Case Records of the Massachusetts General Hospital

Weekly Clinicopathological Exercises

FOUNDED BY RICHARD C. CABOT

NORMAL REFERENCE LABORATORY VALUES

PREPARED BY ALEXANDER KRATZ, M.D., PH.D., AND KENT B. LEWANDROWSKI, M.D.

The following is a table of reference values, methods, and conversion factors for tests commonly ordered at the Massachusetts General Hospital (MGH) and recorded in the Case Records. The table revises the most recently published data (Normal Reference Laboratory Values. N Engl J Med 1992;327:718-24). Laboratory values are expressed in the units used at MGH (MGH units) and the units of the Système International d'Unités (SI units), with a factor to convert MGH units to SI units by multiplication. This table is not intended to provide a comprehensive review of reference values, since this information is widely available in standard textbooks. Detailed information on specific methods and instruments is not provided, in order to avoid suggesting an endorsement of commercial products by the hospital or the *Journal*. Because reference values are affected by many variables, the ranges used at MGH may not be appropriate for other institutions. Furthermore, the methods and units reported should not be interpreted as a judgment about the optimal way to perform or report a given laboratory test.

The table was compiled with the aid of Dr. Michael Laposata, Dr. James Flood, Dr. Neal Smith, Dr. Kathryn Ruoff, Dr. Mary Jane Ferraro, Dr. Elizabeth Van Cott, William Young, Catherine Tuttle, Patricia Puopolo, Linda Ardisson, Ela Dhanak, Edward Masley, Fu-Mei Huang, Stephen Johnson, Linda Jennings, Jeanne Casey, and Debera Grzybek.

CHEMISTRY

ANALYTE	SPECIMEN*	MGH UNIT	SI UNIT	METHOD OR INSTRUMENT	FACTOR FOR CONVERSION TO SI UNIT
Adrenocorticotropin (ACTH)	P	6.0–76.0 pg/ml	1.3–16.7 pmol/liter	Immunoassay	0.2202
Alanine aminotransferase (ALT, SGPT)	S			Kinetic method	0.01667
Female		7–30 U/liter	0.12–0.50 μkat/liter		
Male		10–55 U/liter	0.17–0.92 μkat/liter		
Albumin	S	3.1–4.3 g/dl	31–43 g/liter	Colorimetry (bromocresol purple)	10
Aldolase	S	0–7 U/liter	0–7 U/liter	Kinetic method	1
Aldosterone (adult)				Immunoassay	
Supine, normal-sodium diet	S, P	2–9 ng/dl	55–250 pmol/liter		27.74
Upright, normal-sodium diet	S, P	2–5 times supine value with normal-sodium diet			
Supine, low-sodium diet	S, P	2–5 times supine value with normal-sodium diet			
Urine, normal-sodium diet	U	2.3–21.0 μg/24 hr	6.38–58.25 nmol/24 hr		2.774
Alkaline phosphatase (adult)	S			Kinetic method	0.01667
Female		30–100 U/liter	0.5–1.67 μkat/liter		
Male		45–115 U/liter	0.75–1.92 μkat/liter		
Alkaline phosphatase, heat fractionated	S	20–35%	0.20–0.35	Kinetic method	0.01

CHEMISTRY (Continued)

