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Normal variations of the total leukocyte count in healthy adults

Carter Vance Beghtol
University of Nebraska Medical Center

NORMAL VARIATIONS OF THE TOTAL LEUKOCYTE COUNT IN HEALTHY ADULTS

Carter Vance Beghtol

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I. INTRODUCTION

Clinicians often feel the total leukocyte count to be an indication only of infection or disease whenever that count lies outside its "normal" limits of 5,000 to 10,000/cmm. Nevertheless, it is commonly known among these same clinicians that the white blood cell count (WBC) can vary from hour to hour with physical exertion, meals, emotional states, and the time of day.

Why, then, is so much weight attached to a single WBC determination in actual practice?

This study is presented in an effort to determine what the normal WBC limits might be for a "normal", healthy adult with no evidence of infection or disease, and how those limits can vary under the body's physiologic responses to the usual day-to-day stresses of life. The following information shows 1) that present WBC limits of 5,000-10,000/cmm are wholly arbitrary, and 2) that a high WBC is not necessarily evidence of clinical disease. No effort is made to find the cause of these fluctuations; an attempt is set forth to note the diverse conditions with which the WBC varies.

II. PREVIOUS STUDIES

Mora noted in 1926 (10) that patients awaiting elective surgery and having no evidence of infection commonly had a WBC rise of 12-100% on the day preceding their surgery. Mora attributed this to anxiety and was able to duplicate his observations experimentally in dogs. Hence, emotion appears to play a part in WBC fluctuation.

Another physiologic rise in WBC has been noted by Pepper and Lindsay in 1959 (11) in regard to the menstrual cycle; during 39 observed cycles the WBC was observed to peak on the day of ovulation and then return to the previous base line during the remainder of the cycle. Ovulation was determined by oral temperature rise and by hormonal studies of the urine and blood. The study encompassed 583 counts with a WBC range of 6,000-12,500/cmm and a mean of 7,800/cmm. This might arouse speculation as to a possible hormonal relation to WBC fluctuation.

A similar conclusion can be drawn from work published by Altman in 1961 (1) concerning pregnant and post-partum patients. WBC's were high -- 10,000 to

11,000/cmm -- through the latter two trimesters, rose somewhat -- 12,000-13,000/cmm -- during labor, and peaked at 16,400/cmm during the first week post-partum.

Sex also seems to have an effect on the healthy adult's total WBC, as evidenced by work of Tullis published in 1953 (15) wherein he noted that the total WBC was directly proportional to the molarity of the blood; he found that males had consistently higher WBC and molarity than did females.

Venous and arterial WBC's were determined by Bierman in 1952 (2) in regard to respiration. He found that inspiration caused a decline in arterial WBC and a rise in venous WBC, while expiration caused a reverse effect. The Valsalva maneuver occasioned a marked drop in arterial WBC and little change in venous WBC. Bierman further observed that these changes were not due to a change in blood concentration but did suggest a tidal flow of leukocytes into and out of the pulmonary circulation.

A few studies on many "healthy" subjects over varying lengths of time have been done. A comparative study was reported in 1961 by Jeffrey (8) in which he

did hourly counts for 12-hour periods on 69 men. He compared his results with those of other authors whose methods had not necessarily been the same and showed the following:

	No. of Subjects	No. of Counts	WBC Mean	Range WBC
Osgood 1939	269	269	7,350	4,400-13,200
Blackburn 1947	642	642	7,372	2,360-20,000
Chamberlain & Turner 1951	3098	3098	7,741	4,500-12,100
Jeffrey 1961	69	1643	7,650	3,050-15,800
Total or mean	4,078	5,652	7,528	2,360-20,000

Jeffrey also noted a gradual rise in WBC from morning to late afternoon, with peaks of digestive leukocytosis occurring. He concluded that little emphasis should be placed on a single WBC.

In the work cited by Jeffrey above to Blackburn (3), it was determined that 68% of Blackburn's results lay within the range of 5,365-9,365/cmm, that 95% lay within 4,170-12,500, and that 99.7% lay within 2,760-18,750. These counts were done on healthy men between the ages of 18 and 49.

