

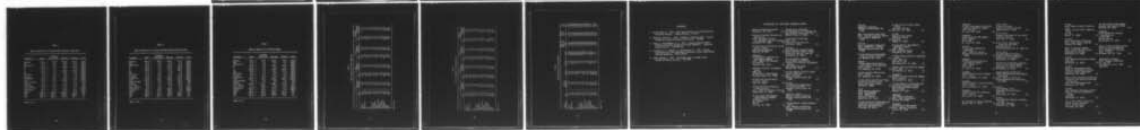
AD-A067 951

ARMY AEROMEDICAL RESEARCH LAB FORT RUCKER ALA
NORMAL BLOOD CHEMISTRY VALUES FOR LABORATORY ANIMALS ANALYZED B--ETC (U)
FEB 79 R L JOHNSON, T GEE, F PETTYJOHN
UNCLASSIFIED USAARL-79-7

F/G 6/5

NL

1 OF 1
AD
A067951



END
DATE
FILMED
6 -79
DDC

LEVEL ^{II}

12

USAARL REPORT NO. 79-7



NORMAL BLOOD CHEMISTRY VALUES FOR LABORATORY ANIMALS ANALYZED BY THE SEQUENTIAL MULTIPLE CHANNEL ANALYZER COMPUTER (SMAC-20)

By

Russell L. Johnson

Terry Gee

Frank Pettyjohn

HUMAN TOLERANCE AND SURVIVABILITY DIVISION

February 1979



U.S. ARMY AEROMEDICAL RESEARCH LABORATORY
FORT RUCKER, ALABAMA 36362

AD A067951

DDC FILE COPY

79 04 25 006
USAARL

NOTICE

Qualified requesters may obtain copies from the Defense Documentation Center (DDC), Cameron Station, Alexandria, Virginia. Orders will be expedited if placed through the librarian or other person designated to request documents from DDC.

Disposition

Destroy this report when it is no longer needed. Do not return it to the originator.

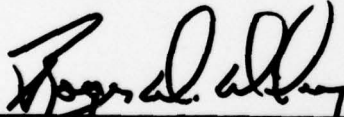
Distribution Statement

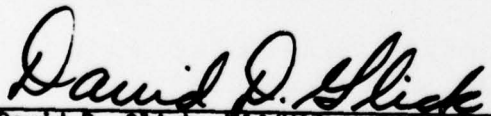
Approved for public release; distribution unlimited.

Disclaimer

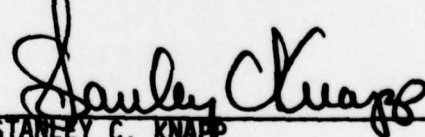
The findings of this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents. Trade or manufacturers names cited in this report do not constitute an official indorsement or approval of the use of such commercial hardware or software. This report may not be cited for purposes of advertisement.

Reviewed:


Roger W. Wiley, MAJ/MS
Director, Human Tolerance and
Survivability Division


David D. Glick, MAJ/MS
Chairman, Scientific Review
Committee

Released for Publication:


STANLEY C. KNAPP
Colonel, MC
Commanding

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM	
1. REPORT NUMBER USAARL Report No. 79-7	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) NORMAL BLOOD CHEMISTRY VALUES FOR LABORATORY ANIMALS ANALYZED BY THE SEQUENTIAL MULTIPLE CHANNEL ANALYZER COMPUTER (SMAC-20)		5. TYPE OF REPORT & PERIOD COVERED	
7. AUTHOR 10 Russell L. Johnson Terry Gee Frank Pettyjohn		6. PERFORMING ORG. REPORT NUMBER USAARL Report No.	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Human Tolerance & Survivability Division Biomedical Tolerance & Standards Group (SGRD-UAH) USAARL, Fort Rucker, AL 36362		8. CONTRACT OR GRANT NUMBER(s)	
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Aeromedical Research Laboratory (SGRD-UAC) Fort Rucker, AL 36362		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Program Element - 6.27.73.A Project #3E162773A819 Work Unit #007	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) US Army Medical Research and Development Command Fort Detrick, Frederick, MD 21701		12. REPORT DATE February 1979	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		13. NUMBER OF PAGES 20	
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		15. SECURITY CLASS. (of this report) Unclassified	
18. SUPPLEMENTARY NOTES		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Blood chemistry Normal serum values Multiple serum testing Sequential Multiple Channel Analyzer Computer			
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) See reverse.			

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

404578

JB

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Block 20.

