process launched
- Housing NZ → technical work commissioned, minimum risk level suggested, includes 300-fold safety factor
- Some media pay attention, *FairGo* runs stories
- Housing NZ and MoH start arguing with each other

2017 various central government shenanigans continue

- New Zealand Standard finalised; slightly higher threshold
- General election; Office of Chief Science Advisor undertakes a review of the area

2018 (June) Chief Science Advisor's report released

- Formal recognition that New Zealand went mad. New working health threshold suggested
- Public narrative undergoes wide-scale reversal
- Some testing companies fight, claiming better science & conspiracy, many OIA requests
- Chaos continues…

0.5 µg /100 cm^2

12.5 µg /100 cm^2

1.5 µg /100 cm^2

15 µg /100 cm^2

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Timeline continued…

From 2018 … chaos resumes

- Two reference values, but neither legally binding
- Tenancy Tribunal develops a preference for the higher value as the health threshold, but banks, insurers, and others can't ignore the NZ Standard

→ 15 µg /100 cm^2

→ 1.5 µg /100 cm^2

2019 Residential Tenancies Act 1986 amended

- Chaos continues…
- s2(1) adds methamphetamine, and any other contaminant prescribed by the Act; s138c inserted to allow regulations for those contaminants
- In the background ESR is doing work for HUD

Late 2022 – Regulation consultation draft proposal

- 'Maximum acceptable level of contamination'
- 'Maximum inhabitable level'

→ 15 µg /100 cm^2

→ 30 µg /100 cm^2

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Events to 2010 …

the prelude to madness

from 2006

- local authorities encounter increasing numbers of meth labs
- ask for guidance on remediation of this unusual class of contaminated site

2009

- the Ministry of Health (MoH) responds by developing a guideline document for remediation of meth labs
- I check the chemistry as one of the peer reviewers

2010

- MoH guidelines released
- the document includes numeric guideline values for 10 representative contaminants
- meth on walls is one of these

CAMERON BURNELL/FAIRFAX MEDIA

DRUG DANGERS: The charred remains of a garage at a Pihama house where a methamphetamine laboratory exploded on Friday.

Source: Quinovic Nelson: https://www.quinovic-nelson.co.nz/

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Guidelines for the Remediation of Clandestine Methamphetamine Laboratory Sites

Disclaimer

These guidelines have been developed using a pragmatic approach to the safe remediation of non-workplace sites that have been used in the illicit manufacture of methamphetamine. Users of this document should seek expert advice to determine if this guideline is applicable to their individual circumstances. The Ministry of Health and the author will not be held liable for any actual or potential economic or adverse effect(s) arising from the use of this information.

'…that have been used in the illicit manufacture of methamphetamine…'

Ministry of Health. 2010. *Guidelines for the Remediation of Clandestine Methamphetamine Laboratory Sites*. Wellington: Ministry of Health.

Published in August 2010 by the
Ministry of Health
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ISBN 978-0-478-36656-3 (online)
HP 5213

This document is available on the Ministry of Health's website:
http://www.moh.govt.nz

Table 3: Summary of remediation guidelines for New Zealand residential properties

Key chemical	Indoor criteria		Outdoor soil (mg/kg)	Potable water (mg/L)
	Surface (µg/100cm²)	Air[9] (mg/m³)		
Benzene	a	0.0036◊	1.1#	0.01*
Hydrogen chloride	a	0.009^	b	x
Iodine	20Δ	0.0008Δ	780±	x
Lead	2+	0.0002◊	⊠	0.01*
Mercury (inorganic)	35Δ	0.0033◊	⊠	0.007*
Methamphetamine	0.5Δ	b	5Δ	x
Phosphine	a	0.0004Δ	c	x
Toluene	a	0.3^	68#	0.8*
Xylenes (total)	a	0.7^	48#	0.6*
pH	6-8	NA	4.5–8 (typical range)	6–8*

Notes:

a No surface residue guideline has been provided for this chemical as it is considered volatile and would not be present as surface residues (or dust) for a sufficient period to be of concern.

b No guideline has been derived for these key chemicals. Only volatile chemicals (or gases) have been considered as they may continue to off-gas from porous surfaces over time. For example, anhydrous hydrogen chloride will readily combine with soil moisture and infiltrate the soil, dissolving some of the soil material, especially carbonates. Neutralisation of the acid will occur (OEHHA 2008).

c It is not considered necessary to attempt to measure for phosphine in soil because phosphine gas is not expected to be present in soil for a sufficient period of time to be of concern.

X At the time of writing no relevant guideline values for these chemicals were available from peer-reviewed sources of relevance for the protection of human health.

⊠ At the time of writing the Ministry for the Environment's proposed *National Environmental Standard for Assessing and Managing Contaminants in Soil* was still under development and confirmation of these numbers was awaiting finalisation. The Ministry for the Environment should be consulted to ensure that these soil guideline values are consistent with the gazetted NES. In practice, the NES is treated like a rule in a plan, and it will override any existing rule that is more lenient. In some circumstances, councils can impose a rule or consent that is more stringent than the NES but only if the standard expressly states that they can.

+ Derived from some states within the United States that have adopted regulations or numeric decontamination guidelines for clan meth labs.

NA Not applicable as pH is not a chemical compound.

