CLIN. CHEM. 22/6, 832-836 (1976)

Tabulation of Therapeutic, Toxic, and Lethal Concentrations of Drugs and Chemicals in Blood

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These data represent information from the literature and personal experience.

References to the data may be found in previous articles (*1–7*). Other authors have also presented such data (*8–11*).

Special attention must be paid to the utilization of these data. Interpretation of test results based on the data presented must be with the usual consideration of factors affecting the pharmacological response of a drug as well as other factors. Table 1 lists general factors that must be considered in interpreting the data. The factors listed cover most aspects for which blood-concentration data may be used: therapeutic monitoring, generic equivalency, efficacy of treatment in poisonings, cause of death, etc.

The intended effect and corresponding dose of a drug will certainly affect the therapeutic blood concentration. For example, a person receiving 25 mg of chlorpromazine rectally will have a lower blood drug concentration than a person receiving 300 mg of chlorpromazine orally, the former dose being used as an antinauseant and the latter as an antipsychotic. The therapeutic concentration is, of course, the most important value, as this serves as a guide to what might be expected vis-à-vis toxic or lethal situations.

Data of this sort are useful for several medical and legal purposes. One of these is monitoring drugs used in the treatment of chronic disorders. Several classes of drugs used for chronic disorders include the digitalis group, the anticonvulsant group, the antipsychotic group, and the antibiotic group. Drug-concentration data for antibiotics are not included in the table.[1]

Because the method of analysis can affect the information on concentrations in blood, information in Table 2 will change as data are generated from newer and better analytical methods.

Many industrial chemicals have not yet been monitored in humans and therefore data on expected concentrations consistent with "safe" occupational exposure are lacking. Several values are contained in Table 2 that indicate exposure to a toxic substance. Monitoring substances such as lead, mercury, cadmium, etc. is routine in some industries. Legislation affecting toxic substances in the industrial environment will require monitoring of other chemicals and this will result in establishing "safe" blood concentrations for many materials.

The general concept of assessing concentrations of chemicals in blood is relatively new, and I have prepared this Table to provide a concise, single source of data to be used as a guide. I reemphasize that the values should

Table 1. Factors Affecting Concentrations in Blood

Drug and Chemical Factors
Dosage form
Use and dose
Route of administration
Concentration of toxicant
Duration of exposure

Human Factors
Age
Weight
Time of sampling
Method of analysis and presence of metabolites
Treatment given, if any
Time interval between sampling and analysis
Storage of specimen

Pathological Factors
Disease state (esp. renal and hepatic)
Body water (normal or dehydration)
Menstruation
Anatomical abnormalities (congenital or surgically and (or) traumatically caused)
Genetic disorders (pharmacogenetics)

Pharmacological/Biochemical Factors
Gastrointestional absorption
Tissue binding at active and inactive sites
Rate of elimination (excretion)
Storage (bone, hair, nails, fat)
Induction or inhibition of microsomal enzymes
Synergistic or antagonistic action of other drugs
Tolerance (from prolonged use or use of drugs with cross tolerance)
Rate of detoxication (metabolism or biotransformation)
Additive drug effects

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[1] But a list of peak antibiotic concentrations in serum can be found in Appendix II to a chapter by A. L. Barry and L. D. Sabath, p 431, 2nd ed. of *Manual of Clinical Microbiology* (Amer. Soc. of Microbiology, Washington, D.C., 1974), E. H. Lennette et al., Eds.

Received and accepted Mar. 5, 1976.

Table 2. Drug and Chemical Blood Concentrations[a]