Sequential Multiple Channel Analyzer Computers are rapidly becoming common diagnostic tools of both physicians and veterinarians in medical and research facilities. This increased use requires a reappraisal of normal serum values presently established for standard diagnostic tests. This report establishes normal serum values for laboratory animals to include dogs, mice, miniature swine and horses. In addition, comparisons are made between age, sex, and age and sex in the dog to show probable discrepancies in the use of standard normal values.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

PREFACE

This work was done under Program Element 6.27.73.A, Project 3E162773A819, Work Unit 007.

In conducting the research described in this report, the investigator(s) adhered to the "Guide for Laboratory Animal Facilities and Care," as promulgated by the Committee on the Guide for Laboratory Animal Resources, National Academy of Sciences-National Research Council.

The authors wish to thank Ms. Carolyn Harris, Ms. Gail Jay and Ms. Carolyn Johnson for the preparation of the report and SP5 Michael Nelson and Mr. John Sowell for the preparation of the figures. The technical assistance of SP5 James Faber, SP4 Michael Cevasco, and SP5 Caela Gargano is also acknowledged. Special thanks to Ms. Doris Hirsch and Mr. Chuck Snow for their operation of the SMAC-20.

COL Frank Pettyjohn is currently with the US Army Aeromedical Center, Lyster Army Hospital, Fort Rucker, AL.

CPT Terry Gee is currently Chief, Biological Research, William Beaumont Army Medical Center, El Paso, TX.

ACCESSION NO.	
DTIC	White Section ☒
DDC	Buff Section ☐
UNANNOUNCED	☐
JUSTIFICATION	
BY.....	
DISTRIBUTION/AVAILABILITY CODES	
Dist.	AVAIL. and/or SPECIAL
A	

TABLE OF CONTENTS

	<u>Page No.</u>
List of Figures.	3
List of Tables	4
Introduction	5
Materials and Methods.	6
Results and Discussion	8
Conclusion	9
References	16

LIST OF FIGURES

<u>Figure No.</u>		<u>Page No.</u>
1	Illustrates position of the pig and the restraint mechanism used to collect blood via anterior vena cava	6
2	Shows a mouse restrained for blood collection from the brachial vessels. The circle represents the collection site	7

LIST OF TABLES

<u>Table No.</u>		<u>Page No.</u>
1	SMAC-20 Profile of 36 Fasted Swiss Webster Albino Mice	10
2	SMAC-20 Profile of 10 Fasted Pittman Moore Miniature Swine	11
3	SMAC-20 Profile of 38 Fasted Horses.	12
4	SMAC-20 Profile of Fasted Female Dogs.	13
5	SMAC-20 Profile of Fasted Male Dogs.	14
6	SMAC-20 Profile of 126 Fasted Dogs	15

INTRODUCTION

Multiple channel serum analyzer capabilities are available today in many community and research medical facilities. Normal serum values for laboratory animals have not been established to date using the Sequential Multiple Channel Analyzer Computer (SMAC-20).

The advantages of multiple channel tests as given by Galen¹ include:

1. It provides additional information in the form of an extra test. Typical screening profile involves both "first-order" and "second-order" tests. When the first-order test shows the existence of some abnormality, a second-order test is usually given to supply additional information and to confirm the diagnosis. The SMAC-20 provides both tests at the same time, thus speeding diagnosis.
2. It provides additional sampling without additional sample labeling thus eliminating potential sources of error.
3. Technician time, analysis time, and reporting time are saved.

The blood chemistry values presented in this report utilize the US Army Aeromedical Research Laboratory's (USAARL) animal colonies. Animals from the Fort Rucker area were used in establishing SMAC blood chemistry values for dogs because USAARL's colony lacked a sufficient number.

This study was initiated to establish normal values for the USAARL animal colony. Review of available literature provided only partial studies of normal blood chemistry values using automated analysis. The data in this report now provides the first available normal values for dogs, miniature swine, mice, and horses analyzed by the Sequential Multiple Channel Analyzer Computer.

MATERIALS AND METHODS

Blood samples for SMAC-20 analysis were collected from 126 dogs, 37 horses, 39 Swiss webster albino mice, and 10 Pittman-Moore miniature swine. All animals were examined by a veterinarian to assure normality and health.

