

TOXIC DRUG CONCENTRATIONS
 OFFICE OF THE CHIEF MEDICAL EXAMINER
 CHAPEL HILL, NC 27713
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The following table is provided only as a guide. The data have been compiled from previously published scientific literature and from prior OCME experience; hence these concentrations cannot be regarded as complete for all therapeutic and poisoning situations. When available, references are included for a drug. Also, the appropriate screening assay [see Key] is designated for each drug. Average concentrations are given in parenthesis from when available. Many of the concentrations listed as toxic are from driving under the influence of drugs (DUID) data and are referenced as such in the comments column. The proper interpretation of postmortem drug concentrations is complex and complicated by many factors including individual variations in response to drugs, tolerance, physical stature, and disease states; the presence of other drugs, and the potential for postmortem changes in blood-drug concentrations. If a toxicological agent is suspected in a case, additional specimens, including peripheral blood (PB) and liver (LVR) should be submitted for a more complete investigation.

References:

1. Baselt RC. Disposition of Toxic Drugs and Chemicals in Man, 6th ed. Biomedical Publications, Foster City, CA, 2002.
2. Druid H, Holmgren P. A Compilation of Fatal and Control Concentrations of Drugs in Postmortem Femoral Blood. *J Forensic Sci* 1997;42:79-87. Druid H, Holmgren P, Hallander S, Ahlner J. Interpretation of postmortem femoral blood concentrations of newer antidepressants and hypnotics. American Academy of Forensic Sciences, February, 2001.
3. Stead AH, Moffat AC. A Collection of Therapeutic, Toxic and Fatal Blood Drug Concentrations in Man. *Human Toxicol* 1983;3:437-464.
4. Repetto MR, Repetto M. Habitual, Toxic, and Lethal Concentrations of 103 Drugs of Abuse in Humans. *Clin Toxicol* 1997;35:1-9.
5. Schultz M, Schmoldt A. Therapeutic and Toxic Blood Concentrations of More than 500 Drugs. *Pharmazie* 1997;52:895-911.

DRUG (Reference)	THERAPEUTIC			LETHAL (mg/L)	COMMENTS/ADDITIONAL INFORMATION
	ASSAY	(mg/L)	TOXIC (mg/L)		
Acetaminophen (1,2,3,5)	N	1-52	30-300	90-320 (170)	The toxic effects of acetaminophen are often seen 2-4 days after ingestion and blood levels may not be extremely high at time of death.
Alprazolam (1,2,4,5)	E	0.005-0.11	0.008-0.64	0.12-2.1 (0.55)	The concentrations listed as toxic are from driving under the influence (DUID) cases. Only 30% of those arrested had concentrations greater than 0.10 mg/L.
Amantidine (1,3,5)	B	0.1-1.0	1-5	21-48 (33)	
Amitriptyline (1,2,3,5)	B	0.01-0.25	>1	>2	Significant postmortem redistribution can occur with all tricyclics. PB and LVR may be required to resolve difficult cases.
Amoxapine (1,5)	B	0.01-0.6	0.3-2.9 (1.6)	0.9-20 (6.9)	Significant postmortem redistribution can occur with this drug. PB and LVR may be required to resolve difficult cases.
Amphetamine (1,3,4,5)	B	0.05-2.0	0.2-3	0.5-41(8.6)	Tolerance is important to consider when evaluating the toxicity of this drug. Cardiotoxic with ethanol consumption.