^ Derived from the OEHHA (2008).

Δ Derived from Environmental Risk Sciences (2009).

◊ Derived from the New Zealand ambient air quality guidelines (Ministry for the Environment 2002).

Derived from the *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand* (Ministry for the Environment 1999). Values for residential soils have been applied and within those, sandy soils and soils less than 1 metre in depth, as a default. Refer to Table 4.10 – Tier Soil acceptance criteria *Residential use* (Ministry for the Environment 1999).

± Derived from USEPA Regional Screening Levels (formerly called Preliminary Remediation Goals).

* These guideline values for contaminants relating to potable water use have been derived from the health-based determinants (maximum acceptable values) set out in the *Drinking–water Standards for New Zealand 2005 (revised 2008)* (Ministry of Health 2008). These guideline values have been developed with a particular reference to the protection of public health, giving consideration to exposure via the ingestion of water, the inhalation of volatile compounds and absorption following direct contact.

A suggested cleanup guideline for meth residues on surfaces. One of ten representative substances.

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Forensic Science International 224 (2013) 8–26

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Review article

A review of impurity profiling and synthetic route of manufacture of methylamphetamine, 3,4-methylenedioxymethylamphetamine, amphetamine, dimethylamphetamine and *p*-methoxyamphetamine

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p-methoxyamphetamine
Impurity profiling

ABSTRACT

Amphetamine-type substances (ATS), like other synthetically derived compounds, can be produced by a multitude of synthetic pathways using a variety of precursors and reagents, resulting in a large number of possible contaminants (by-products, intermediates and impurities). This review article describes the common contaminants found in preparations of methylamphetamine (MA), 3,4-methylenedioxymethylamphetamine (MDMA), amphetamine (AP), *N,N*-dimethylamphetamine (DMA) and *p*-methoxyamphetamine (PMA) synthesised via common synthetic pathways including reductive amination, Leuckart method, Nagai method, Emde method, Birch reduction, "Moscow" method, Wacker process, "Nitrostyrene" method and the Peracid oxidation method.

Contaminants can facilitate identification of the synthetic route, origin of precursors and may suggest information as to the location of manufacture of these illicit drugs. Contaminant profiling can provide vital intelligence for investigations in which linking seizures or identifying the synthetic pathway is essential. This review article presents an accessible resource; a compilation of contaminants resulting from a variety of manufacturing methods used to synthesise the most common ATS. It is important for research in this field to continue as valuable information can be extracted from illicit drug samples, increasing discrimination amongst ATS, and in turn, leading to an increase in evidential value and forensic drug intelligence from forensic drug samples.

Contents

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In the context of labs (only) a single low level guideline for meth can also serve as a useful flag or **marker** to allow for a wide range of other substances that have not been tested for but may be present; and don't have any health guidelines set for them.

What 'other substances'?

…ture and compound of interest.

		…nts
		…mphetamine A2, 1,3-diphenyl-2-methylaminopropane A3, …1-phenyl-2-propylamine A4
		…/-(1-phenylpropan-2-yl)prop-2-enamide (cis-cinnamoyl
		…ephedrine B2, *N*-methyl-*N*-(α-methylphenyl)amino-1-phenyl-2-propanone B3, …phenylethyl)-3-phenylpropanamide B4
		…udoephedrine C1, methylephedrine C2, *N*-formylephedrine C3, *N*-acetylephedrine …C5, *N*-acetylamphetamine C6
		…methylaminopropane D1
		…ylamine F1, α,α′-dimethyldiphenethylamine F2, *N*-α,α′-trimethyldiphenylamine F3
		…hylbenzylamine A5, 4-methyl-5-(3,4-methylenedioxyphenyl)-[1,3]-dioxolan-2-one A6, …thyl-2-(3,4-methylenedioxyphenyl)-ethanamine A7, *N*-cyclohexylacetamine A8, …-methyliminopropyl)benzene A9, *N*-cyanomethyl-*N*-methyl-1-(3,4-methylenedioxyphenyl)-…[1-(3,4-methylenedioxy)phenyl-2-propyl]methylamine (MDMA dimer) A11
		…amphetamine F5, *N*-ethylmethamphetamine F6, *N*-formylamphetamine F7, …benzodioxol-5-ylmethyl)pyrimidine F9, 3,4-bis-(1,3-benzodioxol-5-ylmethyl)pyridine F10
		…yl)-1-methoxypropan-2-one G1, methyl-3-(3,4-ethylenedioxyphenyl)-propanoate G2, …yl)-1,3-dimethoxypropane G3, 3-(3,4-ethylenedioxyphenyl)-1,1-dimethoxypropane G4, …yl)-1-methoxypropane G5
		…thylenedioxyphenyl)tetrahydrofuran H1, 1-(3,4-dimethoxyphenyl)-2-propanone H2
		…l)-1-propanone H3, 2,2,4-trimethyl-5-(3,4-methylenedioxyphenyl)-[1,3]-dioxolane H4, …l)- 1,2-propanedione H5, 1-methoxy-1-(3,4-methylenedioxyphenyl)-2-propanol H6
		…hloronorephedrine C7
		…opropane D2
		…rmamide F11, 4-benzylpyrimidine F12, 4-methyl-5-phenyl-pyrimidine F13, 2,4-dimethyl-3,5-diphenylpyridine F14, 2,6-dimethyl-3,5-diphenylpyridine F15
DMA (refer to Fig. 9)	Nitrostyrene	(2-Nitroprop-1-enyl)benzene I1, benzyl methyl ketoxime I2, *N*-(β-phenylisopropyl)benzaldime I3
	Nagai	1-Propenylbenzene B5, 2-propenylbenzene B6
	Emde	Chloromethylephedrine/chloromethylpseudoephedrine C8, 1-dimethylamino-1-phenyl-2-chloropropane C9
	Birch	1-(1,4-Cyclohexadienyl)-2,2-dimethylaminopropane D3
PMA (refer to Fig. 10)	Leuckart	4-(4-Methoxybenzyl)pyrimidine F16,4-methyl-5-(4-methoxyphenyl)pyrimidine F17, 2,4-dimethyl-3,5-di-(4-methoxyphenyl)pyridine (F18), 2,6-dimethyl-3,4-di-(4-methoxyphenyl)pyridine
	Peracid oxidation	4-Methoxyphenol H7