Standard restraint procedures were used during blood withdrawal from the cephalic and external jugular veins of the dogs and horses, respectively, using 10 milliliter (mℓ) vacutainers. In order to facilitate the venipuncture of the anterior vena cava in swine,² a trough device, Figure 1, was used for restraint. Once restrained the entire trough was inverted, placing the pig in dorsal recumbency. The mice

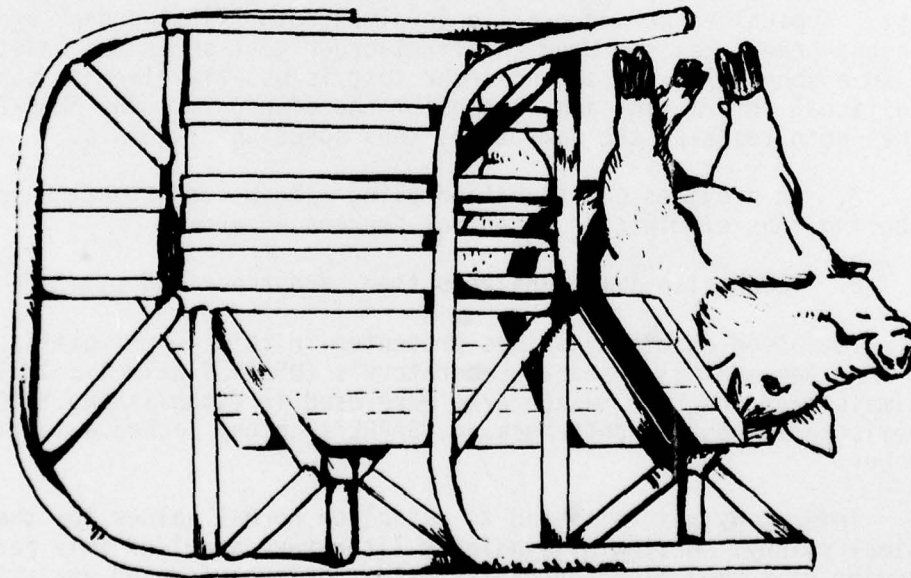


FIGURE 1. Illustrates position of the pig and the restraint mechanism used to collect blood via anterior vena cava.

were anesthetized with halothane, then placed in dorsal recumbency with appendages secured to a small mice restraint board, Figure 2. Blood was then withdrawn from the brachial vessels.³

All blood samples were collected in the morning at 0900 hours $\pm$ 2 hours following a 24-hour fast. The blood was allowed to clot for 30 minutes at room temperature prior to centrifuging and separation of serum from the clot. Serum was stored at 0°C for no more than 1 week before analysis.

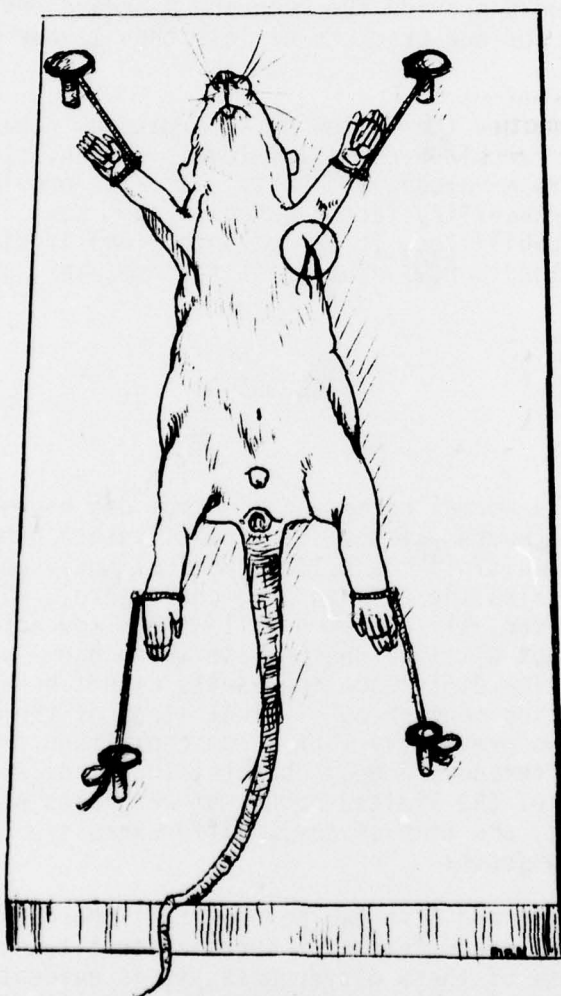


FIGURE 2. Shows a mouse restrained for blood collection from the brachial vessels. The circle represents the collection site.

RESULTS

Tables 1-5 provide a summary of the SMAC-20 profiles. Evaluation of canine blood chemistry samples utilized two parameters to evaluate differences--age and sex.

