

PART XIV

Reference

Chapters 36–40

Glossary

Key scientific, clinical, and policy terms used throughout this volume, defined concisely for quick reference.

Amphetamine. A central-nervous-system stimulant of the substituted-amphetamine class; the *N*-desmethyl relative of methamphetamine and its principal active metabolite.

Amphetamine-type stimulants (ATS). Umbrella category in epidemiology and drug policy grouping amphetamine, methamphetamine, and related stimulants.

Anhedonia. Loss of the capacity to feel pleasure; a hallmark of methamphetamine withdrawal and the chief driver of relapse.

Bruxism. Involuntary grinding and clenching of the teeth; a contributor to "meth mouth."

Cardiomyopathy (methamphetamine-associated). Dilated cardiomyopathy with reduced ejection fraction caused by chronic use; partially reversible with abstinence.

Chemsex. Sexualized drug use, prominent among some men who have sex with men; also "party and play."

Chirality. The property of existing as two non-superimposable mirror-image forms (enantiomers).

Clandestine laboratory. An illicit drug-production site; a source of persistent environmental contamination (Chapter 27).

Contingency management (CM). A behavioral treatment providing tangible incentives for verified drug-negative tests; the best-evidenced treatment for methamphetamine use disorder.

Crystal meth ("ice"). High-purity methamphetamine hydrochloride in a coarse, translucent crystalline form; the same molecule as other forms.

CYP2D6. The polymorphic cytochrome-P450 enzyme chiefly responsible for methamphetamine metabolism.

DAT. The dopamine transporter; a plasma-membrane carrier that methamphetamine reverses to drive dopamine efflux.

Decriminalization. Removal of criminal penalties for drug possession while supply remains prohibited; distinct from legalization.

Desoxyn. The brand name of pharmaceutical dextromethamphetamine hydrochloride, FDA-approved for ADHD.

Dextromethamphetamine (d-). The (S)-(+) enantiomer; the potent central stimulant.

Dopamine. The neurotransmitter central to reward and motor control; the primary mediator of methamphetamine's reinforcing effects.

Drug checking. Analysis of illicit-market samples to inform the people who use them; a

harm-reduction service.

Enantiomer. One of two mirror-image forms of a chiral molecule (see d- and l-methamphetamine).

Ephedrine. A stimulant alkaloid of the ephedra plant, isolated in 1885; a chemical relative of methamphetamine.

Excitotoxicity. Neuronal injury from excessive glutamate signaling and calcium influx; a neurotoxicity mechanism.

Formication. The sensation of insects crawling on or under the skin; drives compulsive skin-picking.

Free base. The un-ionized, volatile oily form of the drug, as opposed to its hydrochloride salt.

GC-MS. Gas chromatography–mass spectrometry; a confirmatory analytical standard for drug identification.

Goofball. A combination of methamphetamine and an opioid (e.g., fentanyl or heroin).

Harm reduction. A public-health approach that reduces the negative consequences of drug use without requiring abstinence.

Hyperthermia. Dangerously elevated body temperature; the leading acute cause of death in methamphetamine toxicity.

Immunoassay. An antibody-based screening test; sensitive but prone to cross-reactivity false positives.

Incentive salience. The process by which drug cues acquire disproportionate motivational pull.

Ion trapping. pH-dependent accumulation of a weak base in acidic compartments (e.g., saliva, relevant to testing).

LC-MS/MS. Liquid chromatography–tandem mass spectrometry; a highly specific confirmatory method.

Levomethamphetamine (l-). The (R)-(–) enantiomer; a weak central stimulant used historically as a decongestant.

MAOI. Monoamine oxidase inhibitor; combining one with methamphetamine risks hypertensive crisis and serotonin syndrome (an absolute contraindication).

MAP. Methamphetamine-associated psychosis.

Matrix Model. An intensive outpatient behavioral program developed for stimulant use disorders.

Meth mouth. Severe, multifactorial dental disease associated with methamphetamine use.

Methamphetamine. *N*-methylamphetamine; a synthetic CNS stimulant (formula $C_{10}H_{15}N$).

Monoamine. A class of neurotransmitters (dopamine, norepinephrine, serotonin) on which methamphetamine acts.

Monoclonal antibody. A laboratory-produced antibody; an investigational passive immunotherapy for methamphetamine.

Naloxone. An opioid antagonist; reverses opioid overdose but not stimulant toxicity (still vital given fentanyl contamination).

Neurotoxicity. Damage to neurons; methamphetamine injures dopaminergic and serotonergic terminals.

Norepinephrine. The neurotransmitter mediating much of methamphetamine's sympathomimetic action.

Oral fluid. Saliva; a testing matrix suited to detecting recent use.