Booth and Hancock (4) reported a study in 1961

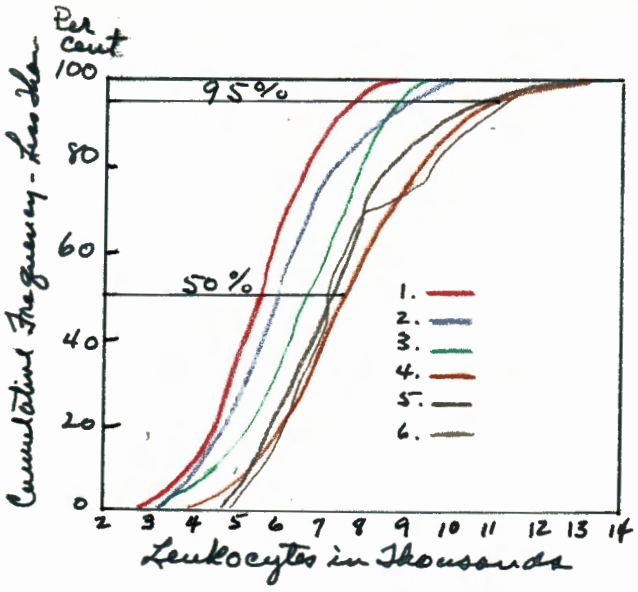
in which 104 men and 23 women were counted every three months over a two-year period for a total of 1,143 counts. The total range was 3,700-18,400 with a total mean of 8,100. It was noted that 10% of the counts lay outside a 4,000-11,000 range, nearly all being above 11,000. It is of practical interest to note that 14.3% of the counts were above the usual limit of 10,000. These counts were all done at mid-morning after rest.

In an experiment reported by Sharp in 1960 (12), it was found possible to reverse the usual diurnal WBC rise by working at night and sleeping by day with constant diet, activity, and lighting. Such reversal was effected in less than three days for all WBC's except neutrophils, whose periodicity was reversed in three to six days. Sharp felt that this reversal might be due to a reversal in adrenocortical activity in response to the activity--sleep reversal.

A review article by Squier (13) quotes Sturgis (Oxford Med. 2:531, 1947) as reporting total leukocyte counts of 14,000--27,000 when taken immediately after a marathon race, with 40-80% of the count being neutrophils.

Squier also quotes Sabin (Bull. Johns Hopkins Hosp. 37:14, 1925), who found an afternoon rise in WBC regardless of food ingestion.

Garrey and Bryan (6) note that "It is well established that excessive physiological activity as well as disease may alter the leukocyte content beyond the usual limits so that there is often a gradation between normal and diseased states, such that it becomes difficult ... to draw a clear cut line which delimits the normal from the abnormal states." (p. 599) The authors then note a series of 627 observations on 200 subjects under random physiological conditions with a normal range of 2,700-14,000. Included in this report is a graph of frequency distributions of results by Garrey and Bryan compared to other workers, as depicted on the following page.



1. Bryan, Chastain and Garrey (1935), after one hour's recumbent rest in the morning
2. Shaw (1927), morning rest
3. Torday (1913), morning counts on fasting subjects
4. Galambos (1912), random counts throughout the day
5. Osgood (1934), random counts
6. Schweizer (1933), counts during morning rest

Garrey and Bryan note that "... the total range /of an individual/ is no greater than that of the same individual for a single day but is less than in a pop-

ulation..." (p. 606). They also generalize that the count is lowest in the morning hours when at rest and varies least when determined under those conditions. These authors quote Stetson (Stetson, R. P., Arch. Int. Med. 40:488, 1927) as showing that an individual's WBC varies from day to day as much as 30%.

These authors then note both controversy and agreement in the literature with the correlation of WBC to random activity, exercise, epilepsy, adrenalin, digestion, starvation, climate, pregnancy, emotion, and training. In general, a lower WBC and less change due to exercise is shown by well trained subjects than by those with no training. Similarly, an emotionally labile person shows a higher and more widely varying WBC than a habitually phlegmatic individual.

These previous studies have shown that the leukocyte count normally varies widely with the day's activity, digestion, emotional expression, physical exertion, sex, ovulation, and parturition. "Normal" ranges of 2,360-20,000 and "normal" WBC means of 7,350-8,100 have been reported. The present study seeks to duplicate these findings.

III. PRESENT STUDY

A. Method

Five individuals were selected who were judged free from infection or disease; almost daily total leukocyte counts were made on these subjects using accepted clinical methods. The third drop of blood from a finger puncture was diluted with 0.1N HCl at a 1:20 ratio in a WBC pipette. In counting, the mean of six squares on the hemocytometer was used in calculation. All counts were done by the author.