A- Acids
 B- Bases
 N- Neutrals
 E- Immunoassay
 S- Special

DRUG (Reference)	THERAPEUTIC			LETHAL (mg/L)	COMMENTS/ADDITIONAL INFORMATION
	ASSAY	(mg/L)	TOXIC (mg/L)		
Arsenic (1,3)	S	0.002-0.062; 0.27 (herbicide workers)		>0.6-9.3 (oral); >0.1 (arsine)	Detection of chronic arsenic poisoning is complex. Blood specimens alone are insufficient. Tissues and/or hair are usually required.
Benzotropine (1)	B	0.008-0.13 (0.1)	0.1	0.2-1.1 (0.5)	
Bupropion (1,5)	B	0.05-0.4	0.19-0.22	4-13 (7.3)	Postmortem redistribution can occur with this drug. PB and LVR may be required to resolve difficult cases.
Buspirone (1,4,5)	B	0.0005-0.003			
Butalbital (1,3,4,5)	A	1-5	0.1-28 (8.5)	13-30	
Butorphanol (1,3)	S	<0.002		0.005	
Caffeine (1,2,3,4,5)	B	12-30	50-400	79-344 (183)	
Carbamazepine (1,2,3,5)	N	2-12	3-77	35-70 (45)	
Carbon Monoxide (1,3,5)	S	<10 % SAT	15-25 % SAT	50 % SAT	smokers:5-6%
Carisoprodol (1,2,3,5)	N	2.6-30	2.6-15	>30	Tolerance is important to consider when evaluating the toxicity of this drug. The concentrations listed as toxic are from driving under the influence (DUID) cases.
Chlordiazepoxide (1,2,3,4,5)	B	0.4-3.0	1-66	>20	
Chlorpheniramine (1,5)	B	0.01-0.02	0.5	>0.5	Significant postmortem redistribution can occur with this drug. PB and LVR may be required to resolve difficult cases.
Chlorpromazine (1,2,3,5)	B	0.02-0.30 low dose 0.75 high dose	0.5-3.0	>1 (mean= 5.0)	Liver levels can usually differentiate high chronic vs. fatal cases. Significant postmortem redistribution can occur with this drug. PB and LVR may be required to resolve difficult cases.
Citalopram (1,2,5)	B	<1	1.0-4.0	>4.0	Significant postmortem redistribution can occur with all SSRIs. PB and LVR may be required to resolve difficult cases. The concentrations listed as toxic are from driving under the influence (DUID) cases.
Clomipramine (1,2,3,5)	B	<0.3	1	2	Significant postmortem redistribution can occur with all tricyclics. PB and LVR may be required to resolve difficult cases.
Clonazepam (1,3,4,5)	S	0.01-0.2	>0.1	>0.3-10 (+mtb.)	Usually present as mtb. only. The concentrations listed as toxic are from driving under the influence cases.
Clorazepate (1,3,4,5)	B	0.12-2.0 (nordiazepam)	>5		Prodrug for nordiazepam. No reported OD for this drug taken alone.
Clozapine (1,2,4,5)	B	0.06-1.0	0.6-9.5	1.2-13	Significant postmortem redistribution can occur with this drug. PB and LVR may be required to resolve difficult cases.
Cocaine (1,3,4,5)	E	0.1-1.0	0.1-5	>0.9	Concentrations listed include the cocaine metabolites benzoylecgonine and ecgonine methyl ester.
Codeine (1,2,3,4,5)	E	0.03-0.4	0.2	1-8.8 (2.8)	
Cyanide (1,3,5)	S	<0.04	0.5	1.1-5.3 (oral); 1-15 (inhalation)	
Cyclizine (1,3,5)	B	0.01-0.3		15-80 (oral) (IV) 1.5	
Cyclobenzaprine (1)	B	<0.1	1	2	Significant postmortem redistribution can occur with all tricyclics. PB and LVR may be required to resolve difficult cases.