Overdose. Acute toxicity from excessive drug exposure; a sympathomimetic emergency (Chapter 15).

Oxidative stress. Cellular damage from reactive oxygen species; a core neurotoxicity mechanism.

PAWS. Post-acute withdrawal syndrome; protracted symptoms (notably anhedonia) lasting months.

Person-first language. Non-stigmatizing usage (e.g., "person who uses methamphetamine") shown to affect clinical judgment.

Pervitin. The German brand of methamphetamine marketed from 1938; used widely in the Second World War.

Pharmacodynamics. What a drug does to the body.

Pharmacokinetics. What the body does to a drug (absorption, distribution, metabolism, elimination).

Placental abruption. Premature separation of the placenta; a maternal risk of methamphetamine use in pregnancy.

Precursor. A chemical used to manufacture a drug; the target of international control (e.g., ephedrine, pseudoephedrine).

Psychosis (methamphetamine-associated). A paranoid, hallucinatory state resembling schizophrenia; may persist or recur via sensitization.

Racemic. Containing equal amounts of both enantiomers.

Reverse transport. Non-exocytotic efflux of neurotransmitter through a reversed transporter; methamphetamine's core mechanism.

Rhabdomyolysis. Breakdown of skeletal muscle releasing myoglobin; a cause of acute kidney injury.

rTMS. Repetitive transcranial magnetic stimulation; an investigational neuromodulation treatment.

Sensitization. Increasing response to a drug effect (notably psychosis) with repeated use; "reverse tolerance."

Serotonin. A neurotransmitter affected by methamphetamine; relevant to mood, thermoregulation, and other functions.

Serotonin. A neurotransmitter affected by methamphetamine, relevant to mood, thermoregulation, and neurotoxicity.

Serotonin syndrome. A potentially life-threatening state of serotonergic excess; a risk when combining methamphetamine with serotonergic drugs.

SERT. The serotonin transporter.

Sympathomimetic. Producing effects resembling activation of the sympathetic nervous system.

Syringe services program (SSP). A harm-reduction program providing sterile injection equipment and linked services.

TAAR1. Trace amine-associated receptor 1; a target through which methamphetamine modulates transporter function.

Tolerance. Diminishing response to a drug effect with repeated use, prompting dose escalation.

Toxidrome. A characteristic cluster of signs indicating a class of poisoning (here, sympathomimetic).

VMAT2. Vesicular monoamine transporter 2; methamphetamine disrupts its vesicular gradient to release stored monoamines.

Wastewater-based epidemiology. Population-level drug monitoring via analysis of sewage.

Withdrawal. The syndrome following cessation; psychologically severe but not physically dangerous like alcohol withdrawal.

Xerostomia. Dry mouth from reduced salivary flow; a contributor to "meth mouth."

Frequently Asked Questions

Concise, evidence-based answers to the questions most commonly asked about methamphetamine, each pointing to fuller treatment elsewhere in the book.

Is methamphetamine ever used as a medicine?

Yes. Pharmaceutical methamphetamine (Desoxyn) is FDA-approved for ADHD, used under tight controls and rarely as a first choice (Chapter 13).

What is the difference between methamphetamine and amphetamine?

Methamphetamine is amphetamine with an added methyl group on the nitrogen, which increases its entry into the brain (Chapter 2).

Is "crystal meth" a different drug?

No. It is high-purity methamphetamine hydrochloride in a coarse crystalline form — the same molecule, differing in purity and presentation (Chapters 2, 5).

What are d- and l-methamphetamine?

The two mirror-image forms. The d-enantiomer is the potent stimulant; the l-enantiomer is a weak decongestant. The distinction matters in drug testing (Chapters 2, 6).

Does using it once cause instant, permanent addiction?

No. Addiction is a process shaped by genetics, environment, and pattern of use; the drug has high addictive liability but a single use does not guarantee dependence (Chapters 1, 19).

Is brain damage from methamphetamine permanent?

Chronic use causes measurable injury, but imaging shows partial recovery of some markers with sustained abstinence. The picture is serious harm with real, if incomplete, recovery (Chapter 12).

What actually causes "meth mouth"?

Multiple factors: dry mouth, teeth-grinding, prolonged intoxication, sugary drinks, and neglected hygiene — not simple chemical corrosion (Chapters 14, 23).

How long does methamphetamine stay in the body?

Roughly 1–4 days in urine (longer with heavy use), 1–2 days in blood or saliva, and about 90 days in hair (Chapter 25).

Is there a medication to treat methamphetamine addiction?

No medication is FDA-approved for it. The best-evidenced treatment is the behavioral intervention contingency management (Chapters 21, 32).

Is methamphetamine withdrawal dangerous?

It is not physically life-threatening the way alcohol withdrawal is, but it is psychologically severe and carries a real risk of suicidal depression during the acute "crash" (Chapter 20).