Descriptions of those persons counted follow:

Person	Age	Sex	Occupation
1. J. V.	19	Female	Full time college student
2. M.T.B.	25	Female	Full time college student
3. M.C.B.	51	Female	Housewife
4. T.H.G.	32	Male	Full time college student and hospital orderly
5. C.V.B.	29	Male	Medical student

At the time of each finger puncture, the individual was asked the following questions in regard to the previous 24 hours:

1. Anything unusual to eat or drink.

2. Any medications.
3. Unusual physical exertion.
4. Menses, with details.
5. Aches, pains, or signs of infection
6. Mood and "how do you feel?"
7. Hours of sleep.
8. Other remarks.

In addition, the barometric pressure was recorded.

Blood was taken at times varying from 2:00 p.m. to 10:00 p.m.; these times are appropriately noted in the Appendix, where copies of the actual worksheets appear. These finger punctures continued until a total of 200 leukocyte counts had been tabulated.

B. Results

Findings from the 200 total leukocyte counts taken from five healthy individuals over an approximate period of two months yielded the following:

Total counts 200
Total range 5,200-16,200
Total mean 8,900
Standard deviation 1,674
50% of counts in range 6,778-10,022
68% of counts in range 6,226-10,574
95% of counts in range 5,552-12,448
99.7% counts in range 3,878-13,922

24% of counts lay above 10,000
12½% of counts lay above 11,000
5% of counts lay above 12,000

Individual results which form the basis for the information tabulated above are represented in the following data:

Individual	J.V.	M.T.B.	M.C.B.	T.H.G.	C.V.B.
Age	19	25	51	32	29
Sex	F	F	F	M	M
Counts	34	43	35	43	45
Range	5,600-9,200	7,800-13,600	5,200-10,000	6,800-11,200	7,600-16,200
Mean	7,165	9,847	7,726	9,526	10,000
Standard Deviation	2,655	1,500	1,067	1,054	432

Two of the subjects had blood drawn at two different times of day. The following shows what difference time of day can make:

(1) Blood drawn at 3-5 p.m.

	T.H.G.	C.V.B.
Range	8,200-9,800	9,600-12,200
Mean	9,180	9,580

(2) Blood drawn at 8-10 p.m.

	T.H.G.	C.V.B.
Range	6,800-11,200	8,200-16,200
Mean	9,085	10,417

More detailed results are available in the actual worksheets appended to this report. No discernible correlation was noted between the WBC and barometric pressure or transient dietary changes. Likewise, amount of sleep and day-to-day aches and pains had

little significant effect on the WBC. One episode of unexplained diarrhea may have caused a jump of 2,000.

Although the sampling of individuals was small, the impression that males have higher counts than females seems to be borne out. Another impression gained from this study is that the question of mood and "how do you feel" had the most correlation with the actual WBC; anxiety, apprehension, and perhaps depression appear to elevate the total leukocyte count. It is the opinion of the writer, in fact, that if an objective "anxiety lability index" for individuals could be formulated, that "index" would correlate almost exactly with the WBC means determined for the individuals participating in this study. For example:

Individual	WBC Mean	Subjective Lability "Anxiety Level"
J.V.	7,165	1+
M.C.B.	7,726	1+
T.H.G.	9,526	3+
M.T.B.	9,847	4+
C.V.B.	10,000	4+

IV. COMPARISON OF PRESENT AND PREVIOUS STUDIES

Nearly all the results of this study are higher than those reported for previous similar studies; the basis for this is probably that afternoon and evening determinations were used here and compared with determinations taken under basal conditions or scattered throughout the day in the previous reports. The results are tabulated here for easier comparison.

Authors	Subjects	Counts	Range	Mean
Pepper & Lindsay	- -	583	6,000-12,500	7,800
Booth & Hancock	127	1,143	3,700-18,400	8,100
Garrey & Bryan	200	627	2,700-14,000	
Osgood	269	269	4,400-13,200	7,350
Blackburn	642	642	2,360-20,000	7,372
Chamberlain & Turner	3,098	3,098	4,500-12,100	7,741
Jeffery	69	1,643	3,050-15,800	7,650
Beghtol	5	200	5,200-16,200	8,900

Booth and Hancock (4) found 14.3% of their counts above 10,000; the present study finds 24% lying above that figure. They also found nearly 10% of their counts above 11,000; the present comparable figure is 12.5%. Booth and Hancock's determinations were made at mid-

morning after rest and the present determinations were made in afternoon or evening after no rest; the comparison of figures is therefore probably valid if the difference in conditions is taken into account.