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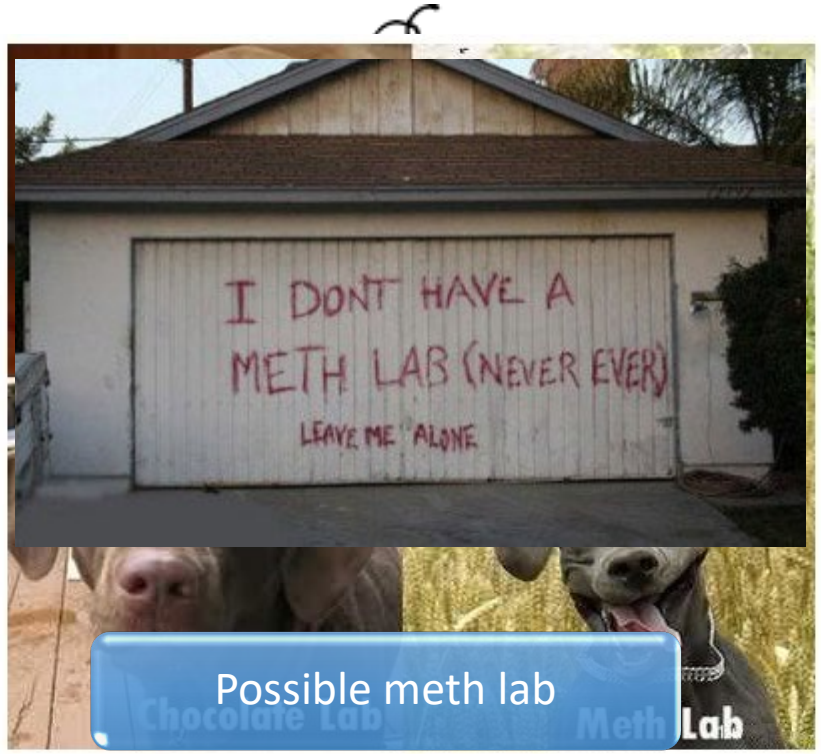
Meth labs

