

TABLE OF CRITICAL LIMITS

Critical limits define boundaries of life-threatening values of laboratory test results. Critical results or values are those that fall outside high and low critical limits. Urgent clinician notification of critical results is the lab's responsibility. The system of critical value reporting was first implemented in a hospital by George D. Lundberg, MD, and first published in *MLO* in 1972. These tables are based on three national surveys by Gerald J. Kost, MD, PhD, MS, F(ACB), of the University of California-Davis Health System. Adapted with permission from his articles,¹⁻⁴ the tables summarize critical limits used by 92 responding U.S. medical centers, including 20 trauma centers, and 39 children's hospitals. Mean and standard deviation (SD) data are presented. The frequency with which critical limits were listed can be found in the original articles.

As a rule of thumb, the "mean low" and "mean high" figures may be considered the critical limits for each test listed. Each institution should establish its own set of critical limits and clinician notification policy.

Dr. Kost conducted an independent national survey of U.S. medical centers and children's hospitals to determine ionized calcium critical limits.⁴ His extensive overview of critical limits and patient outcomes appeared in the March 1993 issue of *MLO*.¹ Readers are also encouraged to review general practice guidelines.⁵

The Joint Commission identifies critical values in current National Patient Safety Goals (NPSG). One goal is: Report critical results of tests and diagnostic procedures on a timely basis (Rationale for NPSG.02.03.01).⁶

Critical results of tests and diagnostic procedures fall significantly outside the normal range and may indicate a life-threatening situation. The objective is to provide the responsible licensed caregiver these results within an established time frame so that the patient can be promptly treated.

Elements of Performance for NPSG.02.03.01:

1. Develop written procedures for managing the critical results of tests/diagnostic procedures that address the following: the definition of critical results of tests/diagnostic procedures; by whom and to whom critical results of tests/diagnostic procedures are reported; the acceptable length of time between availability and reporting of critical results of tests/diagnostic procedures.

2. Implement the procedures for managing the critical results of tests/diagnostic procedures.

3. Evaluate the timeliness of reporting the critical results of tests/diagnostic procedures.⁷

4. Get important test results to the right staff person on time.⁶

Adults ¹						Children ²					
CLINICAL CHEMISTRY		LOW LIMIT		HIGH LIMIT		CLINICAL CHEMISTRY		LOW LIMIT		HIGH LIMIT	
Test	Units	Mean (SD)	Range	Mean (SD)	Range	Test	Units	Mean (SD)	Range	Mean (SD)	Range
Glucose	mmol/L mg/dL	2.6 (0.4) 46 (7)	1.7-3.9 30-70	26.9 (8.0) 484 (144)	6.1-55.5 110-1000	Glucose	mmol/L	2.6 (0.5)	1.7-3.3	24.7 (8.9)	13.9-55.5
Potassium	mmol/L	2.8 (0.3)	2.5-3.6	6.2 (0.4) 8.0 (hemolyzed)	5.0-8.0	Potassium	mmol/L	2.8 (0.3)	2.0-3.5	6.4 (0.5)	5.0-8.0
Calcium	mmol/L mg/dL	1.65 (0.17) 6.6 (0.7)	1.25-2.15 5.0-8.6	3.22 (0.22) 12.9 (0.9)	2.62-3.49 10.5-14.0	Calcium	mmol/L	1.62 (0.17)	1.25-1.87	3.17 (0.22)	2.74-3.74
Sodium	mmol/L	120 (5)	110-137	158 (6)	145-170	Sodium	mmol/L	121 (5)	110-130	156 (5)	150-170
CO ₂ content	mmol/L	11 (2)	5-20	40 (3)	35-50	CO ₂ content	mmol/L	11 (2)	6-18	39 (3)	33-45
Magnesium	mmol/L mg/dL	0.41 (0.16) 1.0 (0.4)	0.21-0.74 0.5-1.8	2.02 (0.82) 4.9 (2.0)	1.03-5.02 2.5-12.2	Magnesium	mmol/L	0.45 (0.04)	0.41-0.49	1.77 (0.45)	1.23-3.00
Phosphorus	mmol/L mg/dL	0.39 (0.10) 1.2 (0.3)	0.26-0.65 0.8-2.0	2.87 (0.48) 8.9 (1.5)	2.26-3.23 7.0-10.0	Phosphorus	mmol/L	0.42 (0.16)	0.16-0.65	2.87 (0.39)	2.26-3.23
Bilirubin	μmol/L mg/dL	— —	— —	257 (86) 15 (5)	86-513 5-30	Bilirubin	μmol/L	—	—	257 (68)	86-342
Chloride	mmol/L	75 (8)	60-90	126 (12)	115-156	Chloride	mmol/L	77 (8)	70-90	121 (5)	115-130
Osmolality	mmol/kg	250 (13)	230-280	326 (18)	295-375	Osmolality	mmol/kg	253 (12)	240-270	318 (10)	300-330
Urea nitrogen	mmol/L mg/dL	— —	— —	37.1 (21.1) 104 (59)	14.3-107.1 40-300	Urea nitrogen	mmol/L	—	—	19.6 (11.4)	3.9-53.6
Uric acid	μmol/L mg/dL	— —	— —	773 (119) 13 (2)	595-892 10-15	Uric acid	μmol/L	—	—	714 (119)	595-892
CSF glucose	mmol/L mg/dL	2.1 (0.6) 37 (10)	1.1-2.8 20-50	24.3 (11.4) 438 (206)	13.9-38.9 250-700	CSF glucose	mmol/L	1.7 (0.7)	1.1-2.8	—	—
Creatinine	μmol/L mg/dL	— —	— —	654 (380) 7.4 (4.3)	177-1326 2.0-15.0	Creatinine	μmol/L	—	—	336 (212)	221-884
Ionized calcium ⁴	mmol/L mg/dL	0.82 (0.14) 3.29 (0.56)	0.50-1.07 2.00-4.29	1.55 (0.19) 6.21 (0.76)	1.30-2.00 5.21-8.02	Ionized calcium ⁴	mmol/L	0.85 (0.13)	0.60-1.08	1.53 (0.11)	1.35-1.75
Lactate	mmol/L mg/dL	— —	— —	3.4 (1.3) 30.6 (11.7)	2.3-5.0 20.7-45.0	Lactate	mmol/L	—	—	4.1 (1.2)	2.4-5.5
						Albumin	g/L	17 (5)	10-25	68 (10)	60-80
						Ammonia	μmol/L	—	—	109 (50)	35-200
						Protein	g/L	34 (5)	30-40	95 (6)	90-100
						CSF protein	mg/L	—	—	1875 (854)	1000-3000