Analyte	Specimen*	MGH Unit	SI Unit	Method or Instrument	Factor for Conversion to SI Unit
Alpha-fetoprotein (nonmaternal)	S	<12.8 IU/ml	<9.92 μg/liter	Immunoassay	0.775
Ammonia	P	12–48 μmol/liter	12–48 μmol/liter	Enzymatic analysis	1
Amylase	S	53–123 U/liter	0.88–2.05 nkat/liter	Kinetic method	0.01667
	P	43–115 U/liter	0.72–1.92 nkat/liter		
	U	4–400 U/liter	0.07–6.67 nkat/liter		
Androstenedione (adult)	S	50–250 ng/dl	1.75–8.73 nmol/liter	Immunoassay	0.0349
Angiotensin-converting enzyme	S			Kinetic method	1
Male		19–95 U/liter	19–95 U/liter		
Female		19–79 U/liter	19–79 U/liter		
Apolipoprotein	S			Nephelometry	
Apolipoprotein A-1		119–240 mg/dl	1.19–2.4 g/liter		0.01
Apolipoprotein B		52–163 mg/dl	0.52–1.63 g/liter		0.01
Apolipoprotein B:apolipoprotein A-1 ratio		0.35–0.98	0.35–0.98		1
Aspartate aminotransferase (AST, SGOT)	S			Kinetic method	0.01667
Female		9–25 U/liter	0.15–0.42 μkat/liter		
Male		10–40 U/liter	0.17–0.67 μkat/liter		
Beta$_2$-microglobulin	S, P	1.2–2.8 mg/liter	1.2–2.8 mg/liter	Immunoassay	1
	U	<200 μg/liter	<200 μg/liter		
Bicarbonate (HCO_3^-)	WB, S	22–26 meq/liter	22–26 mmol/liter	Calculation	1
Bilirubin, direct	S	0.0–0.4 mg/dl	0–7 μmol/liter	Colorimetry	17.1
Bilirubin, total	S	0.0–1.0 mg/dl	0–17 μmol/liter	Colorimetry	17.1
C peptide (adult)	S, P	0.5–2.0 ng/ml	0.17–0.66 nmol/liter	Immunoassay	0.33
C-reactive protein	S	0.0–12.0 mg/liter	0–12 mg/liter	Nephelometry	1
CA 15-3	S	0–30 U/ml	0–30 kU/liter	Immunoassay	1
CA 19-9	S	0–37 U/ml	0–37 kU/liter	Immunoassay	1
CA 27,29	S	0–32 U/ml	0–32 kU/liter	Immunoassay	1
CA-125	S	0–35 U/ml	0–35 kU/liter	Immunoassay	1
Calcitonin	S			Immunoassay	1
Male		3–26 pg/ml	3–26 ng/liter		
Female		2–17 pg/ml	2–17 ng/liter		
Calcium	S	8.5–10.5 mg/dl	2.1–2.6 mmol/liter	Colorimetry	0.25
	U	0–300 mg/24 hr	0.0–7.5 mmol/24 hr	Colorimetry	0.025
Calcium, ionized	WB	1.14–1.30 mmol/liter	1.14–1.30 mmol/liter	Ion-selective electrode	1
