Substance abuse in school aged children: Recent trends and drug of abuse review

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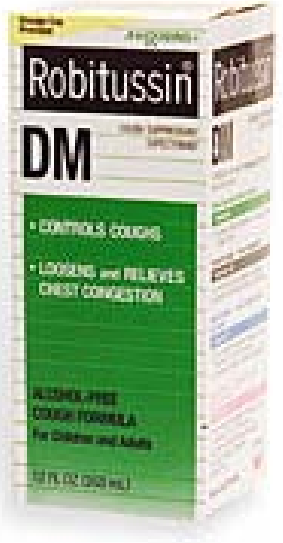


Outline

- Review poisoning scenarios associated with some classic drugs of abuse
  - Opioids
  - Inhalants
  - Anticholinergics
  - Amphetamines and other sympathomimetics
- Describe clinical effects seen with emerging drugs of abuse
  - Designer stimulants
  - Marijuana substitutes
  - Dissociatives
  - Misuse of prescription medications

A brief history of Poison Centers

- In early 1950s pediatricians recognized unintentional poisoning as a major source of morbidity/mortality in young children
- Chicago 1953: 1st US Poison Center
- Initially provided information to physicians to help manage poisonings
- Role expanded to include research, public/professional education, poison prevention, real time surveillance

Poison Center Basics

- Currently 57 US PCs
- Take calls from general public & HCFs
- Staffed by specially trained nurses and pharmacists with physician toxicologist available
- Data from each case entered into National Poison Data System (NPDS)
  - Substances involved, route of exposure, reason for exposure, clinical effects, treatment provided, outcome

Poisoning epidemiology

- Poisonings in children age < 6 typically unintentional (dosing error, exploratory ingestion)
  - After age 12 abuse/misuse and intentional self-harm
  - Age 7-11 too old for exploratory ing, too young for abuse (?)
- Following Poison Prevention Packaging Act (1970) pediatric poisoning mortality has declined
- But poisoning death rates in 15-19 year age group nearly doubled from 2000 to 2009 (1)
  - Proportion of deaths involving prescription drugs also nearly doubled (increased from 30% to 57%)
- 2011: Some fatalities reported in 7-11 age group that were suspicious for intentional misuse (2)

1. CDC 2012
2. Fine, *Clin Toxicol* 2012

Case 1

- 9 year old boy took 10 of his brother's ADHD pills around 7:30 PM
  - He just wanted to see what they would do
- Parents did not find out until next morning
- Seemed hyper, seeing animals that weren't there
- Child brought to ED
- In ED child initially tachycardic (HR 150), had dilated pupils, couldn't sit still

Case 2

- 15 yo F vomited after dinner & seemed confused
- Told Mom she was kidnapped at school, then went riding in a Cadillac
- In ED sleepy but agitated with stimulation
- HR 108, BP 127/85, RR 18, T 37.2
- Pupils 6 mm reactive
- Horizontal nystagmus
- Skin & mucous membranes moist
- Heart, lung, abd exams normal
- Confused, no tremor or rigidity, reflexes normal
- Routine blood work unremarkable

Osterhoudt, *Pediatr Emerg Care* 2005

Opiates/Opioids

- **Opiate**: Derived from the opium poppy
  - Codeine, morphine
- **Opioid**: Broader class includes semi-synthetic & synthetic agents that bind to opioid receptors
  - Heroin (3,6-diacetyl morphine)
  - Oxycodone, hydrocodone
  - Meperidine
  - Propoxyphene
  - Fentanyl
  - Methadone
- Urine opiate screens typically detect
  - Codeine
  - Morphine
  - Heroin
  - +/- Oxycodone & HC

Papaver somniferum

Heroin History

- Diacetylmorphine synthesized by Bayer company in late 19th century
- Seeking less addictive alternative to morphine
- Marketed as antitussive and analgesic in early 20th century until Harrison Narcotics Act (1914)

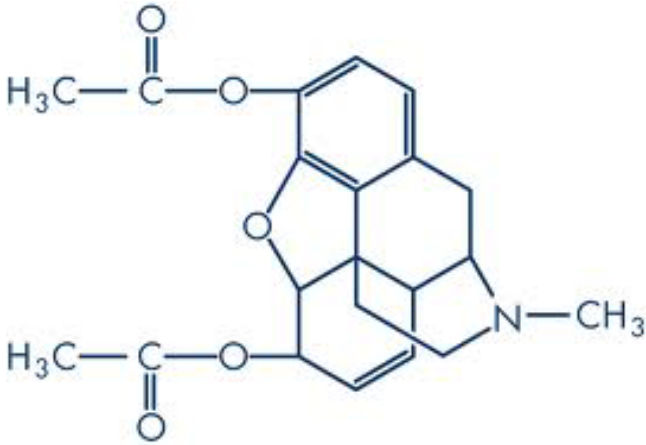
Opioids: Mechanism of action

- Primarily bind to the mu, kappa or delta opioid receptor
  - Mu receptor: responsible for analgesia, miosis, euphoria, respiratory depression, and decreased GI motility
- Clinical effects (opioid toxidrome)
  - CNS depression
  - Pinpoint pupils (miosis)
  - Respiratory depression
    - Also: Peripheral vasodilation with lowish heart rate and BP

Pharmacology of Heroin

- **Heroin**: 3,6-diacetylmorphine
  - Easily synthesized from morphine and acetic anhydride
  - The "rush" related to enhanced blood-brain barrier penetration
  - Lower affinity for mu receptor than morphine
  - But rapidly metabolized to 6-monoacetylmorphine (MAM)*
    - More potent mu agonist than morphine

*Detection of MAM confirms heroin exposure



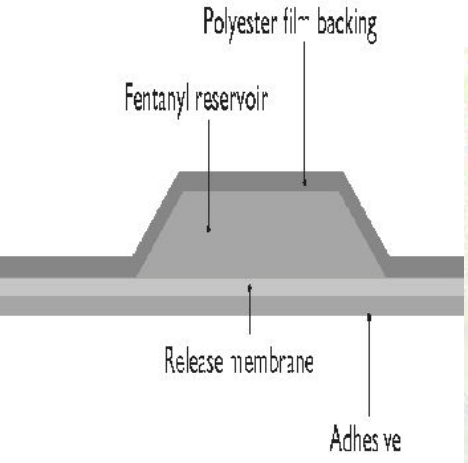
The antidote: Naloxone

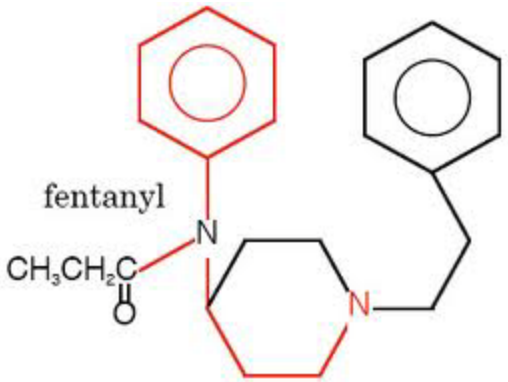
- Competitive antagonist at mu receptor
- Oral naloxone poorly bioavailable
- Well absorbed IM, SQ, via inhalation
  - Onset (IV) 1–2 min, duration of action 30–90 min
  - Elimination half-life 60–90 min
- Indication: reversal of opioid-induced CNS depression with airway/respiratory compromise
  - Can be used diagnostically