HEMATOLOGY						HEMATOLOGY					
Test	Units	Mean (SD)	Range	Mean (SD)	Range	Test	Units	Mean (SD)	Range	Mean (SD)	Range
Hematocrit	L/L	0.18 (0.05)	0.12-0.30	0.61 (0.06)	0.54-0.80	Hematocrit	L/L	0.20 (0.06)	0.10-0.30	0.62 (0.05)	0.54-0.70
Hemoglobin	g/L	66 (17)	40-120	199 (27)	170-300	Hemoglobin	g/L	69 (13)	50-100	208 (29)	170-250
Platelets	×10 ⁹ /L	37 (18)	10-100	910 (147)	555-1000	Platelets	×10 ⁹ /L	53 (25)	20-100	916 (220)	600-1500
WBC count	×10 ⁹ /L	2.0 (0.7)	1.0-4.0	37.0 (20.7)	10.0-100.0	WBC count	×10 ⁹ /L	2.1 (0.9)	0.5-3.5	42.9 (25.1)	15.0-100.0
PT	s	—	—	27 (9)	14-40	PT	s	—	—	21 (6)	15-35
PTT	s	—	—	68 (33)	32-150	PTT	s	—	—	62 (21)	40-100
Fibrinogen	g/L	0.88 (0.17)	0.50-1.00	7.75 (2.63)	5.00-10.00	Fibrinogen	g/L	0.77 (0.30)	0.20-12.0	—	—
						Bleeding time	min	—	—	14.0 (4.0)	9.5-20.0
BLOOD GASES AND pH						BLOOD GASES AND pH					
pCO ₂	mm Hg	19 (3)	9-25	67 (6)	50-80	pCO ₂	mm Hg	21 (6)	15-40	66 (23)	50-150
pH		7.21 (0.06)	7.00-7.35	7.59 (0.03)	7.50-7.65	pH		7.21 (0.05)	7.10-7.30	7.59 (0.04)	7.50-7.70
pO ₂	mm Hg kPa	43 (6) 5.7 (0.8)	30-55 4.0-7.3	— —	— —	pO ₂	mm Hg	45 (7)	30-55	124 (25)	100-150