Tables 4 and 5 provide the mean and standard deviation for male and female dogs for age brackets of less than 1 year to greater than 5 years.

Table 6 provides the following information, regardless of age or sex of the dog, for blood chemistry levels: mean, standard deviation, maximum and minimum values, and units. It also provides the veterinarian with a probability factor based on age, sex, and age and sex. Using these probabilities, it can be determined if significant differences of each blood serum value exist for age, sex, and age and sex.

DISCUSSION

Values for a normal horse and a normal dog have been presented previously for a number of the serum constituents presented in this paper for other multiple channel biochemical analyses. Of those in the horse, only alkaline phosphatase, cholesterol, glucose, SGOT, and triglyceride differ, all of which fall within the normal range presented here except alkaline phosphatase which had a value below our minimum range. The difference in results cannot be explained due to limited information concerning clinical state of the subject. However, it has been shown previously that serum constituents will vary with time of day, differences among subjects, location, and instrumentation.⁴ Because of the limited number of variables within mice (age, sex, environment, and time of day), differences are attributed to variations within subjects.

From Tables 4 and 5 it can be seen that there is a significant difference in the serum levels of certain constituents based on age and sex. Because of these differences, it is evident that age and sex should be considered before clinical laboratory findings of serum constituent values are accepted as normal or abnormal. The range found in this study indicates the difficulty in differentiating the normal

from abnormal for a specific patient. It further implies that the most common approach to establishing normals for clinical laboratory tests, as the mean value plus or minus two standard deviations, is not justifiable for an individual patient.⁵

CONCLUSION

Under a standard laboratory environment, USAARL established individual normal values for the laboratory's animals with only feeding controlled. Due to the various intrinsic and extrinsic factors that affect serum constituent levels, it is becoming more and more advantageous, where possible, for the animal/patient's own normal values to be determined on a control rather than a range of normal values.

The use of the SMAC-20 is of importance in both research and clinical medicine. The SMAC can provide the practicing clinical and research veterinarian with two types of profiles--disease specific and multiphasic screening. The normal range of biochemical determinations has been developed for military and civilian research animal laboratories with the advanced state of the art Sequential Multiple Analyzer Computer. This study provides a ready reference for those military and civilian research facilities initiating animal programs.

TABLE 1

SMAC-20 PROFILE OF 36 FASTED SWISS WEBSTER ALBINO MICE

Parameter	Mean	Standard Deviation	Maximum	Minimum	Units
Glucose	181.2 ±	32.2*	222.0	125.0	mg/dl
BUN	21.5 ±	2.6	29.0	18.0	mg/dl
Creatinine	0.5 ±	0.6	0.6	0.4	mg/dl
Na	150.2 ±	2.7	155.0	144.0	meq/L
K	7.2 ±	9.0	8.5	5.6	meq/L
Cl	114.1 ±	2.1	118.0	112.0	meq/L
CO ₂	8.5 ±	1.8	12.0	6.0	meq/L
Uric Acid	3.8 ±	8.1	4.9	2.0	mg/dl
Calcium	9.8 ±	4.4	10.4	9.0	mg/dl
Phosphorus	8.4 ±	6.1	9.5	7.4	mg/dl
Iron	219.3 ±	35.3	290.0	177.0	mcg/dl
Total Protein	5.6 ±	2.7	6.2	5.1	g/dl
Albumin	3.1 ±	1.3	3.2	2.8	g/dl
Alk. Phos.	90.0 ±	10.7	111.0	75.0	U/L
Total Billir.	0.1 ±	0.2	0.1	0.1	mg/dl
Cholesterol	98.2 ±	9.1	121.0	86.0	mg/dl
Trigly.	42.6 ±	16.9	70.0	17.0	mg/dl
SGOT	2024.1 ±	2918.9	6326.0	96.0	U/L
LDH	463.5 ±	166.1	766.0	220.0	U/L
CPK	1856.3 ±	1061.2	3538.0	245.0	U/L

*Mean ±/S.D.