Another interesting comparison is afforded between Blackburn's (3) finding of standard deviation and the present finding, set out here:

	Blackburn	Beghtol
50% of counts in range	-- - --	6,778-10,022
68% of counts in range	5,365-9,365	6,226-10,574
95% of counts in range	4,170-12,500	5,552-12,448
99.7% counts in range	2,670-18,750	3,878-13,922

Other Points of Comparison

(A) As pointed out above by Mora (10), anxiety does appear to cause a leukocytosis, perhaps as much as his quoted 12-100%. Other investigators have found that blood cholesterol rises 11-16% in healthy individuals under stress (5,7,9,14.)

(B) Although the sampling here is small, Tullis' (15) contention that males have higher counts than females seems to be supported.

(C) Squier (13), quoting Sabin, notes the diurnal

rise in WBC, regardless of dietary intake. This rise seems to be supported by the present work.

(D) Garrey and Bryan (6) quote Stetson as saying that any one individual can be expected to have a normal daily variation of as much as 30% in his WBC. Compared here are each individual's actual range and a 30% range from each individual's mean:

Individual	30% range	Actual range
J.V.	5,015-9,315	5,600-9,200
M.T.B.	6,893-12,801	7,800-13,600
M.C.B.	5,408-10,044	5,200-10,000
T.H.G.	6,668-12,384	6,800-11,200
C.V.B.	7,000-13,000	7,600-16,200

Although the present series is too small a sampling for definite conclusions, it appears that it does support the opinions of previous workers in regard to the effects of anxiety, sex, and diurnal activity on the WBC range. When it is allowed that conditions under which the present study was conducted differ from previous similar studies, a rather close degree of correlation of ranges, means, standard deviations, and variations with those previous studies is evident.

V. SUMMARY AND CONCLUSIONS

A study was conducted in the fall of 1961 to determine the day-to-day variability of the total leukocyte count in five individuals over an approximate period of two months. No basal conditions were set up except that finger punctures were made at roughly the same time of day.

A total of 200 total leukocyte counts were made. The total range was 5,200-16,200 with a total mean of 8,900. Of those counts, 24% lay above the "normal" limit of 10,000 and 5% lay above 12,000.

Little correlation of variation was noted with diet, barometric pressure, amount of sleep, or day-to-day aches and pains. Male counts were noted to be higher than female counts.

The impression was gained but not proved that the WBC did vary directly with emotional lability; viz, subjects with the highest "anxiety lability index" had the widest WBC variation and the highest mean total leukocyte counts. This would correlate well with the findings of others (5,7,9,14) that blood cholesterol levels are directly proportional to anxiety and stress.

Each individual's WBC varied roughly 30% from his mean count during the time in which the study was being made.

It is suggested that fruitful data might be obtained in the future by correlating the WBC fluctuation with some sort of individual "anxiety lability index" determined by objective means.

VI. ACKNOWLEDGEMENTS

The writer wishes to acknowledge his indebtedness to Dr. Carl J. Potthoff of the University of Nebraska College of Medicine for his suggestions and guidance which made this report possible.

Thanks are also due to those persons who participated in this study: Miss Joanne Volence, Mrs. Marilyn T. Bruce, Mrs. Marjorie C. Beghtol, and Mr. Thomas H. Goninion for donating blood, and the writer's wife, Casey Beghtol, for assisting in the preparation of this report.

VII. BIBLIOGRAPHY

1. Altman, P.L. and Dittmer, D.S., Blood and Other Body Fluids, Federation of American Societies for Experimental Biology, 1961, pp. 125 and 127.

2. Bierman, H.R. and others, Influence of Respiratory Movements on Circulating Leukocytes, Blood 7:533-44, 1952.

3. Blackburn, C.R.B., Normal Count, M. J. Australia 1:525-8, 1947.

4. Booth, K. and Hancock, P.E., A Study of the Total and Differential Leukocyte Counts and Haemoglobin Levels in a Group of Normal Adults over a Period of Two Years, Brit. J. Haemat. 7:9-20, 1961.

5. Dreyfuss, F., and Czaczkes, J.W., Blood Cholesterol and Uric Acid of Healthy Medical Students under Stress of an Examination, A.M.A. Arch. Int. Med. 103:708, 1959.

6. Garrey, W.E. and Bryan, W.R., Variations in White Blood Cell Counts, Physiol. Rev. 15:597-638, 1935.

7. Grundy, S.M., and Griffin, A.C., Effects of Periodic Mental Stress on Serum Cholesterol Levels, Circulation 19:496, 1959.