- Usually not hard to identify
- Some made themselves known



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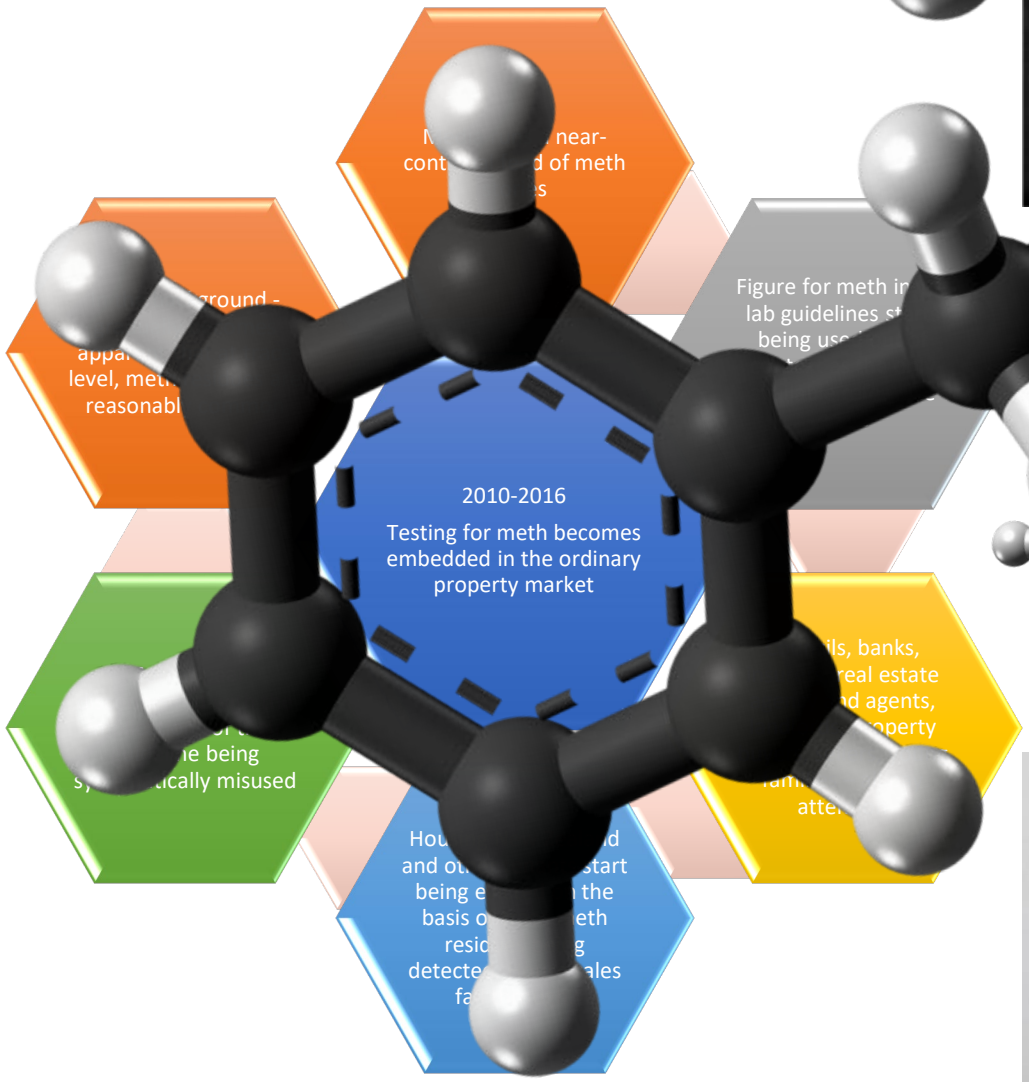
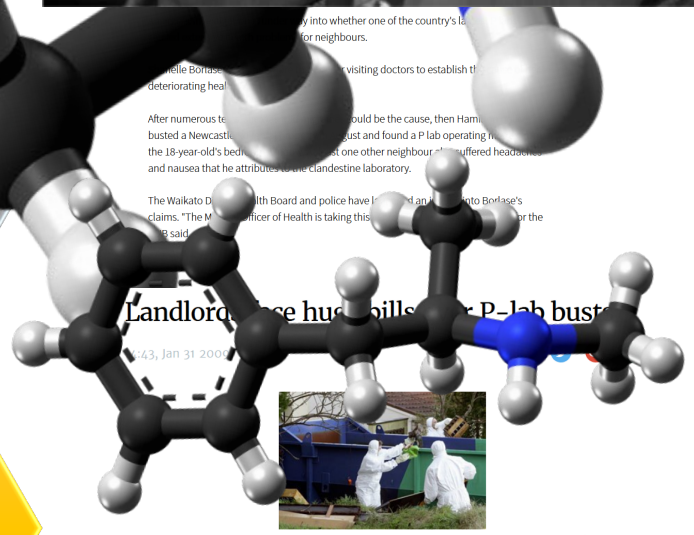
2010-2016

New Zealand goes mad





(image source: deconassist.com.au – for illustration only)

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Question – what misunderstandings may have existed at the outset that could have set the scene for an upcoming fiasco?

Answer – a poor understanding was shown of…

Magnitudes

- half a microgramme per 100 cm^2
- precision of any guideline
- possible prevalence in homes not used as labs
- ease of cross-contamination

Analytical chemistry

- sampling practices including representativeness
- analyte selection – focus on fate of only one substance
- instrumental capabilities
- analytical limitations - accuracy, precision, and comparison to guidelines

Dangers

- what guidelines are and how they relate to risks
- persistence of meth on surfaces
- exposure pathways and likelihoods
- persistence of meth in people
- context with respect to banknotes and therapeutic use

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Rearranging these …

1.

Common difficulties and misconceptions

- numbers and magnitudes
- relevance of instrumental capabilities
- relevance of trace transfer
- potential background prevalence
- persistence – in homes and people

2.

Patchy understanding in the industry & property market

- accuracy and precision; comparing measured results to guidelines
- relevance of representative sampling
- normal expectations for repeat sampling
- misconceptions about migration of residues
- ease of cross-contamination
- potential relevance of untested substances

these ones apply more for **meth** than they do for **residential lead**

3.

Core problem – a misunderstanding of risks

- what guidelines are for in the first place
- relative risks and wider context
- lack of oversight — lack of any ministry surveillance capacity

this area applies to both

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The problem with exposure to residential lead

Core problem – a misunderstanding of risks

- what guidelines are for in the first place
- relative risks and wider context
- lack of oversight — lack of any ministry surveillance capacity

So …

- what's a guideline or standard?
- how does it relate to risk?
- what was the meth guideline for?
- what's the wider context?

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‘The dose determines the poison’

Paracelsus:

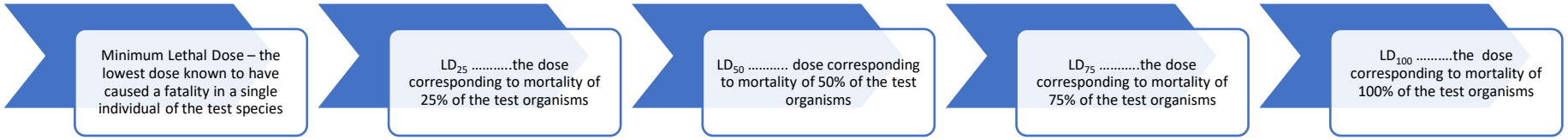
“Alle Ding' sind Gift, und nichts ohn' Gift; allein die Dosis macht, daß ein Ding kein Gift ist.” (German).