Available as 0.4 mg/mL or 1 mg/mL solution

Fentanyl abuse

- Highly lipophilic → rapid CNS penetration
- Fentanyl-related deaths in Philadelphia increased more than 10-fold from 2004 to 2006
- Patch can be eaten (after cutting membrane), used as teabag, smoked, or contents of reservoir extracted and injected
  - Used patches still have significant amount of drug
- Fentanyl analogs have been manufactured in clandestine labs





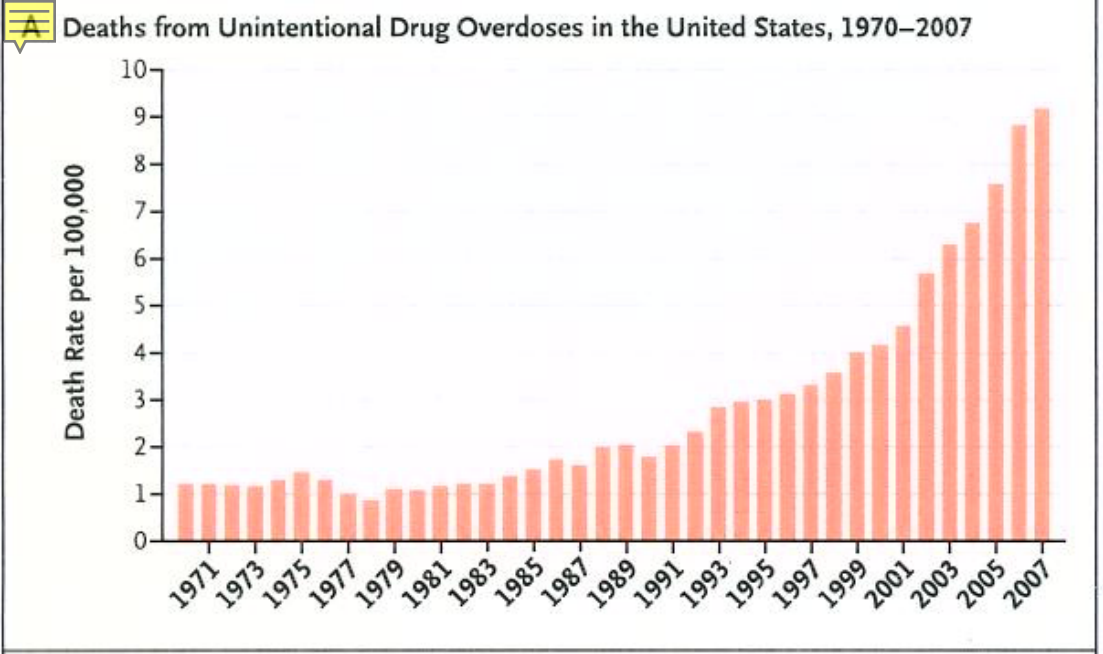
Wong, *J Med Toxicol* 2010

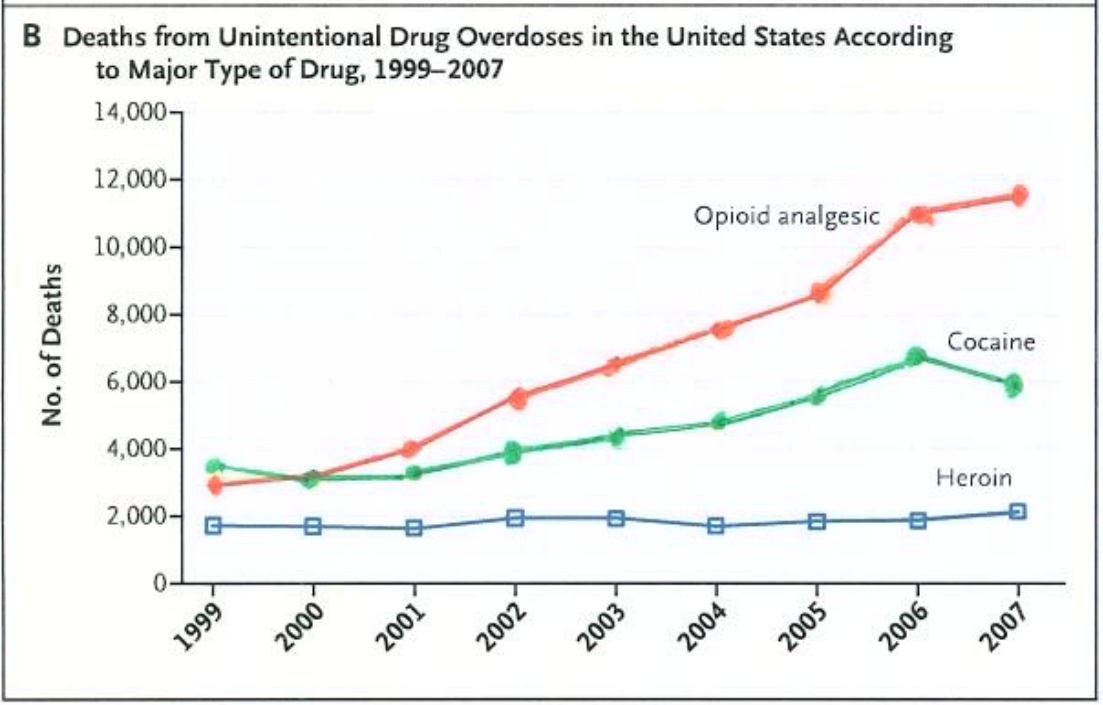
Parenteral use of oral opioids

- Abusers often crush pills and snort or inject for more rapid CNS effect
- Risk of opioid overdose, microemboli, infections, vascular injury
- Drug manufacturers reformulated some products making them more difficult to shoot or snort
- Injection of reformulated Opana ER (oxymorphone) associated with thrombotic thrombocytopenic purpura* (TTP)
  - Not seen with oral abuse (1)

*Microhemangiopathic hemolytic anemia with low platelets

1. CDC, *MMWR Morb Mortal Wkly Rep* 2013





U.S. Rates of Death from Unintentional Drug Overdoses and Numbers of Deaths, According to Major Type of Drug.

US death rates from unintentional overdose tripled in decade from 1997 to 2007

Data from CDC National Vital Statistics System

Okie, *N Eng J Med* 2010

Inhalants

- Glues, spray paints (toluene, xylene, n-hexane)
- Solvents (toluene, xylene, methylene chloride)
- Correction fluid, spot remover (1,1,1-trichloroethane, trichloroethylene)
- Aerosol propellants (chlorofluorocarbons)
- Fuels (butane, propane); markers (acetone)
- Whipped cream propellant (nitrous oxide)
- Products easily accessible and legal
  - Commonly abused by pre-teens/younger adolescents
- Abuse by sniffing, huffing, bagging

Inhalants (cont'd)

- Acute CNS depression, asphyxia, pneumonitis, dysrhythmia ("sudden sniffing death")
- Chronic exposure
  - Dependence and withdrawal syndrome
  - Encephalopathy, cerebellar dysfunction, peripheral neuropathy
  - Potential for impaired CNS development in early adolescence
  - Renal and hepatic injury, bone marrow depression
- Treatment: supportive care, avoid excessive stimulation (risk of ↑ catecholamine release → VFib)
- Recognition
  - Paint/oil stains on face/hands, chemical odor, nystagmus, injected sclerae, unsteady gait, dazed appearance, sleep disturbance, irritability, anorexia
  - Excessive hydrocarbon product or containers around home

Anti-cholinergic abuse

Datura stramonium aka Jimsonweed

Antihistamines, TCAs, some neuroleptics, many other drugs
Datura species (e.g. Jimsonweed) & many other plants