Carbon dioxide content, total	P	24–30 mmol/liter	24–30 mmol/liter	Carbon dioxide electrode	1
Carbon dioxide, partial pressure, arterial ($PaCO_2$)	WB	35–45 mm Hg	4.7–6.0 kPa	Carbon dioxide electrode	0.1333
Carboxyhemoglobin	WB	<5% of total hemoglobin	<0.05 fraction of total hemoglobin saturation	Co-oximetry	0.01
Carcinoembryonic antigen (CEA)	P, S	0.0–3.4 ng/ml	0.0–3.4 μg/liter	Immunoassay	1
Catecholamines (adult)	U			High-pressure liquid chromatography	
Epinephrine		2–24 μg/24 hr	11–131 nmol/24 hr		5.458
Norepinephrine		15–100 μg/24 hr	89–591 nmol/24 hr		5.911
Dopamine		52–480 μg/24 hr	340–3134 nmol/24 hr		6.53
Total (epinephrine + norepinephrine)		26–121 μg/24 hr	142–660 nmol/24 hr		5.458 (as normetanephrine)
Cerebrospinal fluid (adult)	CSF				
Albumin		11–48 mg/dl	0.11–0.48 g/liter	Nephelometry	0.01
Cell count		0–5 mononuclear cells/μl	0–5×10^6 cells/liter	Manual count	1×10^6
Chloride		120–130 mmol/liter	120–130 mmol/liter	Coulometry	1
Glucose		50–75 mg/dl	2.8–4.2 mmol/liter	Enzymatic analysis	0.05551
IgG		8.0–8.6 mg/dl	0.08–0.086 g/liter	Nephelometry	0.01
Pressure		70–180 mm of water	70–180 arbitrary units	Manual measurement	1
Protein					
Lumbar		15–45 mg/dl	0.15–0.45 g/liter	Turbidometry	0.01
Cisternal		15–25 mg/dl	0.15–0.25 g/liter		
Ventricular		5–15 mg/dl	0.05–0.15 g/liter		
Ceruloplasmin	S	27–50 mg/dl	270–500 mg/liter	Nephelometry	10
Chloride	P	100–108 mmol/liter	100–108 mmol/liter	Coulometry	1
	U	Depends on diet	Depends on diet		
Cholesterol	S			Colorimetry	0.02586
Desirable		<200 mg/dl	<5.17 mmol/liter		
Borderline high		200–239 mg/dl	5.17–6.18 mmol/liter		
High		>239 mg/dl	>6.18 mmol/liter		
Cortisol	S			Immunoassay	27.59
Fasting, 8 a.m.–noon		5–25 μg/dl	138–690 nmol/liter		
Noon–8 p.m.		5–15 μg/dl	138–414 nmol/liter		
8 p.m.–8 a.m.		0–10 μg/dl	0–276 nmol/liter		
Cortisol, free	U	20–70 μg/24 hr	55–193 nmol/24 hr	Immunoassay	2.759