DRUG (Reference)	ASSAY	THERAPEUTIC (mg/L)	TOXIC (mg/L)	LETHAL (mg/L)	COMMENTS/ADDITIONAL INFORMATION
Desipramine (1,2,3,5)	B	0.1-0.8	0.4-2.0	3-16.8 (10.8)	Significant postmortem redistribution can occur with all tricyclics. PB and LVR may be required to resolve difficult cases.
Dextromethorphan (1,4,5)	B	0.01-0.04	0.1	1.1-18 (3.5)	May exhibit PMRD; PB and LVR may be required to resolve difficult cases.
Diazepam (1,2,3,4,5)	B	0.2-1.5 (low dose); 2-4 (high dose)	3-5	>5	Diazepam only deaths are infrequent.
Diethylpropion (1,3)	B	<0.2	2	5	
Diflunisal (1)	S	40		>260	
Digoxin (1,3,4,5)	S	0.0004-0.0023	0.0014-0.007	0.0015-0.03	Blood should be taken from a peripheral source. Vitreous is also acceptable
Diltiazem (1,2,4,5)	B	0.1-0.4	>1	6.7-33 (16)	PMRD may occur, PB and LVR excellent complementary specimens to resolve difficult cases.
Diphenhydramine (1,3,5)	B	0.1-1	2-10	>8	Significant postmortem redistribution can occur. PB and LVR excellent complementary specimen to resolve difficult cases.
Doxepin (1,3,5)	B	<0.1	>1	2-26 (13)	Significant postmortem redistribution can occur with all tricyclics. PB and LVR excellent complementary specimens to resolve difficult cases.
Doxylamine (1,5)	B	0.05-0.8	1-2	0.7-12 (4.6)	
Ephedrine (1,2)	B	0.1-0.6		5	
Ethchlorvynol (1,3)	S	5-20	18-163	22-213 (98)	
Ethylene glycol (1,3)	S	na		>300	
Fenfluramine (1,3,4,5)	B	0.3		6.5	
Fentanyl (1,4,5)	E	0.001-0.0038	0.003	0.002(IV); >0.007(patch)	Tolerance is important to consider when evaluating the toxicity of this drug.
Flunitrazepam	S	0.02-0.05		0.01-1.6	Parent drug is rarely detected. Values given are for the 7-amino flunitrazepam metabolite
Fluoxetine (1,4)	B	<1 (parent + mtb)	0.2-0.4	2-6	Significant postmortem redistribution can occur with all SSRIs. PB and LVR excellent complementary specimens to resolve difficult cases. The concentrations listed as toxic are from driving under the influence (DUID) cases.
Fluphenazine (1,5)	S	0.02	0.1	0.1	
Fluvoxamine (1,2)	B	<0.9	0.3	3.4-16	Significant postmortem redistribution can occur with all SSRIs. PB and LVR excellent complementary specimen to resolve difficult cases. The concentration listed as toxic is from a driving under the influence (DUID) case.
Gabapentin (1)	S	<20	45	>250	
Gammahydroxybutyrate (1)	S	20-52	>200	>400	Lethal levels lower with concomitant use of ethanol.
Guaifenesin (1)	A	1.5		14	A lethal conc. of hydrocodone was also detected
Haloperidol (1,3,5)	S	<0.1	0.05-0.5	0.2-1	
Heroin (1,3)	E	0.1 (morphine in chronic user)		>0.1 (morphine)	Tolerance is important to consider when evaluating the toxicity of this drug. Urine or bile are excellent complementary specimens to use in distinguishing between morphine and heroin use.
Hydrocodone (1,3,4,5)	E	<0.1	0.1	0.2-0.6	Tolerance is important to consider when evaluating the toxicity of this drug.