NEWBORN ²		LOW LIMIT		HIGH LIMIT		
Test	Facility	Units	Mean (SD)	Range	Mean (SD)	Range
Glucose	CH	mmol/L	1.8 (0.4)	1.1-2.8	18.2 (3.6)	16.7-27.8
Potassium	CH	mmol/L	2.8 (0.4)	2.5-3.7	7.8 (0.5)	6.5-8.0
Modified potassium	CH	mmol/L	2.8 (0.4)	2.5-3.7	6.5	(See Ref. 3)
Bilirubin	CH	μmol/L	—	—	222 (86)	86-308
Hemoglobin	USMC	g/L	95 (35)	50-150	223 (23)	210-250
Hematocrit	USMC	L/L	0.33 (0.08)	0.24-0.45	0.71 (0.04)	0.65-0.75
pO ₂	USMC	mm Hg	37 (7)	30-50	92 (12)	70-100

1. Adult table modified with permission by *JAMA*, Vol. 263, pp. 704-707, 1990. CSF, cerebrospinal fluid; WBC, white blood cell; PT, prothrombin time; PTT, partial thromboplastin time. Qualitative critical results for adults include the following: For blood bank and immunology—incompatible crossmatch, tests positive for syphilis (RPR or VDRL). For microbiology and parasitology—Positive results from Gram stain or in culture from blood, cerebrospinal fluid, or body cavity fluid; positive India ink preparation; positive rapid antigen detection by agglutination tests for *Cryptococcus*, group B streptococci, *Haemophilus influenzae* b, or *Neisseria meningitidis*, positive results from acid-fast bacillus stain or culture; *Salmonella*, *Shigella*, or *Campylobacter* on stool culture; presence of malarial parasites. For clinical microscopy and urinalysis—elevated white blood cell count in CSF; presence of malignant cells, blasts, or microorganisms in CSF or body fluids; combination of strongly positive test results for glucose and for ketones in urine; presence of pathologic crystals (urate, cysteine, leucine, or tyrosine) on urinalysis. For hematology—Listed frequently are the presence of blasts on blood smear; new diagnosis or findings of leukemia; presence of sickle cells (or aplastic crisis). Listed occasionally are plasma cells, band cells, atypical lymphocytes, and abnormal reticulocyte count.

2. Children and newborn tables modified with permission by *Pediatrics*, Vol. 88, pp. 597-603, 1991. CSF, cerebrospinal fluid; WBC, white blood cell; PT, prothrombin time; PTT, partial thromboplastin time; CH, Children's Hospital; USMC, U.S. Medical Centers. Qualitative critical results for children include the following: For hematology—presence of blasts in the blood smear; new diagnosis or findings of leukemia; presence of drepanocytes (sickle cells); atypical lymphocytes, or abnormal reticulocyte count; abnormal erythrocyte indices (mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration). For clinical microscopy and urinalysis—elevated white blood cells in CSF; presence of malignant cells, blasts, or microorganisms in CSF or body fluids; combination of strongly positive test results for glucose and for ketones in urine. For microbiology and parasitology—positive results from Gram stain or culture from blood, CSF, or body cavity fluid; presence of malarial parasites.

In "Global trends in critical values practices and their harmonization,"⁸ Dr. Kost and Kristin N. Hale investigate trends in critical values practices including improving preanalytical processing; streamlining urgent notification; assuring effective critical limits; assessing decision levels; and using visual logistics. Special considerations for pediatrics is addressed since newborns/neonates must adapt to the extrauterine environment with its striking physiological changes. Identifying existing personal adverse events clustered by time/location could be used to predict a patient's future adverse events. Customizing critical values is possible for some unmet needs like comparing critical values lists to national norms and clarifying protocols for repeat critical values testing. Also, site-neutral policies encourage timely reporting, recording, and integrating critical values into a patient's closed-loop EMR. The authors detail Canadian and U.S. regulatory and accrediting bodies where critical values practices and treatment are a professional concern. In other parts of the world, surveys reveal inconsistent, infrequent, or no use of critical values reporting, which could have detrimental effects on select patient groups. In Europe, the most accepted standard for accreditation and certification of clinical laboratories is ISO EN 15189:2007, which includes immediate notification of critical values as a special requisite. National standards of care must be considered and compared in order to harmonize critical values practices throughout the world. The authors' list eight conclusions and recommendations for critical values practices. They believe coordinated and energetic professional leaders with a clear understanding of the future of standard care will ensure consistent critical values practices, and enhance patient care worldwide. □

References

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