8. Jeffrey, H.C., Normal Variations in Leukocyte Counts, J. Roy. Army Med. Corps 107:93-8, 1961.

9. Miller, S.E., Textbook of Clinical Pathology, Baltimore, Williams and Wilkins Company, 1955. 5th ed., p. 25-30.

10. Mora, J.M., Amtman, L.E., and Hoffman, S.J., Effect of Mental and Emotional States on the Leukocyte Count, J.A.M.A. 86:945-6, 1926.

11. Pepper, H., and Lindsay, S., Levels of Platelets, Eosinophils, Total Leukocytes, and Polymorpho-

nuclear Leukocytes During the Normal Menstrual Cycle, Obstet. Gynec. 14:657-64, 1959.

12. Sharp, G.W., Reversal of Diurnal Leukocyte Variations in Man, J. Endocr. 21:107-14, 1960.

13. Squier, T.L., Variations in Circulating White Blood Cells after Specific and Nonspecific Stimuli, J. Allergy 22:82-90, 1951.

14. Thomas, C.B. and Mruphy, E.A., Further Studies on Cholesterol Levels in the Johns Hopkins Medical Students: Effect of Stress at Examinations, J. Chronic Dis. 8:661, 1958.

15. Tullis, J.L., Blood Cells and Plasma Proteins, New York, Academic Press, Inc., 1953, p. 264.

16. Wertlake, P.T., and others, Relationship of Mental and Emotional Stress to Serum Cholesterol Levels, Proc. Soc. Exper. Biol. and Med. 97:163, 1958.

VIII. APPENDIX

Following appear true copies of the actual worksheets used in compiling this report.

J. V. 19 year old ♀ College student and does

1961 Date	Barometric pressure	Variations in diet	Medications	Unusual Exertion	Mens
Sept 25	30.0"	Little to eat	Vitamins	Moderate	
26	29.9				
27	30.4	Excess sweets	Vit.		
28	30.0		Aspirin		
29	29.6			Severe ½ hour	
Oct 2	30.1	Less than usual	Vit, thyroid	Moderate	
3	30.0		" "	Moderate	
4	29.8		" "	Slight	
5	29.8		"		
9	29.9	Excess sweets			
11	29.9		Vit., pill for cramps		2nd d
17	29.8				
18	30.0		Vit B_{12}		
20	30.0	Less than usual	"		
23			Vit.		
24	29.8		"		
25	29.9		"		
26	29.7		"		
27	30.1				
30	30.0		Aspirin		
31	29.8		Vit		
Nov 1	29.1		Vit B_{12}		
2	29.5		"		
3	29.8		"		
4			"		
5	30.6				
6	30.2		Vit B_{12}		
7	30.2	Less than usual	"		
8	30.1		"		
9	29.8		"		
10	29.8		"		
13	30.4				2nd do
14					3rd do
15	29.8				4th do

- secretarial work

	Infections, Aches, Pains	Mood and "How do you feel?"
	Slight cold & mod. sore throat	Not quite normal
	Slight cold	Depressed + angry; not up +
		Anxious + elated
	Shoulders ached	Fatigued
	(L) foot hurts from standing	Normal, tired in after
	Legs ache and are sore	Angry, not up to pa
	Hip pain, bruised knees, chilled	Upset in afternoon
	Feet + shoulders ache	Normal
		Sleepy
		Not up to par
	Menstrual cramps	Normal
		Jittery (too much coff
	Ache all over, mentally exhausted,	eyes blur, too much s
		Normal
		"
		"
		"
		Anxious
		Normal
	Hip aches, chilled today	Fatigued, normal mood
		Normal
	Head, shoulders, neck ache	Irritable
	Aches milder	Normal
		"
		"
		"
	Headache	"
		"
		"
	Ache in neck	Fatigued
		Normal
		"
		Very fatigued
	Shoulder ache	Slightly depressed

J.

	Hours Sleep	WBC Count	Remarks
	7	7,000	Blood drawn at 2-4 p.m.
	6	7,600	
	5	9,200	
	6	5,600	
	6½	7,000	
	6	8,800	
	6	7,000	34 counts
	5	7,200	range = 5600-9200
	5	6,400	mean = 7165
	4	6,800	std. deviation = 2655
	5½	7,000	
	6	6,800	
	6	7,400	
	7	7,600	
	6	8,200	
	6	7,800	
	5	7,000	
	6	6,600	
	4	8,800	
	6	8,000	
	7	7,600	
	7	6,000	
	6	7,200	
	5	7,600	
	7	7,400	
	6	7,400	
	6	7,200	
	4	7,200	
	7	6,400	
	6	6,800	
	6	7,000	
	6	6,200	
	7	6,200	
	7	8,600	