CHEMISTRY (Continued)

Analyte	Specimen*	MGH Unit	SI Unit	Method or Instrument	Factor for Conversion to SI Unit
Creatine kinase (CK)	S			Kinetic method	0.01667
Male		60–400 U/liter	1.00–6.67 μkat/liter		
Female		40–150 U/liter	0.67–2.50 μkat/liter		
Creatine kinase isoenzyme index	S	0–2.5% relative index	None	ng/ml / Total CK(U/liter) × 100	None
Creatine kinase isoenzymes, MB fraction	S	0–5 ng/ml	0–5 μg/liter	Immunoassay	1
Creatinine	P	0.6–1.5 mg/dl	53–133 μmol/liter	Colorimetry	88.4
	U	15–25 mg/kg/day	0.13–0.22 mmol/kg/day		0.0884
Dehydroepiandrosterone (DHEA) (adult)	S			Immunoassay	0.03467
Male		180–1250 ng/dl	6.24–43.3 nmol/liter		
Female		130–980 ng/dl	4.5–34.0 nmol/liter		
Dehydroepiandrosterone (DHEA) sulfate (adult)	S			Immunoassay	10
Male		10–619 μg/dl	100–6190 μg/liter		
Female					
Premenopausal		12–535 μg/dl	120–5350 μg/liter		
Postmenopausal		30–260 μg/dl	300–2600 μg/liter		
Deoxycorticosterone (DOC) (adult)	S	2–19 ng/dl	61–576 nmol/liter	Immunoassay	30.3
11-Deoxycortisol (adult) (8 a.m. sample)	S	12–158 ng/dl	0.35–4.56 nmol/liter	Immunoassay	0.02886
1,25-Dihydroxyvitamin D	S	18–62 pg/ml	43.2–148.8 pmol/liter	Immunoassay	2.4
Estradiol	S, P			Immunoassay	3.671
Female					
Menstruating					
Follicular phase		50–145 pg/ml	184–532 pmol/liter		
Midcycle peak		112–443 pg/ml	411–1626 pmol/liter		
Luteal phase		50–241 pg/ml	184–885 pmol/liter		
Postmenopausal		<59 pg/ml	<217 pmol/liter		
Male		<50 pg/ml	<184 pmol/liter		
Fatty acids, free (adult)	S	0.17–0.95 mmol/liter	0.17–0.95 mmol/liter	Spectrophotometry	1
Follicle-stimulating hormone (FSH)	S, P			Immunoassay	1
Female					
Menstruating					
Follicular phase		3.0–20.0 U/liter	3.0–20.0 U/liter		
Ovulatory phase		9.0–26.0 U/liter	9.0–26.0 U/liter		
Luteal phase		1.0–12.0 U/liter	1.0–12.0 U/liter		
Postmenopausal		18.0–153.0 U/liter	18.0–153.0 U/liter		
Male		1.0–12.0 U/liter	1.0–12.0 U/liter		
Gastrin	S	<100 ng/liter	<100 ng/liter	Immunoassay	1
Globulin	S	2.6–4.1 g/dl	26–41 g/liter	Calculation: total protein − albumin	10
Glucagon	P	20–100 pg/ml	20–100 ng/liter	Immunoassay	1
Glucose	U	<0.05 g/dl	<0.003 mmol/liter	Enzymatic analysis	0.05551
Glucose, fasting	P	70–110 mg/dl	3.9–6.1 mmol/liter	Enzymatic analysis	0.05551
γ-Glutamyltransferase (GGT)	S			Spectrophotometry	1
Male		1–94 U/liter	1–94 U/liter		
Female		1–70 U/liter	1–70 U/liter		
Growth hormone (resting)	S	2–5 ng/ml	2–5 μg/liter	Immunoassay	1
Hemoglobin A_{1C}	WB	3.8–6.4%	0.038–0.064	Liquid chromatography	0.01
High-density lipoprotein cholesterol, as major risk factor	S	<35 mg/dl	<0.91 mmol/liter	Colorimetry	0.02586
Human chorionic gonadotropin (hCG) (nonpregnant women)	S	<5 mIU/ml	<5 IU/liter	Immunoassay	1
5-Hydroxyindoleacetic acid (5-HIAA)	U	≤6 mg/24 hr	≤31.4 μmol/day	High-pressure liquid chromatography	5.23
17-Hydroxyprogesterone (adult)	S			Immunoassay	0.03
Male		5–250 ng/dl	0.15–7.5 nmol/liter		
Female					
Follicular phase		20–100 ng/dl	0.6–3.0 nmol/liter		
Midcycle peak		100–250 ng/dl	3–7.5 nmol/liter		
Luteal phase		100–500 ng/dl	3–15 nmol/liter		
Postmenopausal		≤70 ng/dl	≤2.1 nmol/liter		
25-Hydroxyvitamin D	S	8–42 ng/ml	20–105 nmol/liter	Immunoassay	2.496
Insulin	S, P	2–20 μU/ml	14.35–143.5 pmol/liter	Immunoassay	7.175
Ketone (acetone)	S, U	Negative	Negative	Colorimetry (nitroprusside)	
17-Ketosteroids	U			Modified Zimmerman reaction	3.467
Male		7–20 mg/24 hr	24.3–69.3 μmol/24 hr		
Female		5–15 mg/24 hr	17.3–52.0 μmol/24 hr		
Lactic acid	P	0.5–2.2 mmol/liter	0.5–2.2 mmol/liter	Enzymatic analysis	1
Lactate dehydrogenase (LDH)	S	110–210 U/liter	1.83–3.50 μkat/liter	Kinetic method	0.01667

CHEMISTRY (Continued)