“All things are poisonous for there is nothing without poisonous qualities. It is only the dose which makes a thing a poison”

***Corollary:** If exposure to a toxic substance is sufficiently low, it should cease to be a problem.*

Starting with lethal doses…

For a group of test animals, various lethal doses can be quantified:



Of these, LD_{50} is the most commonly used measure when the toxic endpoint being monitored is death

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Table 2-1. Approximate LD_{50} values of some representative substances to mammals (modified from Timbrell, 1999).

Substance	LD_{50} (mg/kg)
Ethanol (ethyl alcohol)	10,000
Sodium chloride	4,000
Ferrous sulfate	1,500
Morphine sulfate	900
Phenobarbital sodium	150
Picrotoxin	5
Strychnine sulfate	2
Nicotine	1
***d*-Tubocurarine**	0.5
Hemicholinium-3	0.2
Tetrodotoxin	0.10
Dioxin (TCDD)	0.001
Botulinium toxin	0.00001

Out of interest - quoted LD_{50} values for methamphetamine in mammals fall in this general area (about 7.5-95 mg/kg depending on source). By this measure, it is significantly less toxic than nicotine.

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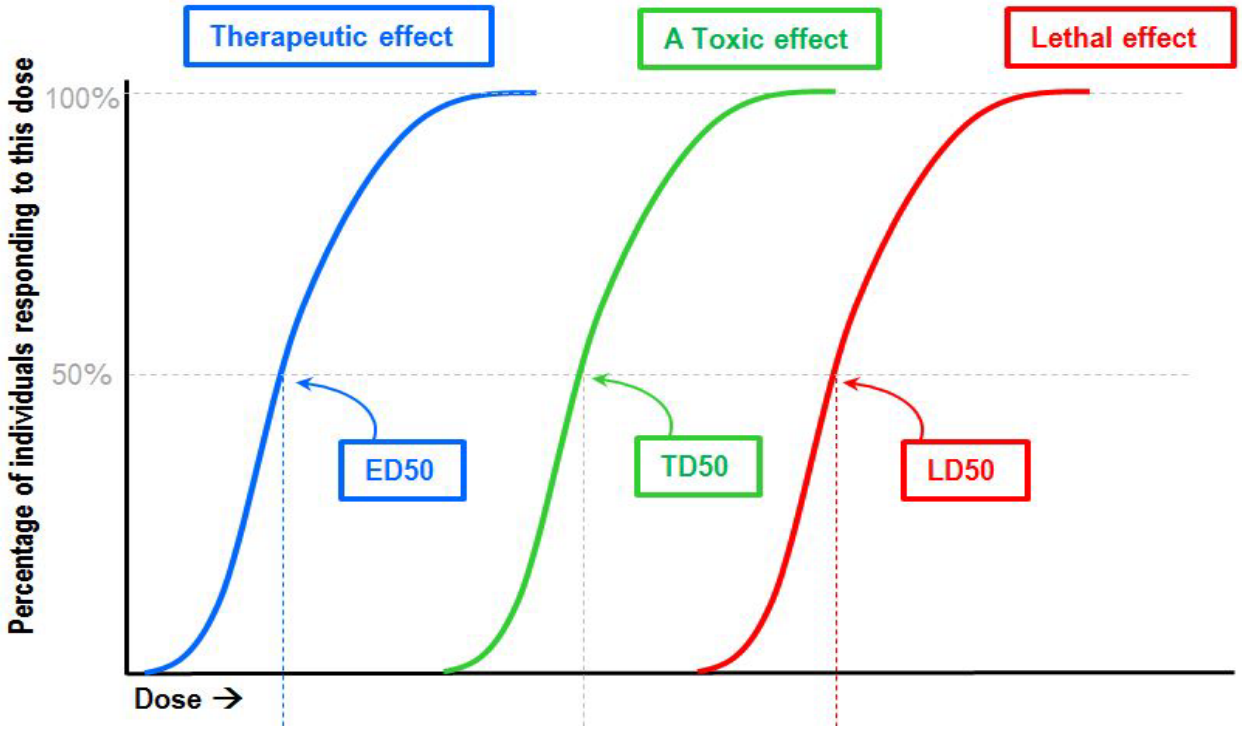
Other toxic endpoints can also be used

This example shows three options that relate to testing of a pharmaceutical drug



An Effective Dose
Drug working well

A Toxic Dose
(*e.g.* LOAEL)

A Lethal Dose
(LD)

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Going down further in dose, to the first point where **any** type of effect can be found…

NOEL and LOEL

No observed effects level

the highest dose at which nothing happens

Lowest observed effects level

the lowest dose at which anything begins to happen

not to be confused with Noël = Christmas

not to be confused with

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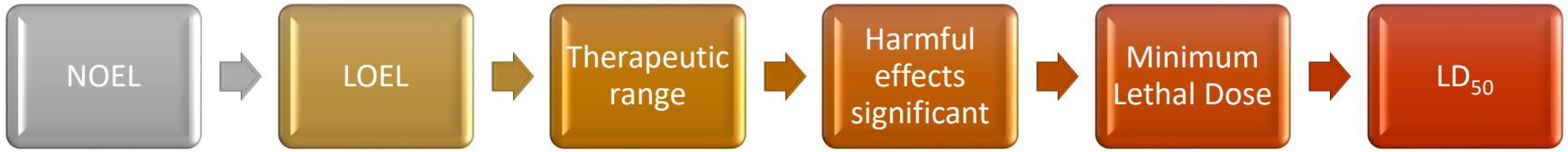
…and we'll also include MLD and LD_{50}