Anticholinergics: Mechanism of action

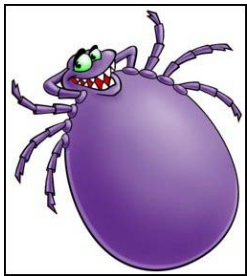
- Antagonize effects of acetylcholine (ACh) by blocking receptors
  - ACh receptors are either nicotinic or muscarinic
  - The “anti-cholinergic” drugs only block muscarinic receptors
  - We should call them “anti-muscarinic” because you don’t see anti-nicotinic effects such as muscle weakness

Anticholinergics: Clinical effects

- Hot as Hades – Fever (mild)
- Fast as a Hare – Tachycardia
- Dry as a Bone – Dry skin, MMs, armpits
- Red as a Beet – Flushed skin
- Mad as a Hatter – Delirium
- Full as a Tick – Urinary retention
- Blind as a Bat – Mydriasis
- Characteristic rapid mumbling speech
- Picking at sheets and clothing
- Public disrobing



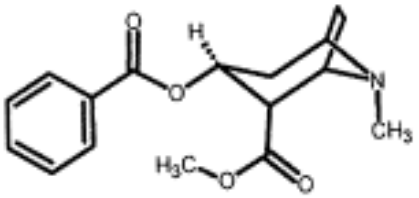




Anticholinergic toxicity (cont'd)

- What are potential major complications?
  - Seizures, aspiration, co-ingestion
  - Rare dysrhythmia and even rarer hyperpyrexia
- How do we treat anticholinergic toxicity?
  - Sedation, airway protection, fluids
  - Rule out co-ingestants and other diseases
  - Benzodiazepines: 1st (sedation & seizure prophylaxis)
  - Physostigmine (2 mg IV over 4-5 min in adult or adolescent) for delirium with patient on monitor – typically given in consultation with medical toxicologist
    - Reversible AChE inhibitor with short duration of action
    - Contraindicated in TCA toxicity with Na channel blockade (wide QRS) or bradycardia

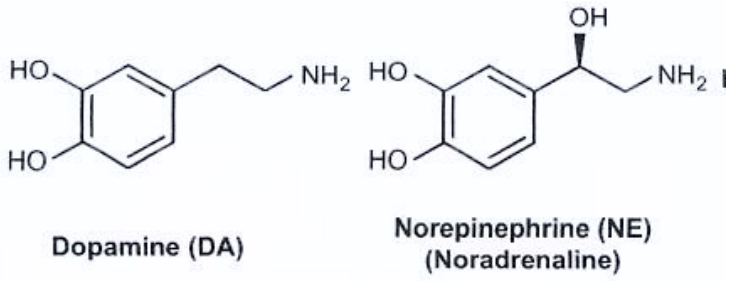
Sympathomimetics



Cocaine

- Cocaine
- Amphetamines/Methamphetamine
- Ecstasy (MDMA)
- ADHD meds like methylphenidate (Ritalin®, etc) & amphetamine/dextroamphetamine (Adderall®)
- "Designer" stimulants (mephedrone, MDPV, 2C-B, many others)

Structurally similar to endogenous neurotransmitters DA & NE



Nonmedical use of ADHD drugs

- Nonmedical use of prescription medications has surpassed illicit drug use except marijuana (1)
  - Calls to Poison Centers about ADHD med abuse rose 76% from 1998 to 2005, higher than ↑ in other calls (2)
- Abused recreationally and used as "study drugs" to enhance academic performance (3, 4)
- Students may give, trade, or sell to friends
- Others may describe ADHD symptoms to obtain prescription from health care provider

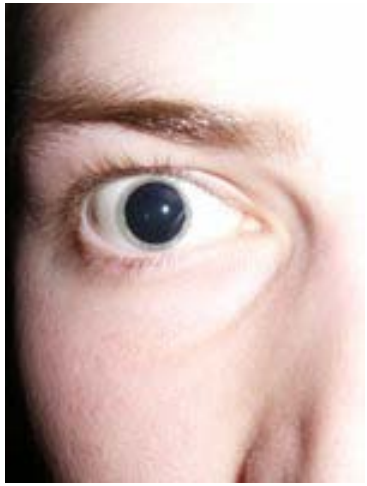
1. Fortuna, Pediatrics 2010
2. Setlik, Pediatrics, 2009
3. Schwarz A. The Good-grade pill. *NY Times* 6/9/12
4. Stein *J Dev Behav Pediatr* 2012; 33: 589

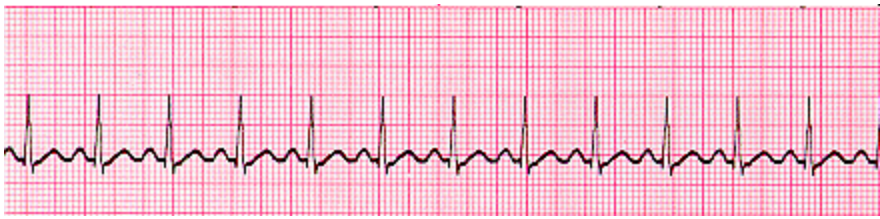
Sympathomimetics: MOA

- Excessive stimulation of alpha and beta adrenergic receptors
- ↑ sympathetic activity through increased norepinephrine, epinephrine, and dopamine release & reuptake inhibition

The sympathomimetic toxidrome

- Tachycardia
- Hypertension
- Confusion
- Agitation
- Diaphoresis
- Mydriasis
- Seizures
- Rhabdomyolysis
- Hyperthermia (T ≥ 104º F or 40º C)
  - Poor prognostic sign
  - Treat with aggressive external cooling





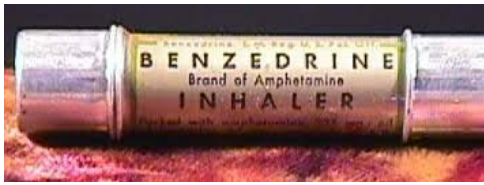
Sympathomimetics (cont'd)

- What are potential major complications?
  - Seizures, dysrhythmias, rhabdomyolysis, hyperthermia and multi-system organ failure
- Treatment of sympathomimetic toxicity
- Supportive care (no specific antidote)
  - Airway
  - IVF, monitor
  - Diagnostic tests
- Liberal use of benzodiazepines
- BP elevation: If severe HTN not improved with benzos short acting vasodilators occasionally used

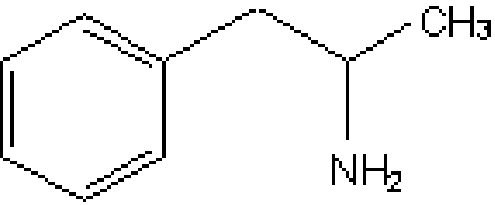
Sympathomimetics: What to avoid

- This class of drugs increases alpha and beta adrenergic stimulation
  - Giving a beta blocker only blocks beta activity
  - Can lead unopposed alpha stimulation
    - Results in vasoconstriction
    - Labetolol is mainly a beta blocker with weak alpha antagonism
- We recommend against using β-blockers to treat sympathomimetic toxicity
- If ↑↑ BP not improved with benzos use vasodilators such as nitrates