Analyte	Specimen*	MGH Unit	SI Unit	Method or Instrument	Factor for Conversion to SI Unit
Lactate dehydrogenase isoenzymes	S				
LD_1		16–29%	0.16–0.29	Electrophoresis	0.01
LD_2		30–41%	0.30–0.41	Electrophoresis	0.01
LD_3		15–24%	0.15–0.24	Electrophoresis	0.01
LD_4		6–13%	0.06–0.13	Electrophoresis	0.01
LD_5		5–29%	0.05–0.29	Electrophoresis	0.01
Total LDH (when isoenzymes determined)		90–250 U/liter	1.5–4.17 μkat/liter	Kinetic method	0.01667
Lipase	S	3–19 U/dl	0.5–3.17 μkat/liter	Kinetic method	0.1667
Lipoprotein(a)	S	0–30 mg/dl	0–300 mg/liter	Nephelometry	10
Low-density lipoprotein cholesterol	S			Calculation	0.02586
Desirable		<130 mg/dl	<3.36 mmol/liter		
Borderline high risk		130–159 mg/dl	3.36–4.11 mmol/liter		
High risk		≥160 mg/dl	≥4.13 mmol/liter		
Luteinizing hormone (LH)	S, P			Immunoassay	1
Female					
Menstruating					
Follicular phase		2.0–15.0 U/liter	2.0–15.0 U/liter		
Ovulatory phase		22.0–105.0 U/liter	22.0–105.0 U/liter		
Luteal phase		0.6–19.0 U/liter	0.6–19.0 U/liter		
Postmenopausal		16.0–64.0 U/liter	16.0–64.0 U/liter		
Male		2.0–12.0 U/liter	2.0–12.0 U/liter		
Magnesium	S	1.4–2.0 meq/liter	0.7–1.0 mmol/liter	Colorimetry	0.5
Metanephrines	U			Chromatography	
Metanephrine		45–290 μg/24 hr	245–1583 nmol/24 hr		5.458
Normetanephrine		82–500 μg/24 hr	448–2730 nmol/24 hr		5.46
Total		120–700 μg/24 hr	655–3821 nmol/24 hr		5.458
Methemoglobin	P	0.4–1.5% of total hemoglobin	0.004–0.015	Co-oximetry	0.01
Microalbumin, random urine	U	<20 μg/ml	<20 mg/liter	Nephelometry	1
5′-Nucleotidase	S	0–11 U/liter	0.02–0.18 μkat/liter	Kinetic method	0.01667
Osmolality	S, P	280–296 mOsm/kg of water	280–296 mmol/kg of water	Freezing-point depression	1
Oxygen, partial pressure, arterial (PaO_2) (room air, age dependent)	WB	80–100 mm Hg	10.7–13.3 kPa	Oxygen electrode	0.1333
Parathyroid hormone	S	10–60 pg/ml	10–60 ng/liter	Immunoassay	1
Parathyroid hormone–related protein	P	<1.3 pmol/liter	<1.3 pmol/liter	Immunoassay	1
pH, arterial	WB	7.35–7.45 pH units	7.35–7.45 pH units	pH electrode	1
Phosphorus, inorganic (adult)	S	2.6–4.5 mg/dl	0.84–1.45 mmol/liter	Spectrophotometry	0.3229
	U	average, 1 g/day	average, 32 mmol/day		32.29
Potassium	P	3.4–4.8 mmol/liter	3.4–4.8 mmol/liter	Ion-selective electrode	1
	S	3.5–5.0 mmol/liter	3.5–5.0 mmol/liter		
	U	Depends on diet	Depends on diet		
Prealbumin (adult)	S	19.5–35.8 mg/dl	195–358 mg/liter	Nephelometry	10
Progesterone	S,P			Immunoassay	3.18
Female					
Follicular phase		<1.0 ng/ml	<3.18 nmol/liter		
Midluteal phase		3–20 ng/ml	9.54–63.6 nmol/liter		
Male		<1.0 ng/ml	<3.18 nmol/liter		
Prolactin	S			Immunoassay	1
Female					
Premenopausal		0–20 ng/ml	0–20 μg/liter		
Postmenopausal		0–15 ng/ml	0–15 μg/liter		
Male		0–15 ng/ml	0–15 μg/liter		
Prostate-specific antigen (PSA)	S			Immunoassay	1
Female		<0.5 ng/ml	<0.5 μg/liter		
Male					
<40 yr old		0.0–2.0 ng/ml	0.0–2.0 μg/liter		
≥40 yr old		0.0–4.0 ng/ml	0.0–4.0 μg/liter		
Prostate-specific antigen (PSA), free, in males 45–75 yr old, with PSA values between 4 and 20 ng/ml	S	>25% associated with benign prostatic hyperplasia	>0.25 associated with benign prostatic hyperplasia	Immunoassay, calculation	0.01
Protein, total	S	6.0–8.0 g/dl	60–80 g/dl	Colorimetry	10
	U	<165 mg/day	<0.165 g/day	Turbidometry	0.001
Renin (adult, normal-sodium diet)	P			Immunoassay	0.2778
Supine		0.3–3.0 ng/ml/hr	0.08–0.83 ng/(liter · sec)		
Upright		1.0–9.0 mg/ml/hr	0.28–2.5 ng/(liter · sec)		
Serotonin	WB	55–260 ng/ml	0.31–1.48 μmol/liter	High-pressure liquid chromatography	0.00568
Sex hormone–binding globulin (adult)	S			Immunoassay	1
Male		6–44 mmol/liter	6–44 mmol/liter		
Female		8–85 mmol/liter	8–85 mmol/liter		