M. B. 25 year old ♀ College student

1961 Date		Barometric pressure	Variations in Diet	Medications	Unusual Exertion	Men
Sept.	24	30.1"		ASA, Coricidin		
	25	30.0	Ate very little	Tussagesic		
	26	29.9		Vit., ASA, Dristan		
	27	30.4		Vit., ASA		
	28	30.0		ASA, Terpin Hydrate		
	29	29.6		Vit		
Oct.	2	30.1		Vit		
	3	30.0		Vit		
	4	29.8				
	5	29.8				
	6	29.7				
	8	29.8	Vodka	Aspirin	Moderate	
	9	29.9				
	10	29.5		Vitamins		
	11	29.9		Vit.		
	12	29.9		Vit.		
	14	30.4		Vit., Darvon	4-mile walk	1st d
	16	29.8		Vit.		3rd d
	17			Vit.		4th d
	18	30.0		Vit		5th d
	19	30.1		Vit		
	23			Vit		
	24	29.8		Vit		
	25	29.9		Vit		
	26	29.7		Vit.		
	27	30.1				
	30	30.0		Vit		
	31	29.8		Vit		
Nov.	1	29.1		Vit		
	2	29.5		Vit		
	3	29.8		Vit		
	4			Vit		
	5	30.6		Vit		
	6	30.2		Vit + tranquilizer		
	7	30.2		Vit		
	8	30.1		Vit		
	9	29.8		Vit		

	Infections, Aches, Pains	Mood and "How do you fe
	Beginning cold	Normal
	Moderate cold	"
	Severe cold	Anxious, depressed, no
	Moderate cold	Same and angr
	Slight cold + cold sores	not up to par
	Sl. cold + headache, diarrhea	Normal
	Slight cold	"Grumpy"
	Tired, headache	Normal
	Bad cough	"
	Cough	"
		"
	Tender breast & transient lump	"
		Angry in a. m.
		Angry in a. m.
		Normal
		"
lay	Menstrual cramps, light flow	" but tired
lay		Angry in a. m.
lay		Irritated
lay	Very light menstrual flow	Apprehensive abo
	Scraped shin	Normal
	Diarrhea many times	"
	Diarrhea x 1	"
		"
		"
	Shoulders ache	Slightly depress
		Normal
		"
	Headache & sore neck	"Hateful"
		Irritable
		Normal
		"
		"
	Beginning cold.	Tired, drove 250
	Moderate cold	Stuffy head
	Severe cold	Stuffy head
	Severe cold	Tired + irritable

M.

19 Dal 8"	Hours sleep	WBC Count	Remarks
Sep	9	7,800	Blood drawn at 2-4 p.m.
	5	10,800	
taptopar	7	12,400	
y	7	8,800	
	4	10,800	
	5	12,000	43 counts
Oc	9½	13,600	range = 7800 - 13,600
	5½	10,800	mean = 9847
	4½	12,000	std. deviation = 1500
	6	11,800	
	9	12,000	
	7	11,600	
	7	11,600	
	8	10,600	
	4	11,000	
	7	11,000	
	7	8,800	
	4	9,800	
	5	9,400	
t test	4	8,600	
	5	8,400	
	4	9,400	
	4	11,400	
	6	11,800	
	5	10,200	
eal	4	9,800	
	6	9,600	
	7	8,200	
Na	6	8,800	
	7	9,200	
	6	9,000	
	4	8,400	
	6	7,800	
mi	1½	8,600	
	9	9,600	
	7	8,200	
	7	8,400	Continued next page

M. B. continued

1961 Date	Barometric pressure	Variations in Diet	Medications	Unusual Exertion	Mes
Nov. 10	29.8		Vitamins		1st
13	30.4		"		4th
14			"		
15	29.8				
20	30.1				
21	29.6				

uses	Infections, Aches, Pains	Mood and "How do you f
day	Bad menstrual cramps	
day		
	Headache, neck hurts, upset stomach	Excited, restless

M

1 Died ?"	Hours Sleep	WBC Count	Remarks
N	5	8,600	
	8	8,600	
	7	8,200	
	6	7,800	
	7	9,200	
	10	10,800	Auto accident 30 minutes before blood drawn