TABLE 2

SMAC-20 PROFILE OF 10 FASTED PITTMAN MOORE MINIATURE SWINE

Parameter	Mean	Standard Deviation	Maximum	Minimum	Units
Glucose	160.9 ±	54.7*	268.0	111.0	mg/dl
BUN	11.3 ±	2.8	17.0	9.0	mg/dl
Creatinine	16.9 ±	2.4	21.0	14.0	mg/dl
Na	151.5 ±	1.9	154.0	149.0	meq/l
K	33.0 ±	2.4	37.0	29.0	meq/l
Cl	107.4 ±	2.5	111.0	104.0	meq/l
CO ₂	15.4 ±	4.7	21.0	7.0	meq/l
Uric Acid	1.1 ±	0.4	2.0	1.0	mg/dl
Calcium	113.8 ±	4.9	121.0	107.0	mg/dl
Phosphorus	52.9 ±	5.4	60.0	46.0	mg/dl
Iron	187.4 ±	20.5	220.0	161.0	mcg/dl
Total Protein	85.3 ±	2.9	91.0	82.0	g/dl
Albumin	49.5 ±	2.9	54.0	46.0	g/dl
Alk. Phos.	18.3 ±	9.3	34.0	10.0	U/L
Total Billir.	6.2 ±	1.0	7.0	5.0	mg/dl
Cholesterol	90.5 ±	10.6	108.0	75.0	mg/dl
Trigly.	48.4 ±	47.2	140.0	6.0	mg/dl
SGOT	59.5 ±	6.7	69.0	49.0	U/L
LDH	348.3 ±	38.4	402.0	290.0	U/L
CPK	275.6 ±	182.3	612.0	107.0	U/L

*mean ±/S.D.

TABLE 3

SMAC-20 PROFILE OF 38 FASTED HORSES

Parameter	Mean	Standard Deviation	Maximum	Minimum	Units
Glucose	98.5 ±	16.9	161.0	61.0	mg/dl
BUN	12.2 ±	3.3	22.0	8.0	mg/dl
Creatinine	1.8 ±	3.8	2.7	1.1	mg/dl
Na	139.7 ±	1.9	144.0	136.0	meq/l
K	4.0 ±	5.5	5.2	2.3	meq/l
Cl	106.6 ±	2.4	110.0	100.0	meq/l
CO ₂	25.8 ±	2.1	30.0	21.0	meq/l
Uric Acid	0.3 ±	1.8	0.6	0.0	mg/dl
Calcium	12.6 ±	5.3	13.5	11.0	mg/dl
Phosphorus	3.3 ±	8.4	6.9	2.2	mg/dl
Iron	164.2 ±	35.1	236.0	108.0	mcg/dl
Total Protein	7.0 ±	5.6	8.0	5.3	g/dl
Albumin	3.5 ±	3.7	4.0	1.8	g/dl
Alk. Phos.	238.0 ±	141.3	999.0	143.0	U/L
Total Billir.	1.1 ±	55.4	2.8	1.0	mg/dl
Cholesterol	101.0 ±	16.4	175.0	79.0	mg/dl
Trigly.	27.0 ±	24.1	11.5	0.0	mg/dl
SGOT	207.0 ±	53.3	375.0	110.0	U/L
LDH	271.0 ±	54.3	396.0	161.0	U/L
CPK	104.0 ±	142.5	934.0	42.0	U/L

*Mean ±/S.D.

TABLE 4
SMAC-20 PROFILE OF FASTED FEMALE DOGS

	< 1 Yr.		1-2 Yrs.		3-4 Yrs.		5 Yrs. and Above	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Glucose	103.1 ±	18.4*	93.6	17.9	10.0	13.8	99.6	11.1
BUN	15.5 ±	7.6	15.6	4.5	18.6	9.6	15.0	6.4
Creatinine	0.8 ±	1.7	1.0	1.8	1.0	2.1	0.9	2.2
Na	142.9 ±	4.0	146.0	3.9	146.0	3.0	148.0	3.1
K	4.9 ±	4.3	4.7	3.5	4.7	4.6	4.7	4.1
Cl	110.8 ±	4.8	113.9	4.3	113.3	3.8	113.9	5.4
CO ₂	20.3 ±	2.5	20.2	2.6	19.7	3.1	21.5	3.6
Uric Acid	1.7 ±	1.7	2.2	1.8	2.4	1.7	1.8	2.0
Calcium	10.6 ±	4.6	10.7	6.3	10.1	19.5	10.1	6.9
Phosphorus	6.5 ±	4.0	4.4	9.9	4.0	7.2	3.5	9.0
Iron	156.9 ±	93.3	179.9	67.1	159.2	86.1	177.4	58.6
Total Protein	6.1 ±	10.8	6.4	7.0	6.4	16.4	6.9	6.7
Albumin	2.8 ±	6.1	3.1	4.8	3.1	4.9	2.9	3.8
Alk. Phos.	97.3 ±	64.2	56.0	25.4	40.9	22.4	52.1	35.1
Total Billir.	0.4 ±	1.5	1.2	4.2	0.3	0.9	0.8	2.5
Cholesterol	152.7 ±	23.7	180.8	47.8	202.3	89.9	155.5	25.3
Trigly.	48.7 ±	22.9	58.1	33.1	51.2	44.7	46.7	13.9
SGOT	30.0 ±	8.4	31.9	19.6	31.5	18.1	150.2	302.1
LDH	132.7 ±	142.8	94.1	66.5	79.9	69.7	92.4	50.3
CPK	115.6 ±	51.2	84.4	114.7	48.5	39.1	56.3	40.9

*Mean ±/S.D.