CHEMISTRY (Continued)

Analyte	Specimen*	MGH Unit	SI Unit	Method or Instrument	Factor for Conversion to SI Unit
Sodium	P	135–145 mmol/liter	135–145 mmol/liter	Ion-selective electrode	1
	U	Depends on diet	Depends on diet		
Somatomedin C (insulin-like growth factor I)	S			Immunoassay	1
16–24 yr		182–780 ng/ml	182–780 μg/liter		
25–39 yr		114–492 ng/ml	114–492 μg/liter		
40–54 yr		90–360 ng/ml	90–360 μg/liter		
>54 yr		71–290 ng/ml	71–290 μg/liter		
Testosterone, total (morning sample)	S			Immunoassay	0.03467
Female		6–86 ng/dl	0.21–2.98 nmol/liter		
Male		270–1070 ng/dl	9.36–37.10 nmol/liter		
Testosterone, unbound (morning sample)	S			Immunoassay	34.67
Female					
20–40 yr		0.6–3.1 pg/ml	20.8–107.5 pmol/liter		
41–60 yr		0.4–2.5 pg/ml	13.9–86.7 pmol/liter		
61–80 yr		0.2–2.0 pg/ml	6.9–69.3 pmol/liter		
Male					
20–40 yr		15.0–40.0 pg/ml	520–1387 pmol/liter		
41–60 yr		13.0–35.0 pg/ml	451–1213 pmol/liter		
61–80 yr		12.0–28.0 pg/ml	416–971 pmol/liter		
Thyroglobulin	S	0–60 ng/ml	0–60 μg/liter	Immunoassay	1
Thyroid hormone–binding index (THBI; T_3RU)	S	0.77–1.23	0.77–1.23	Immunoassay	1
Thyroid-stimulating hormone	S	0.5–5.0 μU/ml	0.5–5.0 μU/ml	Immunoassay	1
Thyroxine, total (T_4)	S	4.5–10.9 μg/dl	58–140 nmol/liter	Immunoassay	12.87
Transferrin	S	191–365 mg/dl	1.91–3.65 g/liter	Nephelometry	0.01
Triglycerides (fasting)	S	40–150 mg/dl	0.45–1.69 mmol/liter	Spectrophotometry	0.01129
Triiodothyronine, total (T_3)	S	60–181 ng/dl	0.92–2.78 nmol/liter	Immunoassay	0.01536
Troponin I	S	<0.6 ng/ml >1.5 ng/ml consistent with acute myocardial infarct	<0.6 μg/liter >1.5 μg/liter	Immunoassay	1
Urea nitrogen (BUN) (adult)	P	8–25 mg/dl	2.9–8.9 mmol/liter	Conductivity	0.357
Urea nitrogen, urine	U	6–17 g/day	6–17 g/day	Conductivity	1
Uric acid	S			Colorimetry	59.48
Male		3.6–8.5 mg/dl	214–506 μmol/liter		
Female		2.3–6.6 mg/dl	137–393 μmol/liter		
Urinalysis	U			Reflectance	
pH		5.0–9.0	5.0–9.0	Spectrophotometry	1
Specific gravity		1.001–1.035	1.001–1.035		1
Chemical screens		Negative	Negative		
Urine sediment	U			Manual method	
White cells		0–2/high-power field	0–2/high-power field		1
Red cells		0–2/high-power field	0–2/high-power field		1
Vasoactive intestinal polypeptide (VIP)	P	<75 pg/ml	<75 ng/liter	Immunoassay	1
Xylose				Colorimetric	
	U	4–9 g/5 hr	4–9 g/5 hr		1
	S (fasting)	None detected	None detected		

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