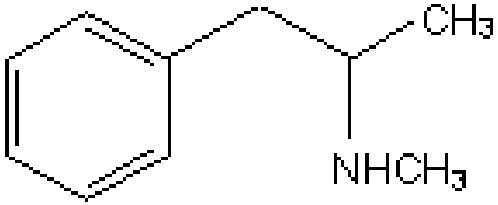
Amphetamines



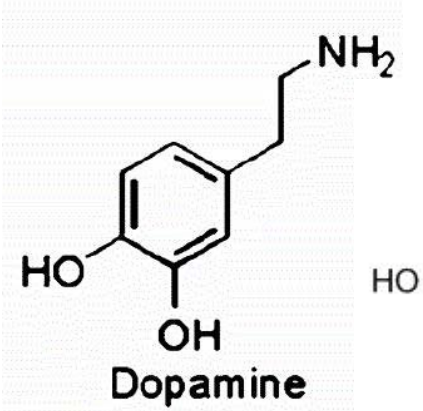
- Amphetamine and methamphetamine developed in 1920s – 1930s
- Benzedrine inhaler – nasal decongestant
- Amphetamine used as appetite suppressant, treatment for narcolepsy
- 1970: amphetamine made Schedule II drug
- Primary mechanism: Enters pre-synaptic neurons via reuptake transporters leading to ↑ NE, DA (and some serotonin) release



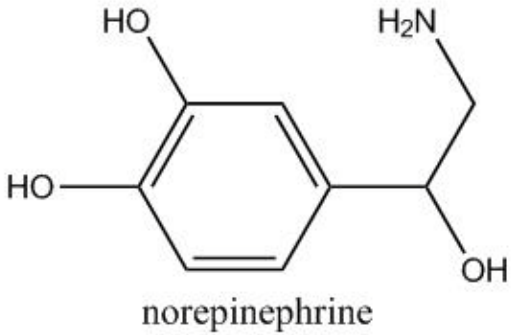
Amphetamine



Methamphetamine



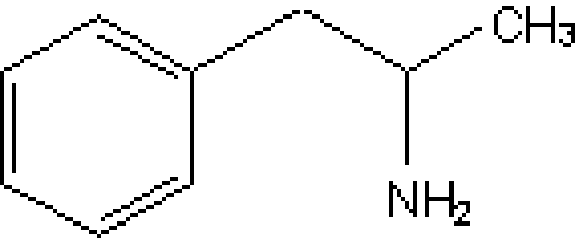
Dopamine



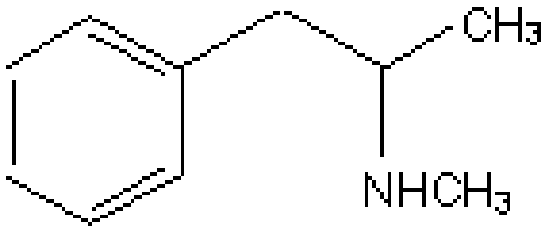
norepinephrine

Evolution of designer stimulants

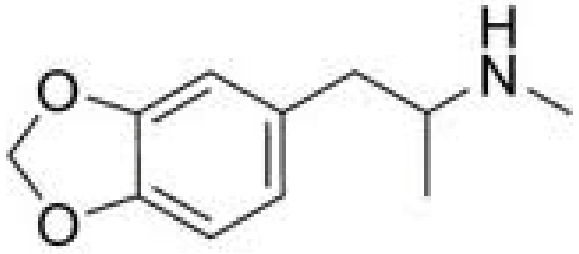
- Early 1980s: Designer amphetamines widely used to circumvent drug laws
- Mid-1980s: Drug laws amended to cover analog substances used for mind-altering purposes
- Newer designer drugs circumvent analog act by labeling "not for human consumption"
  - Sold as "research chemicals", "plant food", "bath salts", etc



Amphetamine



Methamphetamine

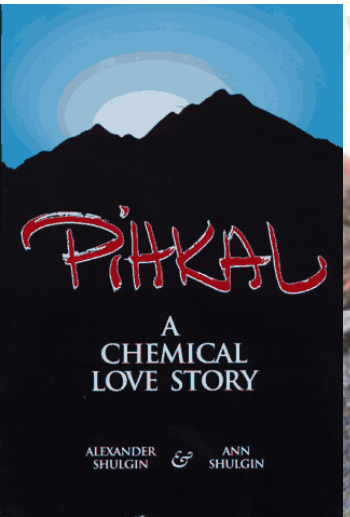


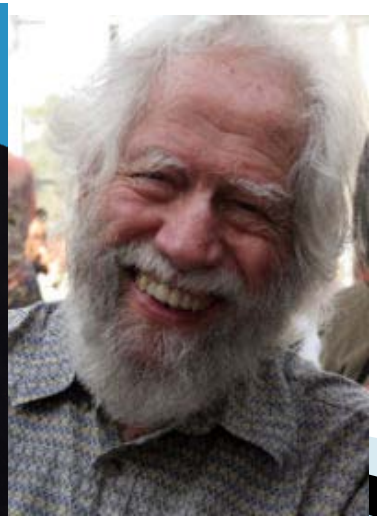
Methylenedioxy-methamphetamine (MDMA)

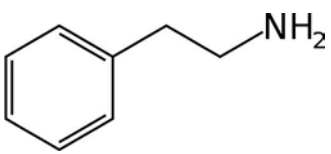
Designer Amphetamines (cont'd)

- Chemist Alexander Shulgin synthesized MDMA & others in 1970s & 80s
  - Consultant for DEA until they raided his lab in 1990s
- Author of PIKHAL, *Phenethylamines I Have Known and Loved* (1991)
- Substitutions determine drug properties, whether more hallucinogenic or sympathomimetic

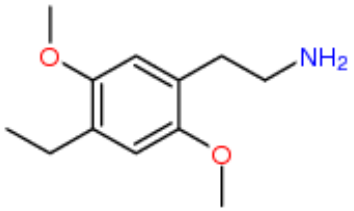
"2C" drugs
(dimethoxyphenethylamines) →



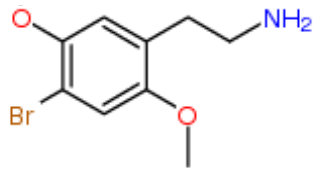




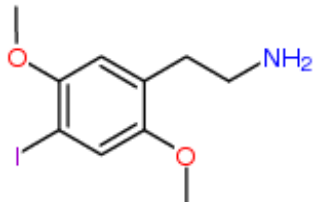
Phenethylamine structure



2C-E



2C-B



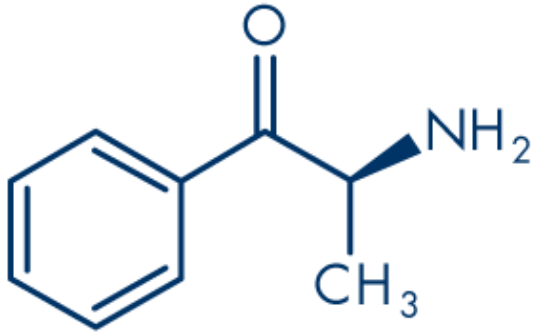
2C-I
aka "smiles"

Cathinones

- From leaves of khat plant
- Active ingredient: cathinone
- Khat-chewing common in Somalia & Yemen
- Khat has short shelf-life
- Synthetic cathinones became popular in Europe in 1990s and early 2000s
  - Aka bk phenethylamines