TABLE 5
SMAC-20 PROFILE OF FASTED MALE DOGS

	< 1 Yr.		1-2 Yrs.		3-4 Yrs.		5 Yrs. and Above	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Glucose	104.2 ±	21.3*	99.6	14.4	89.3	11.7	105.9	15.3
BUN	15.8 ±	5.0	18.9	6.9	19.5	5.7	17.2	15.0
Creatinine	0.8 ±	1.4	1.2	5.6	1.1	2.3	1.1	4.2
Na	143.3 ±	5.3	146.6	2.6	146.5	2.2	146.3	4.9
K	4.6 ±	3.9	4.7	5.0	4.7	3.5	4.7	4.3
Cl	112.1 ±	4.9	115.2	3.3	114.7	1.8	115.7	5.6
CO ₂	20.3 ±	2.8	20.8	2.4	21.3	2.1	18.4	4.9
Uric Acid	1.7 ±	2.6	2.1	1.8	2.9	2.2	1.9	1.9
Calcium	10.7 ±	7.8	10.4	3.6	10.2	6.2	10.1	8.9
Phosphorus	7.3 ±	13.8	4.7	11.7	4.0	8.2	3.8	8.1
Iron	174.8 ±	97.7	192.4	80.2	145.6	38.6	125.4	41.4
Total Protein	5.4 ±	10.7	6.3	7.0	6.9	10.1	6.9	10.1
Albumin	3.0 ±	3.2	3.0	4.5	2.8	5.3	2.8	6.0
Alk. Phos.	137.3 ±	2.0	51.4	31.8	34.3	15.5	42.7	17.9
Total Billir.	0.2 ±	0.8	1.4	3.3	0.8	2.6	---	---
Cholesterol	154.6 ±	24.0	156.0	29.6	150.9	22.5	164.4	38.4
Trigly.	47.2 ±	21.8	46.5	26.8	34.2	9.3	35.6	17.4
SGOT	45.2 ±	35.5	31.1	13.9	27.1	14.6	31.8	33.6
LDH	154.5 ±	133.4	106.9	96.1	77.3	53.2	89.7	57.0
CPK	168.8 ±	113.1	64.1	43.5	46.3	20.9	78.4	83.4

*Mean ±/S.D.

TABLE 6
SWAC-20 PROFILE OF 126 FASTED DOGS

Serum Constituent	Mean	Standard Deviation	Maximum	Minimum	Units	Prob. of Sign. Dif. Based on		Within Ages < 1 Yr.		Age and Sex
						Age	Sex	Age	Sex	
Glucose	98.9	±	147.0	57.0	mg/dl	0.127		0.635		0.834
BUN	17.1	±	58.0	6.0	mg/dl	0.336		0.216		0.636
Creatinine	1.0	±	3.6	0.6	mg/dl	0.003		0.117		0.665
Na	145.7	±	154.0	130.0	meq/l	0.001		0.784		1.000
K	4.7	±	6.3	3.9	meq/l	0.154		0.860		0.996
Cl	113.7	±	126.0	99.0	meq/l	0.012		0.067		0.045
CO ₂	20.3	±	28.0	8.0	meq/l	0.935		0.837		0.907
Uric Acid	0.2	±	0.8	0.0	mg/dl	0.269		0.976		0.699
Calcium	10.4	±	12.0	2.4	mg/dl	0.041		0.836		0.505
Phosphorus	4.8	±	9.2	2.2	mg/dl	0.001		0.045		0.357
Iron	167.9	±	388.0	0.0	mcg/dl	0.203		0.878		0.127
Total Protein	6.4	±	8.4	0.0	g/dl	0.002		0.691		0.281
Albumin	3.0	±	4.1	1.5	g/dl	0.218		0.280		0.046
Alk. Phos.	62.8	±	269.0	8.0	u/L	0.001		0.407		0.834
Total Billir.	0.1	±	1.5	0.0	mg/dl	0.360		0.926		0.082
Cholesterol	167.5	±	438.0	106.0	mg/dl	0.145		0.014		0.776
Trigly.	47.8	±	214.0	6.0	mg/dl	0.400		0.045		---
SGOT	41.8	±	999.0	10.0	U/L	0.047		0.333		0.041
LDH	102.9	±	569.0	13.0	U/L	0.053		0.532		0.947
CPK	81.5	±	619.0	0.0	U/L	0.001		0.478		0.213

*Mean ±/S.D.