M. C. B. 51 year old ♀ Homemaker

1961 Date	Barometric pressure	Variations in Diet	Medications	Unusual Exertion	Menses
Sept 24	30.1"		Phenylbutazone + anti-histamine		
25	30.0		"	"	
26	29.9		"	"	
27	30.4				
29	29.6				
Oct 2	30.1		Phenylbutazone + anti-histamine		
3	30.0	1000 Cal diet	"		
4	29.8	"	"		
5	29.8	"	"		
6	29.7	"	"		Yes
8	29.8	"	"		Yes
9	29.9	"	"		
10	29.5	"	"		
14	30.4	"	"		
16	29.8	"	" + cold tabs		
18	30.0	"	" "		
19	30.1	"	" "		
20	30.0	"	" "		
23		"	"	Slight	
24	29.8	"	"		
30	30.0	"	"		
31	29.8	"	"		
Nov 1	29.1	"	"		
2	29.5	"	"		
3	29.8	"	"		
4		"	"		
5	30.6	"	"		
6	30.2	"	"		
7	30.1	"	"		
8	30.4	"	"		
13		"	"		
14	29.8	"	"		
15	30.2	"	"		
16	30.2	"	" + Coricidin		
20	30.1	"	"		

res	Infections, Aches, Pains	Mood and "How do you feel
		Anxious
		"
		" (moving)
	Stuffy nose	Fatigued, irritable
	"Achey" - time for normal period	not up to par
		Apprehensive re test
		Normal
		"
		Fatigued
		Normal
	Stuffy nose	"
		"
	Cold and sore throat	"
	Cough	"
		"
		"
		"
		Keyed up, drove 400 miles
		Normal
		"
		"
		"
		"
		"
		"
		"
		"
		"
		"
		"
		"
		"
	Stuffy nose	"
		"
		"

M.

Did?	Hours Sleep	WBC Count	Remarks
Se	7	6,600	Blood drawn at 7-9 p.m.
	7	6,800	
	8	6,800	
	7	7,400	
	4	8,200	
Oc	7	9,600	
	8	8,200	
	8	9,600	
	8	8,800	35 counts
	7	6,800	range = 5200 - 10,000
	7	8,400	mean = 7726
	8	10,000	Std. deviation = 1067
	7	8,200	
	6	5,200	
	8	7,600	
	12	7,800	
	7	8,400	
	7	8,000	
	7	7,200	
	7	7,600	
	7	9,400	
	8	8,600	
no	7	6,800	
	8	6,800	
	7	7,200	
	7	7,200	
	8	6,200	
	3	6,800	
	7	9,600	
	8	8,200	
	10	7,600	
	7	7,400	
	7	7,800	
	7	6,800	
	7	7,800	

T. H. G. 32 year old ♂ College student, hospital

1961 Date		Barometric pressure	Variations in Diet	Medications	Unusual Exertion
Sept	24	30.1"	1 pt. Whiskey	Tussagesic Coricidin, Terpin Hydrate	
	25	30.0		Tussagesic	
	26	29.9			
	27	30.4		Expectorant	
	28	30.0	Less to eat	Terpin Hydrate	Severe ½ hour
	29	29.6		Tussagesic, Equanil	
Oct	2	30.1			
	3	30.0	Less to eat	Expectorant	
	4	29.8	"		
	5	29.8			
	6	29.7			
	8	29.8	1 pt. vodka		
	9	29.9			
	10	29.5			
	11	29.9			
	12	29.9			
	16	29.5			
	18	30.0		Dexedrine	
	19	30.1	Less to eat	Dexedrine	
	23				
	24	29.8			
	25	29.9			
	26	29.7			
	27	30.1			
	30	30.0			
	31	29.8			
Nov	1	29.1			
	2	29.5			
	3	29.8			
	4				
	5	30.6			
	6	30.2			
	7	30.2			
	8	30.1			
	9	29.8			
	10	29.8			
	13	30.4			

orderly

Infections, Aches, Pains	Mood and "How do you feel
Severe cold	Not up to par
Moderate cold	Not up to par
" "	Normal
Slight cold	Anxious
"	Normal
"	"
"	"
"	"
"	"
"	"
"	"
Hangover, no cold	"
	"
	Not up to par
	Normal
	"
	"
	"
Headache	"
	"
	"
	"
	"
	"
	"
	"
	Not up to par
	Normal
	"
	"
	"
	Not up to par
	Normal
	"
	"
	"