Why is methamphetamine now mixed with fentanyl?

Through both deliberate co-use and an adulterated supply. The result is a sharp rise in overdose deaths — the "fourth wave" (Chapters 16, 24).

Does naloxone reverse a methamphetamine overdose?

No — naloxone reverses opioids only. But because the supply is often contaminated with fentanyl, naloxone remains essential (Chapters 17, 24).

What is the most dangerous drug interaction?

Combining methamphetamine with a monoamine oxidase inhibitor (MAOI), which can cause a hypertensive crisis, cerebral hemorrhage, and serotonin syndrome (Chapter 24).

Is methamphetamine use increasing?

In the U.S., use prevalence has been relatively stable recently, but harm — especially overdose death — has risen sharply, driven by a more dangerous supply (Chapter 16).

What is harm reduction, and does it encourage drug use?

It is a public-health approach that reduces death and disease among people who already use drugs. Evidence does not support the claim that it encourages use (Chapters 1, 17).

Did drug decriminalization work?

The evidence is contested. Portugal's model showed benefits; Oregon's was rolled back in 2024. Implementation — treatment investment above all — appears decisive (Chapter 31).

Why do people use methamphetamine?

For functional, economic, psychological, and social reasons — energy, self-medication, sexual enhancement, and more — not senselessly (Chapter 28).

Is addiction a moral failing?

The scientific consensus treats it as a chronic health condition arising from genetic, developmental, environmental, and neurobiological factors (Chapters 19, 30).

Timeline

Major discoveries, medical developments, and policy milestones in the history of methamphetamine.

- 1885** Nagai Nagayoshi isolates ephedrine from the ephedra plant.
- 1887** Amphetamine is first synthesized (by Lazăr Edeleanu).
- 1893** Nagai first synthesizes methamphetamine from ephedrine.
- 1919** Akira Ogata produces methamphetamine in stable crystalline (hydrochloride) form.
- 1930s** The amphetamine-containing Benzedrine inhaler is marketed in the U.S. (Smith, Kline & French).
- 1938** Temmler introduces methamphetamine in Germany under the brand Pervitin.
- 1939–45** Mass military use during the Second World War (Pervitin; Philopon in Japan).
- 1944** The FDA approves Desoxyn (methamphetamine hydrochloride) in December.
- 1950s–60s** Peak legal prescribing; a postwar epidemic in Japan; the "speed" subculture and "speed kills."
- 1961** The UN Single Convention on Narcotic Drugs is adopted.
- 1970** The U.S. Controlled Substances Act places methamphetamine in Schedule II.
- 1971** The UN Convention on Psychotropic Substances brings amphetamine-type stimulants under international control.
- 1988** The UN Convention against Illicit Traffic (precursor control) is adopted; the U.S. bans federal funding for syringe programs.
- 2001** Portugal decriminalizes possession of all drugs.
- 2005** The U.S. Combat Methamphetamine Epidemic Act restricts pseudoephedrine sales.
- 2015** The U.S. federal syringe-program funding ban is partially lifted after the Scott County, Indiana, HIV outbreak.
- 2017** reSET becomes the first FDA-authorized prescription digital therapeutic for substance use disorders.
- 2020** Oregon voters pass Measure 110, decriminalizing drug possession.
- 2021** The ADAPT-2 trial reports a modest benefit for naltrexone plus bupropion; the first officially recognized U.S. overdose-prevention centers open in New York City.
- 2023** Pear Therapeutics (maker of reSET) enters bankruptcy; British Columbia begins a decriminalization pilot.

2024 Oregon rolls back Measure 110, with recriminalization of possession effective in September.

2025–26 UNODC reports continued global expansion of the methamphetamine market; multi-site trials of rTMS and pharmacotherapy for stimulant use disorder proceed.

Statistics Atlas

A consolidated, time-stamped compilation of the key figures — global, mortality, healthcare utilization, and treatment — drawn from authoritative sources and subject to periodic re-verification.

Every figure below is dated, because methamphetamine statistics change rapidly. Surveys under-capture the most marginalized people, so prevalence figures are likely conservative, and harm indicators (deaths, hospitalizations, treatment admissions) are shaped by coding practices and the changing drug supply. These numbers should be read as the best available estimates, not exact counts.