REFERENCES

1. Galen, Robert S. 1976. Panel testing moves into animal medicine. *Laboratory Animals*. January/February. 20-29 p.
2. Dewhurst, Charles R. 1942. A method of bleeding swine. *Journal of American Veterinary Medical Association*. 101:495.
3. Young, L, and Chambers, T. R. 1973. A mouse bleeding technic yielding consistent volume with minimal hemolysis. *Laboratory Animal Sciences*. 23(3):428-30.
4. Statland, B. E., Winkel, P., and Bokelund, H. 1973. Factors contributing to intra-individual variation of serum constituents. *Clinical Chemistry*. 19(12):1374-9.
5. Abbey, Murphy L. 1967. The normal range--A common misuse. *Journal of Chronic Diseases*. 20:79-88.

DISTRIBUTION LIST FOR USAARL LABORATORY REPORTS

Defense Documentation Center Alexandria, VA 22314	(12)	Aeromechanics Laboratory US Army Research & Technology Labs Ames Research Center, M/S 215-1 Moffett Field, CA 94035	(1)
Director of Defense Research and Engineering ATTN: Assistant Director (Environmental and Life Sciences) Washington, DC 20301	(1)	Sixth United States Army ATTN: SMA Presidio of San Francisco, California 94129	(1)
Uniform Services University of the Health Sciences 4301 Jones Bridge Road Bethesda, MD 20014	(1)	Director Army Audiology & Speech Center Walter Reed Army Medical Center Forest Glen Section, Bldg 156 Washington, DC 20012	(1)
Commander US Army Medical Research and Development Command ATTN: SGRD-AJ (Mrs Madigan) Fort Detrick Frederick, MD 21701	(5)	US Army Materiel Command Harry Diamond Laboratories Scientific & Technical Information Offices 2800 Powder Mill Road Adelphi, MD 20783	(1)
Redstone Scientific Information Center DRDMI-TBD US Army Missile R&D Command Redstone Arsenal, AL 35809	(1)	US Army Ordnance Center & School Library, Bldg 3071 ATTN: ATSL-DOSL Aberdeen Proving Ground, MD 21005	(1)
US Army Yuma Proving Ground Technical Library Yuma, AZ 85364	(1)	US Army Environmental Hygiene Agency Library, Bldg E2100 Aberdeen Proving Ground, MD 21010	(1)
US Army Aviation Engineering Flight Activity ATTN: DAVTE-M (Technical Library) Edwards AFB, CA 93523	(1)	Technical Library Chemical Systems Laboratory Aberdeen Proving Ground, MD 21010	(1)
US Army Combat Developments Experimentation Command Technical Library HQ, USACDEC Box 22 Fort Ord, CA 93941	(1)	US Army Materiel Systems Analysis Agency ATTN: Reports Distribution Aberdeen Proving Ground, MD 21005	(1)

Director
Biomedical Laboratory
Aberdeen Proving Ground, MD
21010

HDQ, First United States Army
ATTN: AFKA-MD (Surgeon's Office)
Fort George G. Meade, MD
20755

Director
Ballistic Research Laboratory
ATTN: DRDAR-TSB-S (STINFO)
Aberdeen Proving Ground, MD
21005

US Army Research & Development
Technical Support Activity
Fort Monmouth, NJ 07703

CDR/DIR
US Army Combat Surveillance &
Target Acquisition Laboratory
ATTN: DELCS-D
Fort Monmouth, NJ 07703

US Army Avionics R&D Activity
ATTN: DAYAA-O
Fort Monmouth, NJ 07703

US Army White Sands Missile Range
Technical Library Division
White Sands Missile Range
New Mexico 88002

Chief
Benet Weapons Laboratory
LCWSL, USA ARRADCOM
ATTN: DRDAR-LCB-TL
Watervliet Arsenal
Watervliet, NY 12189

US Army Research & Technology Labs
Propulsion Laboratory MS 77-5
NASA Lewis Research Center
Cleveland, OH 44135