Hours Sleep	WBC Count	Remarks
12	9,400	Blood drawn at 8-10 p.m.
7	8,800	
8	8,800	
7	11,200	
4	9,600	
5	10,800	
6	8,200	
7	10,000	
6	9.000	43 counts
8	9,600	range = 6800 - 11,200
6	8,600	mean = 9526
6½	10,200	Std. deviation = 1054
7½	10,800	
8	10,000	
4	8,600	
4	10,400	
6	9,200	
4	9,400	
5½	10,000	
3	8,400	
6	9,600	
5	9,800	
7	8,200	
4	9,600	
6	9,600	
6	9,200	
4	6,800	
8	8,800	
6	7,600	
6	7,600	
5	8,000	
3	7,400	
8	7,600	
6	8,200	Blood drawn at 3-5 p.m.
5	8,800	
5	9,200	
6	9,400	

continued next page

T. H. G. continued

1961 Date	Barometric pressure	Variations in Diet	Medications	Unusual Exertion
Nov 14				
15	29.8	Nothing to eat		
16	30.2			
17				20 min
20	30.1			
21	29.6			

Infections, Aches, Pains

Mood and
"How do you feel
Normal
"
"
"
"
"

Hours Sleep	WBC Count	Remarks
6	9,600	
6	9,400	
6	9,000	
6	8,800	
6	9,600	Blood drawn at 9 p.m.
6	9,800	"

C. V. B. 29 year old ♂ Medical Student

1961 Date		Barometric pressure	Variations in Diet	Medications	Unusual Exertion
Sept	24	30.1"			Slight
	25	30.0			Moderate
	26	29.9	1 highball	ASA	Severe 1 hr.
	27	30.4			Slight
	28	30.0			
	29	29.6		ASA	
Oct	2	30.1			
	3	30.0			
	4	29.8			Moderate
	5	29.8			
	6	29.7			Moderate
	8	29.8			
	9	29.9		Vitamins	
	10	29.5		"	
	11	29.9		"	
	12	29.9		"	Slight
	14	30.4		"	
	16	29.8		"	
	18	30.0		"	
	19	30.1		"	
	23			"	
	24	29.8		"	
	25	29.9		"	
	26	29.7		"	Slight
	27	30.1		"	
	30	30.0		"	
	31	29.8		"	
Nov	1	29.1		" + ASA	
	2	29.5		"	
	3	29.8		"	
	4			"	
	5	30.6		"	
	6	30.2		" + ASA	
	7	30.2		"	
	8	30.1	4 beers	"	
	9	29.8		" + ASA	
	10	29.8		"	

Infections, Aches, Pains	Mood and "How do you feel?"
	Anxious
Mild headache	"
Backache & sore legs	" & depressed
Sore legs	Normal
	"
Stiff neck	Depressed
	"
	Normal
	"
	"
	" & fatigued
	"
	"
	"
	Very frustrated & fatigued
	Normal
	"
	"
	"
	"
	"
	"
Slight headache	Depressed
	Normal
	"
	Very fatigued
	Irritable
	Normal
	Tired
	Normal
	"
Severe headache	Sleepy
	Normal
	Anxious
Headache	Normal & sleepy
	Normal

Hours Sleep	WBC Count	Remarks
9	10,200	Blood drawn at 8-10 p.m.
5	12,000	
6	14,000	Irritable today
8	10,000	
7	10,200	
5	9,600	
6	10,800	
4	11,200	
7	11,600	
8	11,200	(45 counts
6	11,800	range = 7600 - 16,200
8	9,000	mean - 10,000
7	10,400	Std. deviation = 432
5	10,400	
5	16,200	
7	11,200	
7	11,400	
4	9,200	
6	8,800	
6	9,800	
6	8,800	
6	9,600	
6	9,200	
7	9,800	
6	9,000	
5	8,400	
7	10,200	
6	11,600	
6	9,600	
4	12,800	
7	10,200	
6	9,400	
5	8,200	
7	8,400	
6	7,600	Blood drawn at 3-5 p.m.
6	8,600	
6	8,800	continued next page

C.V.B. Continued

1961 Date	Barometric pressure	Variations in Diet	Medications	Unusual Exertion
Nov 13	30.4		vitamins	
14			"	
15	29.8		"	
16	30.2		"	
17			"	
20	30.1		"	
21	29.6		"	

Infections, Aches, Pains

Mood and "How do you feel

Very fatigued
Sl. fatigued
Normal
"
"
Depressed
"

Hours Sleep	WBC Count	Remarks
3	12,200	
5	9,800	
5	9,600	
10	9,200	
6	11,600	
5	8,200	Blood drawn at 9 p.m.
6	10,200	