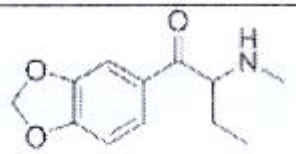
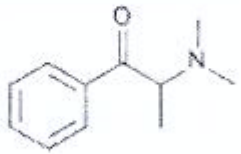
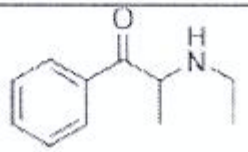
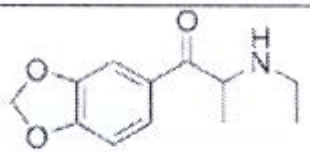
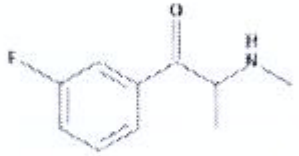
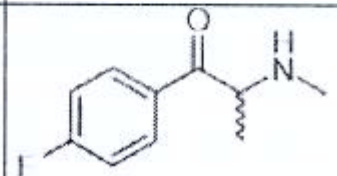
Catha edulis

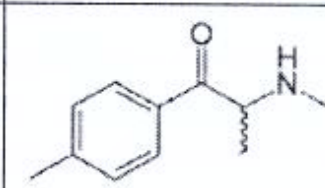
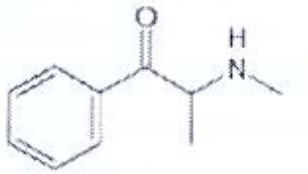
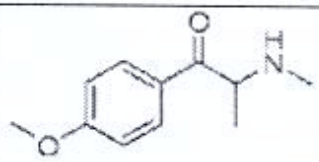
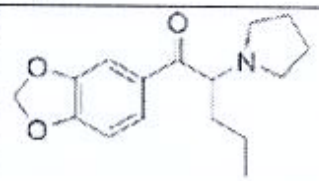
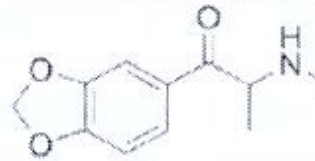
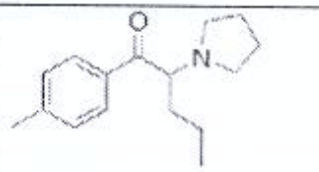
Chewing khat in Yemen



Cathinone

Synthetic cathinones used as DOAs

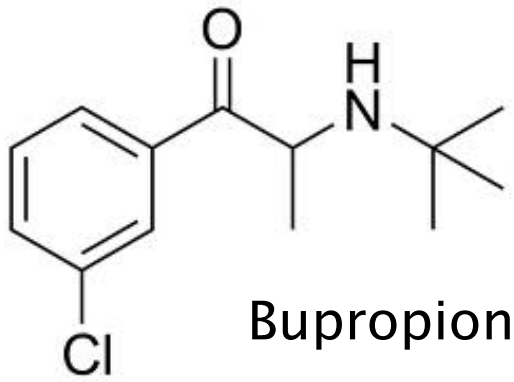
Common Name	Chemical Name	Chemical Structure
Butylone	1-(1,3-benzodioxol-5-yl)-2-(methylamino)butan-1-one	
Dimethylcathinone	(*RS*)-2dimethylamino-1-phenylpropan-1-one	
Ethcathinone	(*RS*)-2-ethylamino-1-phenyl-propan-1-one	
Ethylone	(*RS*)-1-(1,3-benzodioxol-5-yl)-2-(ethylamino)propan-1-one	
3-Fluromethcathinone	(RS)-1-(3-fluorophenyl)-2-methylaminopropan-1-one	
4-Fluromethcathinone	(*RS*)-1-(4-fluorophenyl)-2-methylaminopropan-1-one	

Mephedrone	(RS)-2-methylamino-1-(4-methylphenyl)propan-1-one	
Methcathinone	α-methylamino-propiophenone	
Methedrone	(*RS*)-1-(4-methoxyphenyl)-2-(methylamino)propan-1-one	
Methylenedioxypyrovalerone (MDPV)	(*RS*)-1-(Benzo[*d*][1,3]dioxol-5-yl)-2-(pyrrolidin-1-yl)pentan-1-one	
Methylone	(±)-2-methylamino-1-(3,4-methylenedioxyphenyl)propan-1-one	
Pyrovalerone	(*RS*)-1-(4-methylphenyl)-2-(1-pyrrolidinyl)pentan-1-one	

Prosser, *J Med Toxicol* 2011

Cathinones (cont'd)

- Buproprion is the only cathinone used therapeutically (Wellbutrin®)
- Low abuse potential as an oral drug
- Sometimes abused by nasal insufflation (snorting) or IV administration
  - Bypasses first pass effect resulting in higher serum levels



Bupropion

Cathinones often labeled “not for human consumption”

Source: Gibbons, *Clin Toxicol* 2012

Synthetic cathinone legal status

- Calls to PCs in 1st half of 2011 > 10 X number of calls for all of 2010
- September 2011: DEA announced temporary scheduling of mephedrone, methylone, and MDPV
- Multiple states have banned SCs

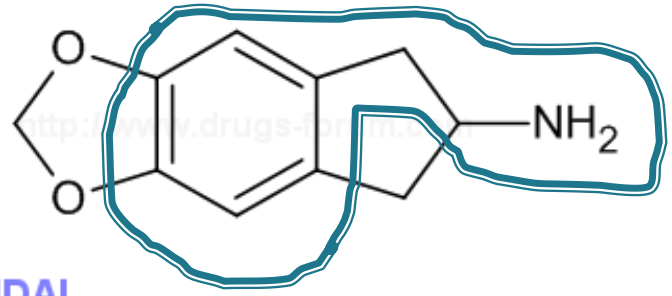
Synthetic cathinones: clinical features

- Effects expected to be similar to older sympathomimetics
- Pharmacology & pharmacokinetics less well known
- Ingredients often not listed
  - MDPV, mephedrone, & methylone most common agents found in recent analysis of US “bath salt” samples (1)
  - Other substances may be present
- Most common routes of administration
  - Insufflation, injection, ingestion
- Most common clinical features:
  - Agitation, violent behavior, tachycardia (1)

1. Spiller, *Clin Toxicol* 2011

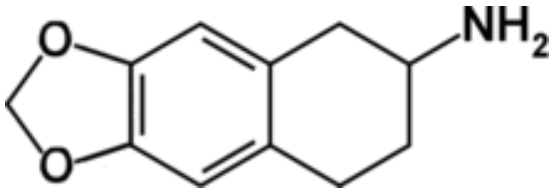
Other designer stimulants

- "Masked amphetamines" have phenethylamine hidden in an extra 5 or 6 membered ring (1)
- Methylenedioxy-2-amino-indane (MDAI), methylenedioxy-2-amino-tetralin (MDAT), others
  - Thought to be more serotonergic
- Bromodragonfly (2) and DOI (3) a/w peripheral vasoconstriction