DRUG (Reference)	ASSAY	THERAPEUTIC (mg/L)	TOXIC (mg/L)	LETHAL (mg/L)	COMMENTS/ADDITIONAL INFORMATION
Hydromorphone (1,3,4,5)	S	<0.05		>0.1	Tolerance is important to consider when evaluating the toxicity of this drug.
Hydroxyzine (1,2,3,5)	B	0.1-0.4	1	2	
Ibuprofen (1,3,5)	S	<50	100-400	185-680	
Imipramine (1,2,3,5)	B	< 0.5 (parent + mtb)	1	2.0-13 (4.5)	Significant postmortem redistribution can occur with all tricyclics. PB and LVR excellent complementary specimen to resolve difficult cases.
Ketamine (1,2,3,5)	B	<2.0		7-10	Nonmedical IV use can be lethal at conc. as low as 2.0 mg/L
Lamotrigene	A	5.6 (monotherapy) 2.3-9 (combo therapy)	17	52	
Lidocaine (1,2,5)	B	2.0-5.0	>8.0	10-33 (20)	
Lithium (1,3,5)	S	<1.3 mEq/L	2.0 mEq/L	2.4-8.0 mEq/L	
Lorazepam (1,5)	S	<0.25	0.3-0.6	1.0-2.8	Lower toxic concentrations are found in cases of ingestion of multiple respiratory depressants.
Loxapine (1,3)	B	<0.1	0.2	2-8	Significant postmortem redistribution can occur. PB and LVR excellent complementary specimens to resolve difficult cases.
Meperidine (1,4,5)	B	<0.50	4-8.6	8 (oral); 1-8 (IV)	
Meprobamate (1,2,3,4,5)	N	<25	25-60	35-240 (95)	Tolerance is important to consider when evaluating the toxicity of this drug. DUID cases reported to have meprobamate concentrations of 35-96 mg/L.
Methadone (1,2,3,4,5)	B	0.01-1.06		0.06-3.1(0.28)	Significant postmortem redistribution can occur. Liver is an excellent complementary specimen to resolve difficult cases. Tolerance is important to consider when evaluating the toxicity of this drug.
Methamphetamine (1,3,5)	B		0.15-2.6	0.09-18	DUID cases reported to have methamphetamine concentrations of 0.05-2.6 mg/L.
Methanol (1,3)	S		200 mg/dL	200-630 mg/dL	
Methylenedioxymethamphetamine (1)	B		0.08	0.6-2.8 (1.8)	The concentration listed as toxic is an average value from driving under the influence (DUID) cases.
Metoprolol (1,3,4,5)	B	0.03-0.5	12-18	4.7-142	
Midazolam (1,2,4,5)	E	0.05-0.1	0.03-0.4	0.07-0.35	
Mirtazapine (1,5)	B	0.1-0.2	0.1	2.1-12	The concentration listed as toxic is from a driving under the influence (DUID) case.
Morphine (1,3,4,5)	E	0.05-0.15	0.1	0.1-4	0.7 mg/L for tolerant, living cancer patients
Naproxen (1,3,4,5)	S	<90	400		
Nefazadone (1)	B	2	5	7	
Nicotine (1,3,5)	B	0.044	0.3-0.4	1.4-63	Lower toxic concentrations are associated with transdermal patch use.
Nifedipine (1,5)	S	<0.1	0.15	0.15-0.27	
Nortriptyline (1,2,3,5)	B	0.05-0.25 (0.18)	0.5-1.3	1.6-4 (3.8)	Significant postmortem redistribution can occur with all tricyclics. Liver is excellent complementary specimen to resolve difficult cases.
Olanzapine (1,5)	B	0.1-0.4	0.05-1.0	1.0-4.9	Freeze specimen to prevent analyte degradation:
Oxazepam (1,2,3,4,5)	E	0.1-1.4	0.2-8.0	4.4-6.1 (5.3)	The concentrations listed as toxic are from driving under the influence (DUID) cases.