Compound	Therapeutic or "normal" concn	Toxic concn	Lethal concn
Acetaminophen (Tylenol)	10–20 mg/liter	400 mg/liter	1500 mg/liter
Acetazolamide (Diamox)	10–15 mg/liter		—
Acetohexamide (Dymelor)	21–56 mg/liter		—
Acetone		200–300 mg/liter	550 mg/liter
Aluminum	0.13 mg/liter	—	—
Ammonia	500–1700 mg/liter		—
Aminophylline (Theophylline)	20–100 mg/liter		—
Amitriptyline (Elavil)	50–200 μg/liter	400 μg/liter	10–20 mg/liter
Amphetamine	20–30 μg/liter	—	2 mg/liter
Arsenic	0.0–20 μg/liter	1.0 mg/liter	15 mg/liter
Barbiturates			
Short-acting	1 mg/liter	7 mg/liter	10 mg/liter
Intermediate-acting	1–5 mg/liter	10–30 mg/liter	30 mg/liter
Phenobarbital	~10 mg/liter	40–60 mg/liter	80–150 mg/liter
Barbital	~ 10 mg/liter	60–80 mg/liter	100 mg/liter
Benzene	—	any measurable	0.94 mg/liter
Beryllium	Tissue levels generally used (lung & lymph)	—	—
Boron (boric acid)	0.8 mg/liter	40 mg/liter	50 mg/liter
Bromide	50 mg/liter	0.5–1.5 g/liter	2 g/liter
Brompheniramine (Dimetane)	8–15 μg/liter		
Cadmium	0.1–0.2 μg/liter	50 μg/liter	—
Caffeine	—	—	>100 mg/liter
Carbamazepine (Tegretol)	2 mg/liter	8–10 mg/liter	—
Carbon monoxide	1% saturation of Hb	15–35% saturation of Hb	50% saturation of Hb
Carbon tetrachloride	—	20–50 mg/liter	—
Carisoprodol (Rela, Soma)	10–40 mg/liter	—	—
Chloral hydrate (Noctec)	10 mg/liter	100 mg/liter	250 mg/liter
Chloroform	—	70–250 mg/liter	390 mg/liter
Chlordiazepoxide (Librium)	1.0–3.0 mg/liter	5.5 mg/liter	20 mg/liter
Chlorpheniramine	—	20–30 mg/liter	—
Chlorpromazine (Thorazine)	0.5 mg/liter	1–2 mg/liter	3–12 mg/liter
Chlorpropamide (Diabinese)	30–140 mg/liter	—	—
Chlorprothixine (Taractan)	0.04–0.3 mg/liter	—	—
Codeine	25 μg/liter	—	—
Copper	1–1.5 mg/liter	5.4 mg/liter	—
Cyanide	0.15 mg/liter	—	>5 mg/liter

(continued)

Table 2. Continued

Compound	Therapeutic or "normal" concn	Toxic concn	Lethal concn
DDT	13 μg/liter	—	—
Desipramine (Norpramin)	0.59–1.4 mg/liter	—	10–20 mg/liter
Dextropropoxyphene (Darvon)	50–200 μg/liter	5–10 mg/liter	57 mg/liter[b]
Diazepam (Valium)	0.5–2.5 mg/liter	5–20 mg/liter	>50 mg/liter
Dieldren	1.5 μg/liter	—	—
Digitoxin	1.7–2.1 μg/liter	—	320 μg/liter
Digoxin	0.6–1.3 μg/liter	2–9 μg/liter	—
Dinitro-*o*-cresol	—	30–40 μg/liter	75 mg/liter
Diphenhydramine (Benadryl)	5 mg/liter	10 mg/liter	—
Ethinamate (Valmid)	5–10 mg/liter	—	—
Diphenylhydantoin (Dilantin)	5–22 mg/liter	50 mg/liter	100 mg/liter
Divinyl oxide	—	—	700 mg/liter
Doxepin (Sinequan)	—	—	>10 mg/liter
Ethanol	—	1.5 g/liter	>3.5 g/liter
Ethchlorvynol (Placidyl)	5 mg/liter	20 mg/liter	150 mg/liter
Ethosuximide (Zarontin)	25–75 mg/liter	—	—
Ethyl chloride	—	—	400 mg/liter
Ethyl ether	0.9–1.0 g/liter	—	1.4–1.89 g/liter
Ethylene glycol	—	1.5 g/liter	2–4 g/liter
Fluoride	0.5 mg/liter	—	2 mg/liter
Gold (sodium aurothiomalate)	3–6 mg/liter	—	—
Glutethimide (Doriden)	0.2 mg/liter	10–80 mg/liter	30–100 mg/liter
Halothane (Fluothane)	—	—	200 mg/liter
Hydrogen sulfide	—	—	0.92 mg/liter
Hydromorphone (Dilaudid)	—	—	0.1–0.3 mg/liter
Imipramine (Tofranil)	0.05–0.16 mg/liter	0.7 mg/liter	2 mg/liter
Isopropanol	—	3.4 g/liter	—
Iron	500 mg/liter (erythrocytes)	6 mg/liter (serum)	—
Lead	0.05–1.3 mg/liter	0.7 mg/liter	—
LSD (lysergic acid diethylamide)	—	1–4 μg/liter	—
Lidocaine	2 mg/liter	6 mg/liter	—
Lithium	4.2–8.3 mg/liter	13.9 mg/liter	13.9–34.7 mg/liter
Magnesium	0.8–1.3 mmol/liter	—	0.5 mmol/liter
Manganese	0.15 mg/liter	4.6 mg/liter	—
Mercury	60–120 μg/liter	—	—
Meperidine (Demerol)	600–650 μg/liter	5 mg/liter	30 mg/liter