Global data

Indicator	Figure (date) — source
People using any drug (excl. alcohol/tobacco)	~316 million (2023) — UNODC WDR 2025
People with drug use disorders	~64 million (2023) — UNODC WDR 2025
ATS share of global synthetic-drug seizures	~half; record ATS seizures (2023) — UNODC WDR 2025
Golden Triangle methamphetamine seizures	236 tons (2024, +24% y/y) — UNODC WDR 2025
Myanmar methamphetamine production	~420 t (2021) → >1,000 t (2025) — UNODC WDR 2026
People with drug dependence receiving treatment	~1 in 12 (2023) — UNODC WDR 2025

Mortality (United States)

Indicator	Figure (date) — source

Methamphetamine-involved deaths	1,887 (2011) → 9,356 (2017) — CDC/NCHS
Psychostimulant-involved overdose deaths	2,266 (2011) → ~35,000 (2023, ~33% of all) — CDC/NVSS
Total drug overdose deaths	105,007 (2023) → 79,384 (2024) — CDC/NCHS
Psychostimulant share of overdose deaths	22.9% (2019) → ~36.2% (2024 provisional) — CDC/NVSS
Opioid co-involvement in psychostimulant deaths	~69% (2023) — CDC/NVSS
Largest death-rate increase (demographic)	American Indian/Alaska Native: 11.0 → 32.9 per 100k (2018–2023) — CDC MMWR

Hospitalizations and emergency-department use (United States)

Indicator	Figure (date) — source
Amphetamine-involved hospitalizations	+270% (2008–2015; highest in the West) — Winkelman et al.
Methamphetamine-involved psychiatric hospitalizations	+68% (Q4 2015–Q4 2019) — Calcaterra et al. 2024
Methamphetamine-related ED visits (DAWN)	67,954 (2007) → 102,961 (2011) — SAMHSA DAWN
Share of methamphetamine ED visits admitted to hospital	~16% — SAMHSA DAWN
ED visits involving opioids + psychostimulants	+14.0% per year (2011–2016) — Hoots et al.

Treatment (United States)

Indicator	Figure (date) — source

Primary methamphetamine treatment admissions	138,379 (2010) → 201,021 (2019) — TEDS
Injection as usual route among those admissions	18.0% (2010) → 28.2% (2019) — TEDS
Past-year methamphetamine use (survey)	1.4 M (2016) → ~2 M (2019); ~2–2.6 M (stable since 2021) — NSDUH
FDA-approved medications for the disorder	None (as of 2026); contingency management best-evidenced — see Chs. 21, 32

Comprehensive Index

An alphabetical topical index. References are to chapter numbers; on final assembly of the complete volume these resolve to page numbers.

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The Statistics Atlas figures are listed below; the Glossary, FAQ, Timeline, and Index consolidate and cross-reference the verified content and sources of Parts I–XIII. Figures are time-stamped and subject to periodic re-verification; sources current as of 2026.

1. United Nations Office on Drugs and Crime, *World Drug Report 2025* and *World Drug Report 2026* — global prevalence, drug use disorders, ATS seizures, Golden Triangle and Myanmar production, and treatment coverage (see Part VII).
2. CDC National Center for Health Statistics and National Vital Statistics System — U.S. overdose mortality: methamphetamine-involved deaths 1,887 (2011) to 9,356 (2017); psychostimulant-involved deaths 2,266 (2011) to ~35,000 (2023); total overdose deaths 105,007 (2023) to 79,384 (2024); psychostimulant share and opioid co-involvement (see Part VII; NCHS Data Briefs 522 and 549).
3. CDC MMWR, Drug Overdose Deaths Involving Stimulants — United States, 2018–2024 (2025) — demographic disparities, including American Indian/Alaska Native death-rate increases.
4. Jones CM, et al.; Winkelman TNA, et al. Evaluation of amphetamine-related hospitalizations and associated clinical outcomes and costs in the United States (amphetamine-involved hospitalizations +270%, 2008–2015).
5. Calcaterra SL, et al. U.S. trends in methamphetamine-involved psychiatric hospitalizations, 2015–2019 (+68%). *Drug Alcohol Depend.* 2024;262:111409 (PMC11343609).
6. Substance Abuse and Mental Health Services Administration, Drug Abuse Warning Network (DAWN) — methamphetamine-related ED visits 67,954 (2007) to 102,961 (2011); ~16% resulting in hospital admission. ED trends: Hoots B, et al.; Liu S, et al. (opioid-psychostimulant ED visit increases).
7. Treatment Episode Data Set (TEDS) analyses — primary methamphetamine treatment admissions 138,379 (2010) to 201,021 (2019), with injection route rising from 18.0% to 28.2% (PMC9809156); regional and demographic trends (CDC, "Methamphetamine use in the United States," stacks.cdc.gov/117327).
8. National Survey on Drug Use and Health (NSDUH) — past-year methamphetamine use 1.4 million (2016) to ~2 million (2019), ~2–2.6 million and relatively stable since 2021 (Han B, et al.; SAMHSA).

End of Part XIV — Reference (Chapters 36–40)

All forty chapters complete. The Appendices (A–H) conclude the volume.