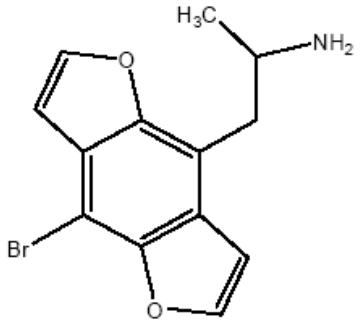


MDAI

5,6-methylenedioxy-2-aminoindane

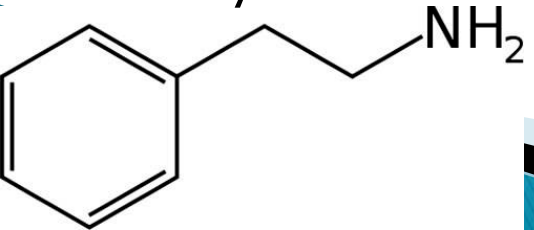


MDAT



Bromo-DragonFLY

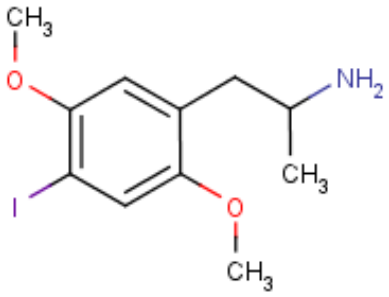
Phenethylamine



!. Gibbons, *Clin Toxicol* 2012

2. Wood, *J Med Toxicol* 2009

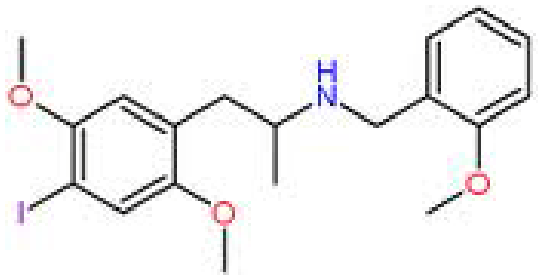
3. Kowalski, *Clin Toxicol* 2012



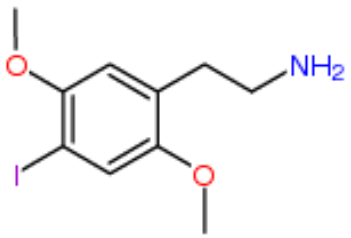
DOI

Other designer stimulants (cont'd)

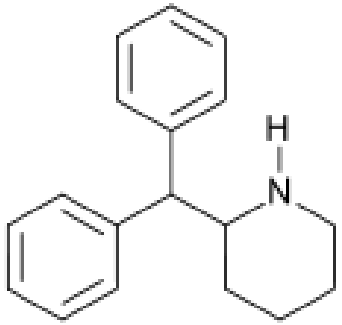
- 25I-NBOMe: New derivative of 2C-I associated with delirium and seizures (1)
- Desoxypipradol developed by Ciba-Geigy in 1950s to arouse patients from anesthesia ("Weckamine")
  - Found in 2010 UK cluster of "ivory wave" abuse (2)
  - Chemically similar to DA/NE reuptake inhibitor methylphenidate
- Drugs sold as "LSD" often contain designer stimulants



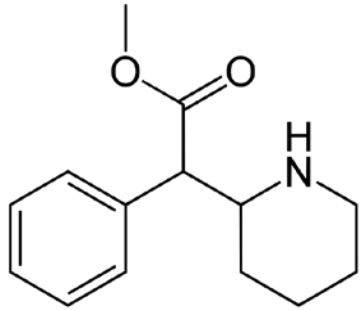
25I-NBOMe



2C-I



Desoxypipradol

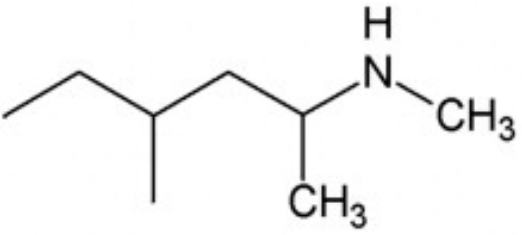


Methylphenidate

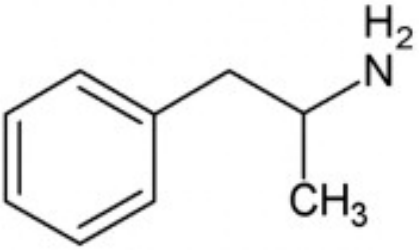
1. Kelly, *Clin Toxicol* 2012
2. Murray, *Clin Toxicol* 2012

Other designer stimulants (cont'd 2)

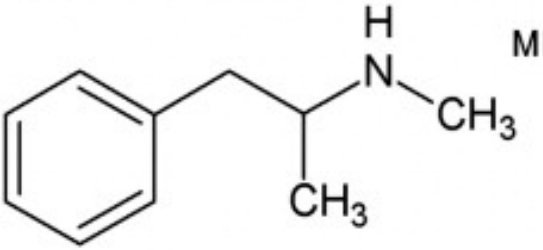
- Dimethylamylamine (DMAA) aka Geranamine, developed as nasal decongestant in 1940s
  - Structurally similar to methamphetamine
- Sold as dietary supplement, weight loss aid
- Associated with intracranial hemorrhage



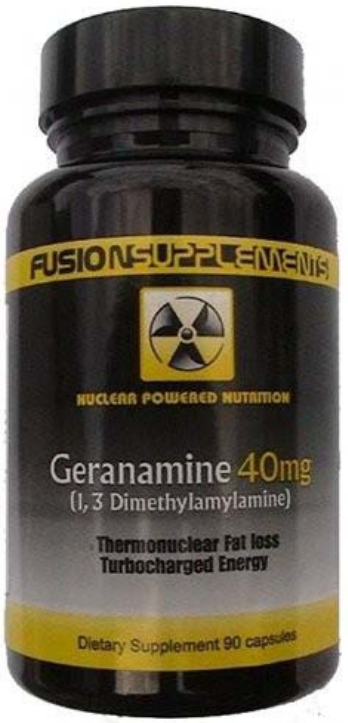
DMAA
$C_7H_{17}N$
mol. wt. 115.2



AMPHETAMINE
$C_9H_{13}N$
mol. wt. 135.2



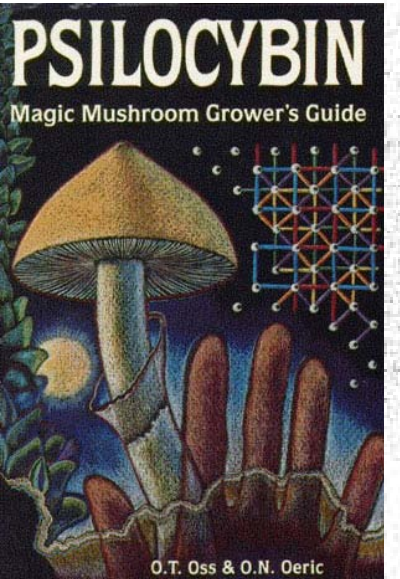
METHAMPHETAMINE
$C_{10}H_{15}N$
mol. wt. 149.2

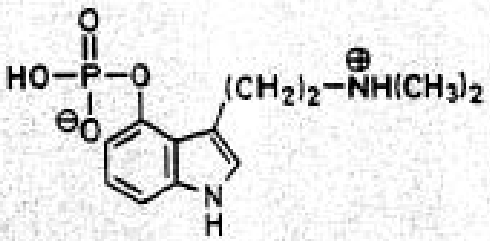


Gee, *Ann Emerg Med* 2012

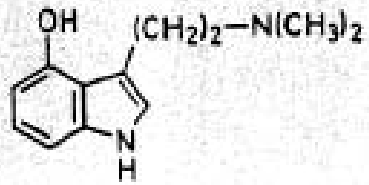
Tryptamines

- Structural similarity to serotonin (aka 5-hydroxytryptamine)
- Natural (psilocin) and man-made (DMT, etc)
- Interact with serotonin receptors/transporters
- Primarily hallucinogenic
- Some also have sympathomimetic activity
- Treatment: supportive care, benzos prn