DRUG (Reference)	THERAPEUTIC				COMMENTS/ADDITIONAL INFORMATION
	ASSAY	(mg/L)	TOXIC (mg/L)	LETHAL (mg/L)	
Oxcarbazepine	N	8-12 (mtb)	46	2.5 (parent) 92 (mtb)	10-OH carbamazepine metabolite (mtb) accumulates with chronic dosing, whereas, parent analyte does not.
Oxycodone (1,3,4,5)	B	0.05-0.1	0.01-0.5 (0.24)	0.12-2.7 (0.84)	Tolerance is important to consider when evaluating the toxicity of this drug. The concentrations listed as toxic are from driving under the influence (DUID) cases.
Paroxetine (1,2,5)	B	0.1-0.6		0.7-4.6	Significant postmortem redistribution can occur with all SSRIs Liver is excellent complementary specimen to resolve difficult cases.
Pentobarbital (1,2,3,4,5)	A	1-5	10-19	10-51	
Phencyclidine (1,3)	S	na	0.01-0.24	0.3-25	
Phenobarbital (1,2,4,5)	A	6-40	30	>60	
Phentermine (1,3,4)	B	0.18-0.51	0.2	1.5-7.6	
Phenylpropranolamine (1,2,3,5)	B	0.1	2	>2	
Phenytoin (1,2,3,5)	A	10-20	20-50	>70	
Primidone (1,3,5)	A	5-15	20-50	65	
Procainamide (1,3,5)	S	4-10	10-16	17-260 (100)	
Promethazine (1,2,4,5)	B	<0.5	1	2.4-12	
Propoxyphene (1,2,5)	B	0.13-1.0	>1	>2 (parent only)	
Propranolol (1,2,4,5)	B	0.34	1-3	2-4	
Pseudoephedrine (1,3)	B	<1		10	
Quetiapine (1)	B	<1		5-49	PMRD may occur, PB and LVR excellent complementary specimens to resolve difficult cases.
Quinidine (1,3,4,5)	B	<3	6-10	10-45	
Quinine (1,3,5)	B	1-10	>10	6-24	
Risperidone (1)	S	0.04-0.11	1.8		
Salicylate (1,2,3,5)	S	10-300	>200	400-7300 (600)	Higher conc. are with arthritic patients that have been titrated to this level (44-330).
Sertraline (1)	B	<0.5		>1.5 (parent only)	PMRD may occur, PB and LVR excellent complementary specimens to resolve difficult cases.
Temazepam (1,3,4,5)	E	0.2-1.0	1	3-14	
Theophylline (1,2,3,5)	N	4.0-10	>20	>50	
Thioridazine (1,2,5)	B	0.14-2.6	2.8-14	2.4-10 (4.0)	PMRD may occur, PB and LVR excellent complementary specimen to resolve difficult cases.
Topiramate	A	30			
Tramadol (1,5)	B	0.1-0.8	0.1-0.9	1.4-23	The concentrations listed as toxic are from driving under the influence (DUID) cases.
Trazodone (1,3,5)	B	<2.5	19-26	9.4-34	PMRD may occur, PB and LVR excellent complementary specimens to resolve difficult case. The concentrations listed as toxic are from overdose cases in which the patient survived with supportive therapy.
Triazolam (1,3,5)	E	<0.02	0.004-0.04	0.01-0.22	The concentrations listed as toxic are from driving under the influence (DUID) cases.
Trichlorethanol (1,2)	S	2-27	330	20-640 (250)	Mtb. of chloral hydrate. Significant postmortem redistribution can occur. PB and LVR may be required to resolve difficult cases.
Trimipramine (1,2,3,5)	B	0.011-0.241	0.5-1.0	1.1-12 (5.0)	PMRD may occur, PB and LVR excellent complementary specimens to resolve difficult cases.

A- Acids
 B- Bases
 N- Neutrals
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 S- Special

DRUG (Reference)	ASSAY	THERAPEUTIC (mg/L)	TOXIC (mg/L)	LETHAL (mg/L)	COMMENTS/ADDITIONAL INFORMATION
Valproic acid (1,3,5)	S	50-100 (plasma) 27-50 (whole blood)	52-148 (hepatotoxic); 482-2120 (coma)	720-1969	
Venlafaxine (1,5)	B	<1	6-12	6.6-89 (45)	PMRD may occur, PB and LVR excellent complementary specimens to resolve difficult cases.
Verapamil (1,2,4,5)	B	0.1-1.0	1-4	0.9-85 (11)	
Zaleplon	S	<0.3		>1	
Zolpidem (1,2,4,5)	B	<0.3	0.07-0.7	>1	The concentrations listed as toxic are from driving under the influence (DUID) cases. Tolerance should be considered when evaluating the toxicity of this drug.