US Army Field Artillery School
Library

Snow Hall, Room 16
(1) Fort Sill, OK 73503 (1)

US Army
Dugway Proving Ground
Technical Library
(1) Bldg 5330
Dugway, UT 84022 (1)

US Army Material Development &
Readiness Command
ATTN: DRCSG
(2) 5001 Eisenhower Avenue
Alexandria, VA 22333 (1)

US Army Foreign Science & Technology
Center
(1) ATTN: DRXST-IS1
220 7th St., NE
Charlottesville, VA 22901 (1)

US Army Training & Doctrine Command
(1) ATTN: ATCD
Fort Monroe, VA 23651 (2)

Commander
(1) US Army Training & Doctrine Command
ATTN: Surgeon
Fort Monroe, VA 23651 (1)

US Army Research & Technology Labs
(1) Structures Laboratory Library
NASA Langley Research Center
Mail Stop 266
Hampton, VA 23665 (1)

Commander
10th Medical Laboratory
(1) ATTN: DEHE (Audiologist)
APO New York 09180 (1)

Commander
US Army Natick R&D Command
(1) ATTN: Technical Librarian
Natick, MA 01760 (1)

Commander US Army Troop Support & Aviation Material Readiness Command ATTN: DRSTS-W St. Louis, MO 63102	(1)	US Air Force Flight Test Center Technical Library, Stop 238 Edwards AFB, CA 93523	(1)
Commander US Army Aviation R&D Command ATTN: DRDAV-E PO Box 209 St. Louis, MO 63166	(1)	US Air Force Armament Development & Test Center Technical Library Eglin AFB, FL 32542	(1)
Director US Army Human Engineering Laboratory ATTN: Technical Library Aberdeen Proving Ground, MD 21005	(1)	US Air Force Institute of Technology (AFIT/LDE) Bldg 640, Area B Wright-Patterson AFB, OH 45433	(1)
Commander US Army Aviation Research & Development Command ATTN: Library PO Box 209 St. Louis, MO 63166	(1)	US Air Force Aerospace Medical Division School of Aerospace Medicine Aeromedical Library/TSK-4 Brooks AFB, TX 78235	(1)
Commander US Army Health Services Command ATTN: Library Fort Sam Houston, TX 78234	(1)	Director of Professional Services Office of The Surgeon General Department of the Air Force Washington, DC 20314	(1)
Commander US Army Academy of Health Sciences ATTN: Library Fort Sam Houston, TX 78234	(1)	Human Engineering Division 6570th Aerospace Medicine Research Laboratory ATTN: Technical Librarian Wright-Patterson Air Force Base, OH 45433	(1)
Commander US Army Airmobility Laboratory ATTN: Library Fort Eustis, VA 23604	(1)	US Navy Naval Weapons Center Technical Library Division Code 2333 China Lake, CA 93555	(1)
Air University Library (AUL/LSE) Maxwell AFB, AL 36112	(1)	US Navy Naval Aerospace Medical Institute Library Bldg 1953, Code 012 Pensacola, FL 32508	(1)

US Navy Naval Submarine Medical Research Lab Medical Library, Naval Submarine Base Box 900 Groton, CT 06340	CO, Naval Medical R&D Command National Naval Medical Center Bethesda, MD 20014	(1)
Director Naval Biosciences Laboratory Naval Supply Center, Bldg 844 Oakland, CA 94625	Commander Naval Aeromedical Research Laboratory Det. PO Box 29407 Michoud Station New Orleans, LA 70129	(1)
Naval Air Systems Command ATTN: V/STOL Aircraft Branch Department of the Navy Washington, DC 20360	Federal Aviation Administration Office of Aviation Medicine Civil Aeromedical Institute ATTN: Library Oklahoma City, OK 73101	(1)
US Navy Naval Research Laboratory Library Code 1433 Washington, DC 20375	Department of Defence R.A.N. Research Laboratory P.O. Box 706 Darlinghurst, N.S.W. 2010 Australia	(1)
US Navy Naval Air Development Center Technical Information Division Technical Support Department Warminster, PA 18974		(1)
Human Factors Engineering Division Aircraft & Crew Systems Technology Directorate Naval Air Development Center Warminster, PA 18974		(1)
US Navy Naval Research Laboratory Library Shock & Vibration Information Center Code 8404 Washington, DC 20375		(1)
Dir of Biol & Med Sciences Div Office of Naval Research 800 N. Quincy Street Arlington, VA 22217		(1)