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Most guidelines developed for protection of human health are based on a…

reference dose (RfD)

an estimated ‘safe routine dose’ that is unlikely to cause any appreciable adverse effects over the long term

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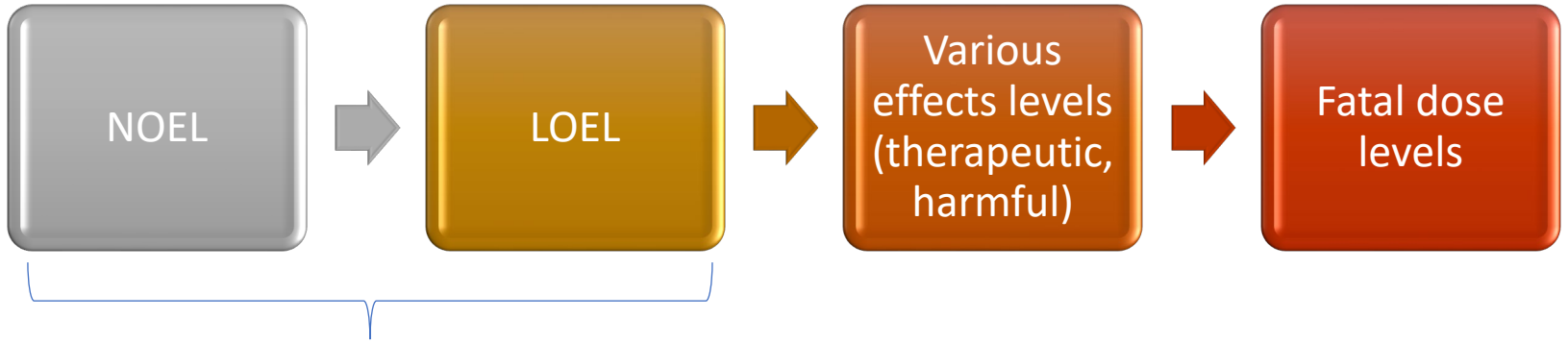
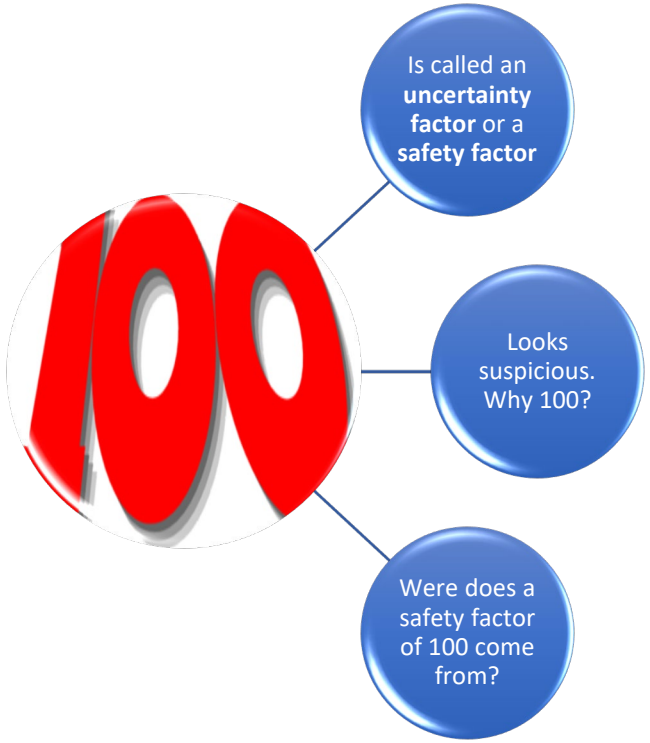


In general, a **reference dose** is determined by taking one of these *'first onset of the first possible effect'* doses and dividing it by **100**

This factor of 100



…is designed to allow for possible differences between:

- Lab animals and humans (10 x)
- Individual humans (10 x)

…in the case of the meth guideline, the reference dose was even more conservative. It was based on ‘lowest anything’ dose divided by a factor of