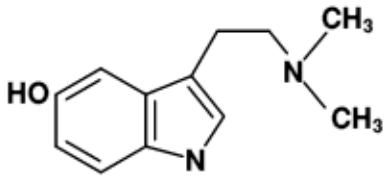




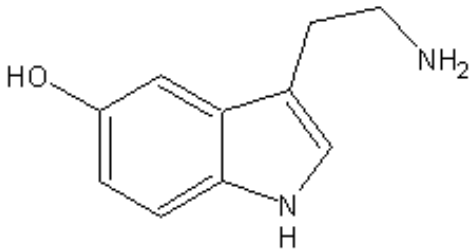
Psilocybin



Psilocin

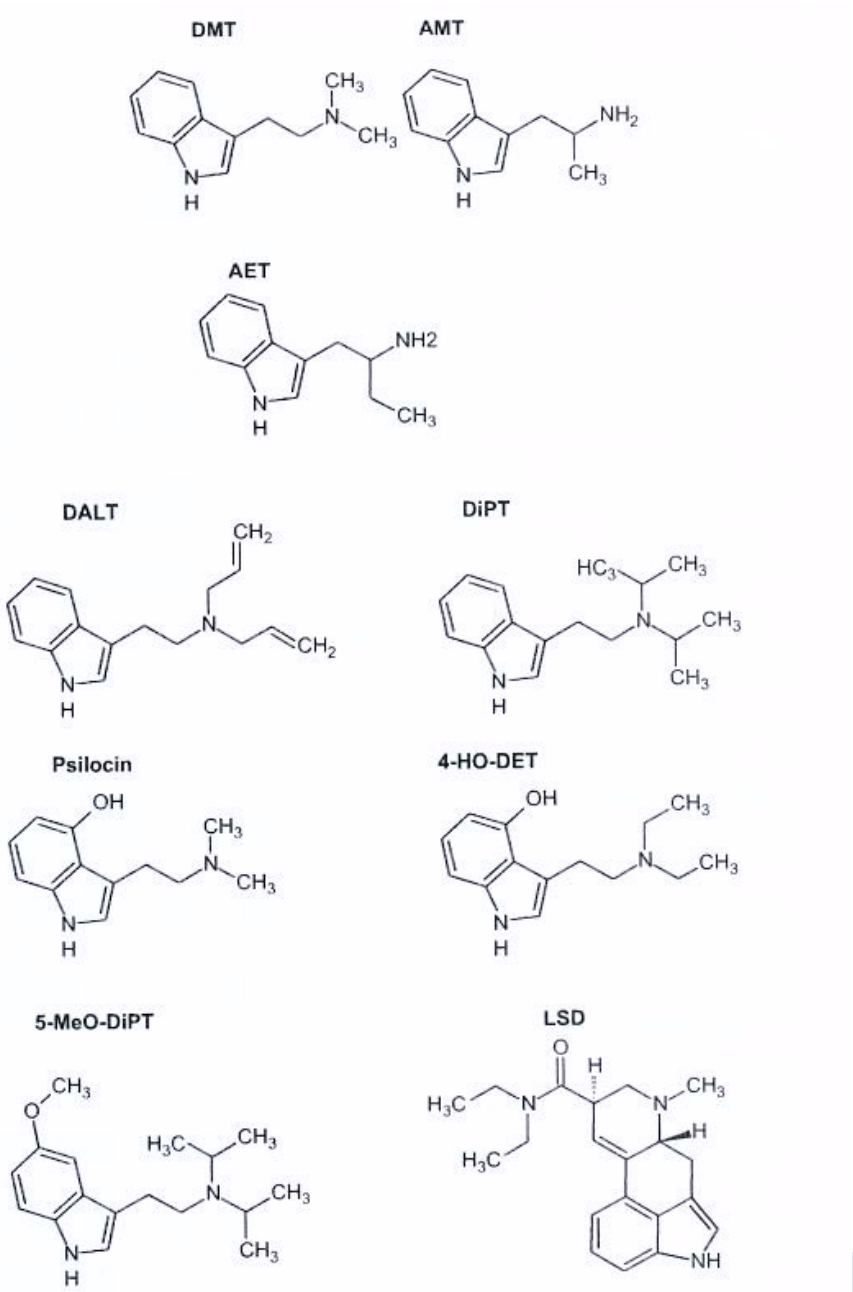


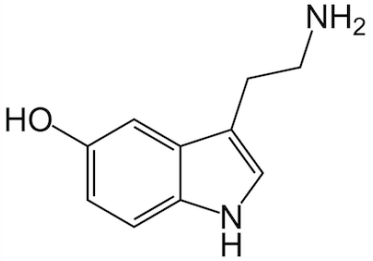
Bufotenine



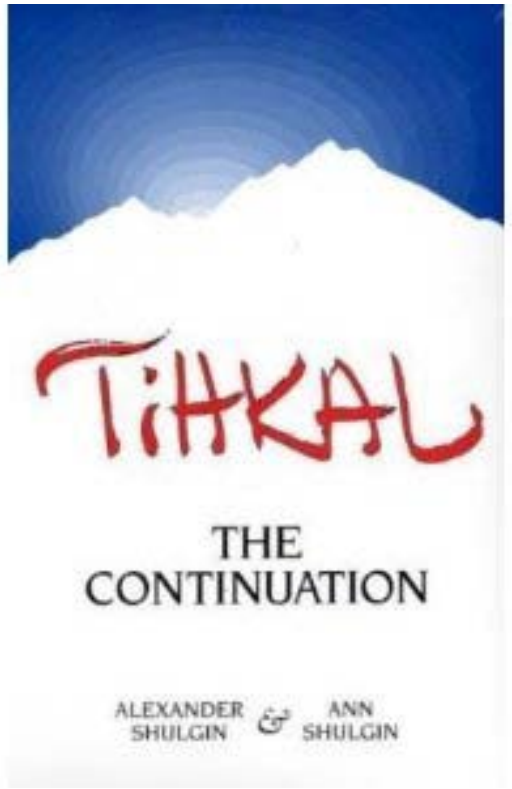
Serotonin

Tryptamine structures





Serotonin

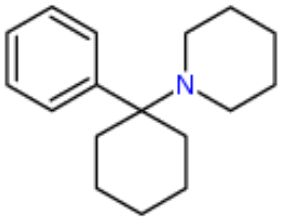


Tryptamines I Have Known and Loved, Alexander & Ann Shulgin, 1997

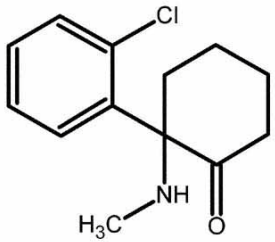
Hill, *Clin Toxicol* 2011

Phencyclidine (PCP)/ketamine

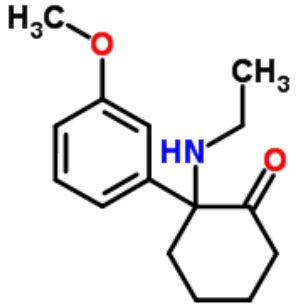
- PCP (Phenylcyclohexylpiperidine): Dissociative anesthetic in use until mid-1960s
  - Dissociative effects thought due to glutamate antagonism
  - Abandoned due to post-op dysphoria & psychosis
  - Became popular as a street drug in 1970s
  - Tachycardia, delirium, hallucinations, nystagmus
  - Effects can last 24-48 h (T ½ 18-24 h)
  - Treatment: Supportive care, benzos prn
- Ketamine introduced in 1970: Potency & T ½ ~10% compared with PCP
- Methoxetamine analog of ketamine available on internet
  - Potency & duration of action intermediate between PCP & ketamine