Table 2. Continued

Compound	Therapeutic or "normal" concn	Toxic concn	Lethal concn
Meprobamate	10 mg/liter	100 mg/liter	200 mg/liter
Methadone	480–860 μg/liter	2 mg/liter	>4 mg/liter
Methamphetamine	—	5 mg/liter	40 mg/liter
Methanol	—	200 mg/liter	>890 mg/liter
Methapyrilene	2 μg/liter	30–50 mg/liter	>50 mg/liter
Methaqualone (Quaalude)	5 mg/liter	10–30 mg/liter	>30 mg/liter
Methsuximide (Celontin)	2.5–7.5 mg/liter	—	—
Methylene chloride	—	—	>280 mg/liter
Methylenedioxyamphetamine (MDA)	—	—	4–10 mg/liter
Methyprylon (Noludar)	10 mg/liter	30–60 mg/liter	100 mg/liter
Morphine	0.1 mg/liter	—	0.05–4 mg/liter
Nickel	0.41 mg/liter	—	—
Nicotine	—	10 mg/liter	5–52 mg/liter
Nitrofurantoin (Furadantin)	1.8 mg/liter	—	—
Nortriptyline (Aventyl)	1.2–1.6 μg/liter	5 mg/liter	13 mg/liter
Orphenadrine	—	2 mg/liter	4–8 mg/liter
Oxalate	2 mg/liter	—	10 mg/liter
Papaverine	1 mg/liter	—	—
Paramethoxyamphetamine (PMA)	—	—	2–4 mg/liter
Paraldehyde	50 mg/liter	200–400 mg/liter	500 mg/liter
Pentazocine (Talwin)	0.14–0.16 mg/liter	2–5 mg/liter	10–20 mg/liter
Perphenazine (Trilafon)	—	1 mg/liter	—
Phencyclidine	—	<.5 mg/liter	1.0 mg/liter
Phenmetrazine	—	—	4 mg/liter
Phensuximide (Milontin)	10–19 mg/liter	—	—
Phenylbutazone (Butazolidin)	100 mg/liter	—	—
Phosphorus	concn in tissues usually used		
Primidone (Mysoline)	10 mg/liter	50–80 mg/liter	100 mg/liter
Probenecid (Benemid)	100–200 mg/liter	—	—
Procaine amide	6 mg/liter	10 mg/liter	—
Prochlorperazine (Compazine)	—	1 mg/liter	—
Promazine (Sparine)	—	1 mg/liter	—
Propoxyphene	50–200 μg/liter	5–20 mg/liter	57 mg/liter[b]
Propranolol (Inderal)	0.025–0.2 mg/liter		8–12 mg/liter

(continued)

Table 2. Continued

Compound	Therapeutic or "normal" concn	Toxic concn	Lethal concn
Propylhexedrine (Benzedrex)	—	—	2–3 mg/liter
Quinidine	3–6 mg/liter	10 mg/liter	30–50 mg/liter
Quinine	—	—	12 mg/liter
Salicylate (acetylsalicylic acid)	20–100 mg/liter	150–300 mg/liter	500 mg/liter
Sulfadiazine	80–150 mg/liter	—	—
Sulfadimethoxine (Madribon)	80–100 mg/liter	—	—
Sulfaguanidine	30–50 mg/liter	—	—
Sulfanilamide	100–150 mg/liter	—	—
Sulfisoxazole (Gantrisin)	90–100 mg/liter	—	—
Strychnine	—	2 mg/liter	9–12 mg/liter
Theophylline	20–100 mg/liter	—	—
Thioridazine (Mellaril)	1–1.5 mg/liter	10 mg/liter	20–80 mg/liter
Tin	0.12 mg/liter	—	—
Tolbutamide (Orinase)	53–96 mg/liter	—	—
Toluene	—	—	10 mg/liter
Tribromoethanol	—	—	90 mg/liter
Trichloroethane	—	—	0.01–1 g/liter
Trimethobenzamide (Tigan)	1.0–2.0 mg/liter	—	—
Warfarin	1.0–10 mg/liter	—	—
Zinc	0.68–1.36 mg/liter	—	—
Zoxazolamine (Flexin)	3–13 mg/liter	—	—

[a] Some common brand names that may be more familiar than the generic name, alternative forms (e.g., aminophylline/theophylline), and the like are given parenthetically.

[b] McBay reports much lower values.

not be considered absolute in light of the factors that can affect blood concentrations. The values represented are for adult man generally and via the oral route of administration, with obvious exceptions (e.g., chemicals that are inhaled).

It is my intent to periodically update the data as new information becomes available. Information, comments, and criticisms are welcome.

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