

Table of critical limits

Critical limits define the boundaries of the life-threatening values of laboratory test results. Critical results, also called critical values, are those that fall outside the high and low critical limits. Urgent clinician notification of critical results is a responsibility of the laboratory. The system of critical value reporting was first implemented in a hospital by George D. Lundberg, MD, and first published in *MLO* in 1972.

The tables presented here are based on three national surveys by Gerald J. Kost, MD, PhD, of the University of California-Davis Health System. Adapted with permission from his articles,¹⁻⁴ the tables summarize the critical limits used by 92 responding U.S. medical centers, including 20 trauma centers, and 39 responding 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. Those goals are:

1. The hospital defines critical tests and critical results and values.
2. The hospital defines the acceptable length of time between the ordering of critical tests and reporting the results of these tests, whether normal or abnormal.
3. The hospital defines the acceptable length of time for reporting the results of routine tests with critical abnormal values or findings.
4. The hospital defines the acceptable length of time between the availability of critical tests and critical results and values, and receipt by the responsible licensed caregiver.

Adults ¹					
Clinical chemistry		Low limit		High limit	
Test	Units	Mean (SD)	Range	Mean (SD)	Range
Glucose	mmol/L	2.6 (0.4)	1.7-3.9	26.9 (8.0)	6.1-55.5
	mg/dL	46 (7)	30-70	484 (144)	110-1000
Potassium	mmol/L	2.8 (0.3)	2.5-3.6	6.2 (0.4)	5.0-8.0
				8.0 (hemolyzed)	
Calcium	mmol/L	1.65 (0.17)	1.25-2.15	3.22 (0.22)	2.62-3.49
	mg/dL	6.6 (0.7)	5.0-8.6	12.9 (0.9)	10.5-14.0
Sodium	mmol/L	120 (5)	110-137	158 (6)	145-170
CO ₂ content	mmol/L	11 (2)	5-20	40 (3)	35-50
Magnesium	mmol/L	0.41 (0.16)	0.21-0.74	2.02 (0.82)	1.03-5.02
	mg/dL	1.0 (0.4)	0.5-1.8	4.9 (2.0)	2.5-12.2
Phosphorus	mmol/L	0.39 (0.10)	0.26-0.65	2.87 (0.48)	2.26-3.23
	mg/dL	1.2 (0.3)	0.8-2.0	8.9 (1.5)	7.0-10.0
Bilirubin	μmol/L	—	—	257 (86)	86-513
	mg/dL	—	—	15 (5)	5-30
Chloride	mmol/L	75 (8)	60-90	126 (12)	115-156
Osmolality	mmol/kg	250 (13)	230-280	326 (18)	295-375
Urea nitrogen	mmol/L	—	—	37.1 (21.1)	14.3-107.1
	mg/dL	—	—	104 (59)	40-300
Uric acid	μmol/L	—	—	773 (119)	595-892
	mg/dL	—	—	13 (2)	10-15
CSF glucose	mmol/L	2.1 (0.6)	1.1-2.8	24.3 (11.4)	13.9-38.9
	mg/dL	37 (10)	20-50	438 (206)	250-700
Creatinine	μmol/L	—	—	654 (380)	177-1326
	mg/dL	—	—	7.4 (4.3)	2.0-15.0
Ionized calcium ⁴	mmol/L	0.82 (0.14)	0.50-1.07	1.55 (0.19)	1.30-2.00
	mg/dL	3.29 (0.56)	2.00-4.29	6.21 (0.76)	5.21-8.02
Lactate	mmol/L	—	—	3.4 (1.3)	2.3-5.0
	mg/dL	—	—	30.6 (11.7)	20.7-45.0

Hematology					
Hematocrit	L/L	0.18 (0.05)	0.12-0.30	0.61 (0.06)	0.54-0.80
Hemoglobin	g/L	66 (17)	40-120	199 (27)	170-300
Platelets	×10 ⁹ /L	37 (18)	10-100	910 (147)	555-1000
WBC count	×10 ⁹ /L	2.0 (0.7)	1.0-4.0	37.0 (20.7)	10.0-100.0
PT	s	—	—	27 (9)	14-40
PTT	s	—	—	68 (33)	32-150
Fibrinogen	g/L	0.88 (0.17)	0.50-1.00	7.75 (2.63)	5.00-10.00