300

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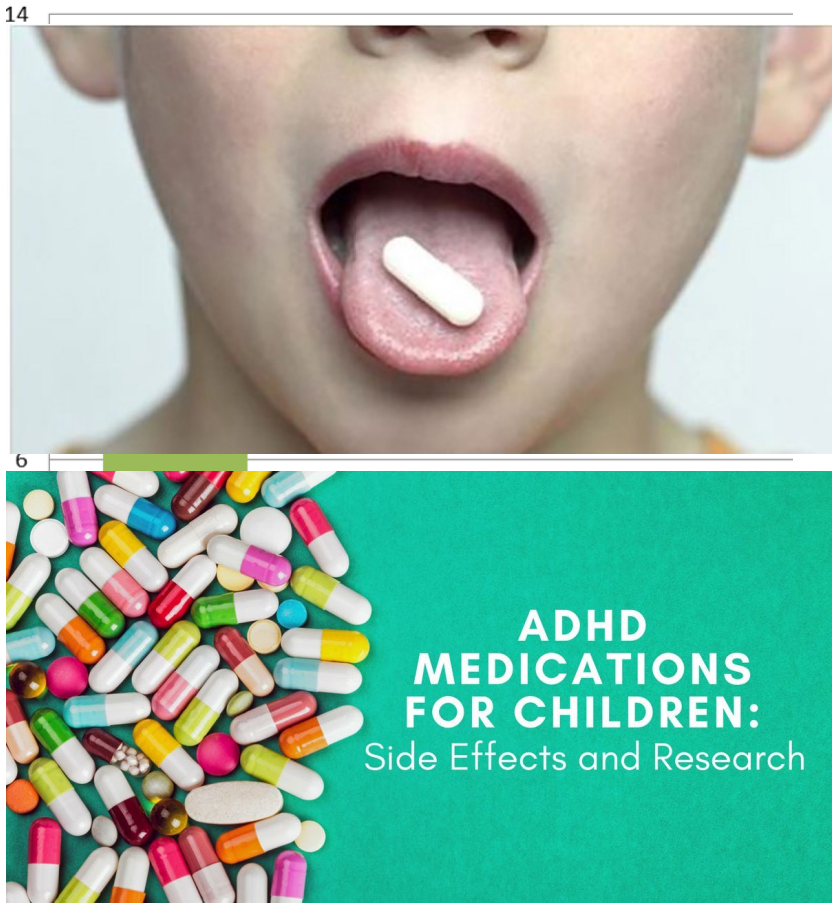
implications

At the meth lab guideline level, risks are neither appreciable nor quantifiable

Lowest possible effect level 20-30 times higher – still with a 300-fold safety factor

Dose range for treatment of ADHD in children: 1000-2,000 times higher

Any guideline of this type should not be confused with a hazardous level



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Most guidelines are determined by modelling possible exposures and indexing those against reference doses. Some key (New Zealand) guideline and standard documents …

Air:

- Workplace Exposure Standards (2011 update)
- Ambient Air Quality Guidelines (2002)
- Resource Management (National Environmental Standards for Air Quality) Regulations 2004 (as amended 1 June 2011)

Food and drinking water:

- Australia New Zealand Food Standards Code - Standard 1.4.1 - Contaminants and Natural Toxicants (updated 11 July 2011)
- Drinking-water Standards for New Zealand 2005 (Revised 2008)

Soil quality:

- Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health
- Identifying, Investigating and Managing Risks Associated with Former Sheep-dip Sites: A guide for local authorities (2006)

Protection of aquatic life:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)

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Back to lead (Pb), with a proviso:

- Wall-based childhood meth poisoning – **zero** known cases
- Residential childhood lead poisoning – **many** known cases

What are the two main investigative approaches?

1. Exposure-led, responsive

Clinical / environmental case management

- Including behaviour assessment/modification

Investigation of possible sources – aim to prevent further exposure

- Foods, spices
- Drinking-water
- Lead painted or alloyed toys
- Paint flakes
- Household dust
- Garden soil
- Inhalation, lead in air?

Main relevance of guidelines – in assessing the significance of each

2. Property-focused, proactive

Suitability of the property

Predominant focus outside the house

- Soil hot-spots
- Soil 95% UCL
- Possible look at exterior house paint
- Possible sources
- Possible contribution to total lead exposure (usually impossible to know)

Relevance of guidelines/standards – compliance

- With respect to the garden, is it okay for people to live here?
- At what point would there be **too much** lead for people to live here?

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What does the NESCS soil standard officially **mean?**