Phencyclidine



Ketamine



Methoxetamine

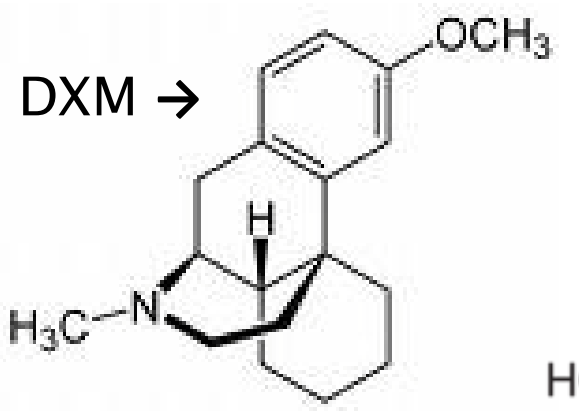
Rosenbaum, *J Med Toxicol* 2012
Hofer, *Ann Emerg Med* 2012

OTC meds

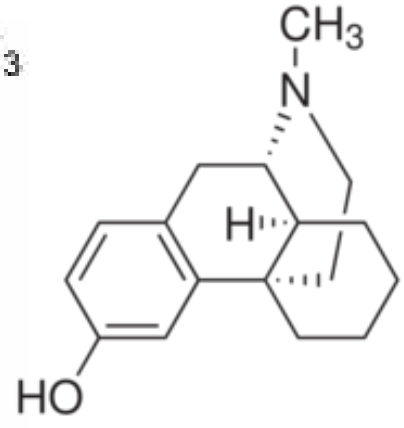
- Dextromethorphan (DXM)
  - ↑s CNS serotonin activity (serotonin syndrome if combined with other serotonergic drugs)
  - Glutamate antagonist similar to PCP or ketamine
  - PCP-like dissociative effects (from metabolite)
  - Available as Robitussin & in other cold/cough meds
    - Some may contain acetaminophen
  - Robo-tripping, Tussing, Pharming popular among adolescents

Robo-tripping

DXM →

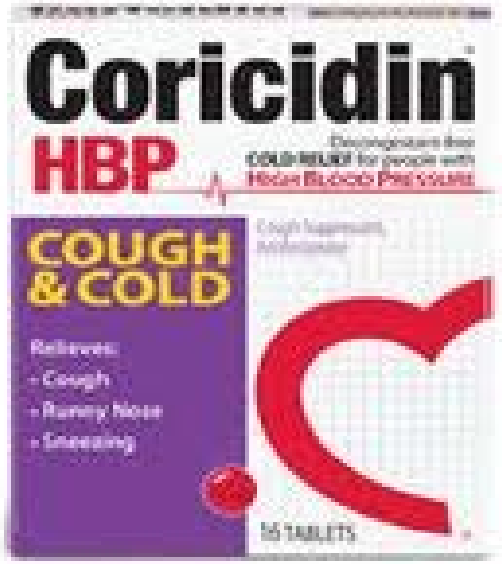


Dextrorphan
(DXM metabolite)
↓



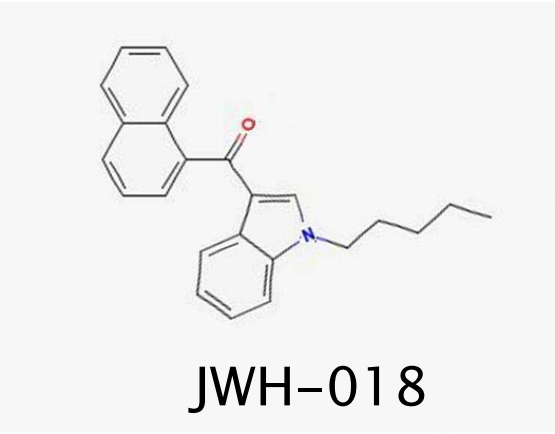
Dextromethorphan (cont'd)

- L-isomer is opioid levorphanol but DXM has minimal opioid activity except at very high doses
- Short T ½ (3-5 h) except in slow metabolizers
- Metabolized by CYP 2D6 to active metabolite
- Can give false + for PCP on UDS
- Coricidin: DXM + chlorpheniramine (antihistamine)
  - Aka Skittles, Cap'n Crunch, Triple Cs
  - Can have AMS from DXM or anticholinergic delirium from antihistamine
- Treatment
  - Supportive care
  - Benzodiazepines as needed
  - Check for acetaminophen



Marijuana substitutes

- Synthetic cannabinoids developed in 1990s as potential analgesics
  - JWH-018, JWH-073, JWH-250, many others
  - Became DOAs in late 2000s
- Sprayed on herbs or dried leaves
- Marketed as incense or potpourri but typically smoked (K-2, Spice, etc)
- Illegal in most European countries
- DEA banned some synthetic CBs in Mar 2011



JWH-018

Marijuana substitutes (cont'd)

- Not detected by marijuana drug screen
- Delirium, tachydysrhythmias, and seizures have been reported
- Treatment: Supportive care, benzos prn seizure or agitation, look for coingestants
- Seizures with synthetic CB products
  - May be due to
    - ↑ potency of synthetic CBs
    - Other pharmacologic properties of these agents
    - Adulterants/contaminants
    - Absence of anticonvulsant substances present in marijuana plant

Case 1 conclusion

- 9 year old who took brother's ADHD pills
- Methylphenidate 18 mg X 10
- Given IV fluids and multiple doses of lorazepam
- Discharged home on afternoon of hospital day 3

Case 2 conclusion

- 15 year old girl riding in Cadillac
- In girl's pocket ED nurses found empty blister packs of Coricidin HBP
  - Dextromethorphan 30 mg/chlorpheniramine 4 mg
- Parents found empty box in her bedroom
- Confusion resolved after 8 hours without treatment
- Referred for substance abuse counseling

Osterhoudt *Ped Emerg Care* 2005

Key points

- Misuse of pharmaceuticals is the fastest growing drug abuse problem among adolescents
  - Includes opioids, stimulants, antidepressants, neuroleptics, as well as OTC cold/cough preparations
  - May be perceived as safer than street drugs
  - Easy access in home, from friends, or health care provider
- Most common site of abuse appears to be at home
- Parents and children should be educated on risks of abuse and casual medication sharing
  - Parents to be alert for decline in schoolwork, loss of interest in usual activities, behavioral changes
  - Securing and monitoring of medications

Useful resources

- Substance Abuse and Mental Health Services Administration (SAMHSA) National Survey on Drug Use & Health: www.oas.samhsa.gov/nhsda.htm
  - 2010 is most recent year for which full survey results are available
- National Institute on Drug Abuse (NIDA): www.drugabuse.gov/drugs-abuse/prescription-drugs
- Nebraska Regional Poison Center: www.nebraskapoison.com/Prescription-Drug-Abuse.aspx
  - Journal articles
  - Presentations and handouts for parents and educators

Key points – treatment approaches

- Naloxone (but not flumazenil) for drug intoxication with CNS/respiratory depression
  - Start with low dose if chronic opioid use suspected
  - Repeated dosing or infusion may be needed
- Supportive care, cooling & benzodiazepines are mainstays for treating stimulant toxicity
  - Escalating doses of benzos
  - Check temperature; external cooling as needed
  - Direct vasodilators for vasospasm or ↑↑ BP not improved with benzos (avoid β-blockers)
  - Similar approach for hallucinogens, DXM & other dissociatives
- Consider anticholinergic toxicity if dry skin, axillae & mucous membranes
  - Initial treatment similar to stimulants

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Questions ?


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Thank you!

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