Blood gases and pH					
pCO ₂	mm Hg	19 (3)	9-25	67 (6)	50-80
pH		7.21 (0.06)	7.00-7.35	7.59 (0.03)	7.50-7.65
pO ₂	mm Hg	43 (6)	30-55	—	—
	kPa	5.7 (0.8)	4.0-7.3	—	—

1. Adult table modified with permission by *JAMA*, Vol. 263, pages 704-707, 1990. CSF, cerebrospinal fluid; WBC, white blood cell; PT, prothrombin time; PTT, partial thromboplastin time. Qualitative critical results for adults¹ 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 cerebrospinal fluid; presence of malignant cells, blasts, or microorganisms in cerebrospinal fluid 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, pages 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 children² 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 cerebrospinal fluid; 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.

Children ²						
Clinical chemistry		Low limit			High limit	
Test	Units	Mean (SD)	Range	Mean (SD)	Range	
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)	2.0-3.5	6.4 (0.5)	5.0-8.0	
Calcium	mmol/L	1.62 (0.17)	1.25-1.87	3.17 (0.22)	2.74-3.74	
Sodium	mmol/L	121 (5)	110-130	156 (5)	150-170	
CO ₂ content	mmol/L	11 (2)	6-18	39 (3)	33-45	
Magnesium	mmol/L	0.45 (0.04)	0.41-0.49	1.77 (0.45)	1.23-3.00	
Phosphorus	mmol/L	0.42 (0.16)	0.16-0.65	2.87 (0.39)	2.26-3.23	
Bilirubin	μmol/L	—	—	257 (68)	86-342	
Chloride	mmol/L	77 (8)	70-90	121 (5)	115-130	
Osmolality	mmol/kg	253 (12)	240-270	318 (10)	300-330	
Urea nitrogen	mmol/L	—	—	19.6 (11.4)	3.9-53.6	
Uric acid	μmol/L	—	—	714 (119)	595-892	
CSF glucose	mmol/L	1.7 (0.7)	1.1-2.8	—	—	
Creatinine	μmol/L	—	—	336 (212)	221-884	
Ionized calcium ⁴	mmol/L	0.85 (0.13)	0.60-1.08	1.53 (0.11)	1.35-1.75	
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						
Hematocrit	L/L	0.20 (0.06)	0.10-0.30	0.62 (0.05)	0.54-0.70	
Hemoglobin	g/L	69 (13)	50-100	208 (29)	170-250	
Platelets	×10 ⁹ /L	53 (25)	20-100	916 (220)	600-1500	
WBC count	×10 ⁹ /L	2.1 (0.9)	0.5-3.5	42.9 (25.1)	15.0-100.0	
PT	s	—	—	21 (6)	15-35	
PTT	s	—	—	62 (21)	40-100	
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						
pCO ₂	mm Hg	21 (6)	15-40	66 (23)	50-150	
pH	—	7.21 (0.05)	7.10-7.30	7.59 (0.04)	7.50-7.70	
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

5. The hospital collects data on the timeliness of reporting critical test results and critical results and values from routine tests.

6. The hospital assesses the data on the timeliness of reporting critical test results and critical results and values from routine tests and determines whether a need for improvement exists.

7. The hospital takes appropriate action to improve the timeliness of reporting critical test results and critical results and values from routine tests and measures the effectiveness of those actions.

The [organization] measures, assesses, and, if needed, takes action to improve the timeliness of reporting, and the timeliness of receipt of critical tests, critical results and values by the responsible licensed caregiver.⁶

8. (Measure of success required): Critically abnormal test results are communicated quickly to a responsible licensed caregiver so that prompt action may be taken (Direct Impact Requirement).

9. When the responsible licensed caregiver is not available, a backup reporting system provides the information in a timely manner to another qualified responsible caregiver to prevent avoidable delays in treatment or response (Direct Impact Requirement).⁷

Note: Readers need to be aware of the need for prompt action (No. 8) and the prevention of delay in prompt treatment of response (No. 9), since these are being vigorously enforced by The Joint Commission during accreditation inspections. □

References

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