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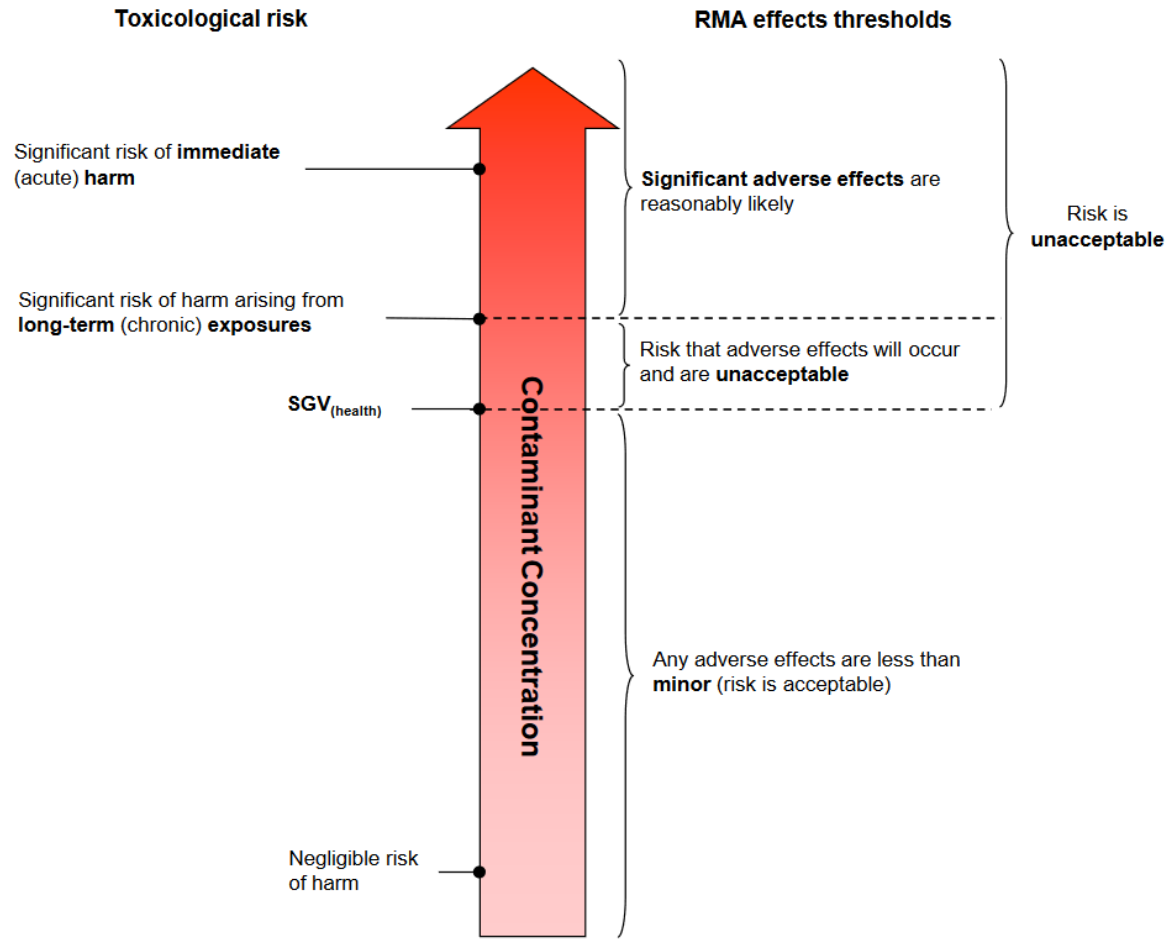
Figure 6: Relationship between human health risk, $SGVs_{(health)}$ and the RMA effects thresholds



(also note that **any** impacts assume that exposure pathways are operative)

Source: MfE, 2010. Proposed National Environmental Standard for Assessing and Managing Contaminants in Soil: Discussion document

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Points

Guidelines or standards have a context	•Problems arise when they're used out of context
It's important to link risks to cost/benefits of possible actions	•For meth, no guideline or standard to date denotes an 'actual' quantifiable health risk •Similarly SCS values do not denote 'actual' health risks and are not contaminated land thresholds
Don't expect any top-down assistance from central government	•Stop asking. National agencies will not act without a large and painful public reason, and even then… •You won't get it; you'd only be wasting your time. **Instead:** •Rely on standards and guidelines that already exist •Develop a best-practice application framework around those

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What numbers could we currently use, and how could we use them?

Reference values – what do we have?

- Soil Contaminant Standards (SCS values)
  - Are really council 'sign-off' values. *At this level there is no way anyone could possibly hold us liable for there being too much lead in that property's soil, for that land-use and on that sign-off date.*
  - Do **not** denote RMA contaminated land

- Any other Government documents that we already have?
  - *Environmental Case Management of Lead Exposed Persons*
    - One threshold **could be used** to denote RMA contaminated land

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Reference values for soil (in mg/kg, ppm)

210 — Council (and state landlord?) liability sign-off for standard residential

210 - 1000 — Bare soil should be covered (grass, bark chips)

1000 - 3000 — An **either/or** zone:
- Soil removal may not be indicated, but is an option
- **If not**, focus on improving ground cover and behaviour modification

above 3000 — Soil removal warranted

2011/361

Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011

Jerry Mateparae, Governor-General

Order in Council

At Wellington this 10th day of October 2011

Ministry for the Environment

Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health

New Zealand Government

Table ES1: Summary of soil contaminant standards – $SCS_{(health)}$ – for inorganic substances (mg/kg)

	Arsenic	Boron	Cadmium (pH 5)[1]	Chromium III[2]	Chromium VI	Copper	Inorganic lead	Inorganic mercury
Rural residential / lifestyle block 25% produce	17	NL	0.8	NL	290	NL	160	200
Residential 10% produce	20	NL	3	NL	460	NL	210	310
High-density residential	45	NL	230	NL	1,500	NL	500	1,000
Recreation	80	NL	400	NL	2,700	NL	880	1,800
Commercial / industrial outdoor worker	70	NL	1,300	NL	6,300	NL	3,300	4,200

Ministry of Health

New Zealand Government

The Environmental Case Management of Lead-exposed Persons

Guidelines for Public Health Units

Revised March 2021

Soil lead and blood lead

Studies by Weitzman et al (1993) and Lanphear et al (2003) for soil lead levels in the range of 1000 to 3000 µg/g, suggest soil removal is probably not indicated, and measures such as improving ground cover and behaviour modification (eg, relocating the principal play area away from the house) may suffice. At soil lead levels less than 1000 µg/g bare soil areas should still be covered (a soft cover such as grass or bark chips is generally adequate), if indicated by use pattern analysis, as soil lead tracked or blown into the house will be contributing to dust lead in the home.

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