SALMONELLOSIS AND SHIGELLOSIS IN COOK COUNTY, ILLINOIS; 1. CLASSIFICATION OF SIX HUNDRED SALMONELLA AND SHIGELLA STRAINS ISOLATED FROM PATIENTS OF COOK COUNTY HOSPITAL

OSCAR FELSENFELD, M. D., VIOLA MAE YOUNG, M. S. AND TAMA YOSHIMURA, B. S., Chicago, Illinois

SALMONELLOSIS, especially salmonellosis caused by typhoid and paratyphoid bacilli, has been known for a very long time. Recent advances in bacteriology, especially the introduction of modern laboratory technics, facilitate the detection of Salmonellae and Shigellae to such an extent that the late '30-s and early '40-s saw a real boom in the diagnosis of salmonellosis and shigellosis. The serologic classification of these organisms progressed so far and branched into so many details that it nearly became a science by itself. Salmonella and Shigella typing centers were created, which diagnosed the types (or species) of these microbes. The largest of them in the United States is that of the U. S. Public Health Service, operated at the Communicable Disease Center in Chamblee, Georgia.

Hand-in-hand with the increasing differentiation of the strain went the recognition of their ecology. While all types of Salmonella are potentially pathogenic for man and animals, some strains have an epidemiology of their own, as, e.g., the typhoid bacillus. Others, as S. pullorum, are more frequent in fowl and infect man only occasionally.

The clinical picture of shigellosis has been well established, while that of salmonellosis is still less known to the general practitioner who is seeing today, thanks to great improvements in sanitation, few cases of typhoid fever but whose textbooks tell him little about salmonellosis caused by S. typhimurium, S. montevideo, S. oranienburg and other frequently encountered organisms.

Shigellae are transferred from man to man, eventually with the aid of food, while Salmonellae are propagated by man, animals and birds. The latter two groups serve as great reservoirs of food-borne human salmonellosis. The eating habits of the American people underwent some changes during World War II, when animal meat was scarce and the consumption of poultry steadily rose. With the increasing use of fowl meat, poultry-borne salmonellosis became a question to be studied.

Finally, the therapy of salmonellosis and shigellosis is still a matter of debate, especially since many claims have been raised concerning the efficacy of antibiotics in these diseases.

In view of these numerous interesting problems encountered in salmonellosis and shigellosis, it was decided to report the concepts of this Typing Center and this Enteric Service in a series of articles, the first of them being presented herewith.

Detailed studies on the distribution of Salmonella and Shigella types in large general hospitals of the middle west have not been carried out. It seemed, therefore, of interest to present to the medical profession such a survey covering detailed type and species identification of Salmonellae and Shigellae. The writers of the present paper previously submitted studies on the occurrence of these organisms in Illinois mental hospitals (1,2,3) and on material received from different laboratories in North and South America (4). These surveys, however, did not differentiate between hospitalized cases, contacts and carriers. Thus it was necessary to work up recently collected material from patients admitted to Cook County Hospital with this new purpose in mind.

It seemed also advisable to describe the laboratory procedures involved in the isolation of Salmonellae and Shigellae, since these are of paramount interest to the physician. His diagnostic work often depends so much on a well-functioning laboratory that a short recapitulation of a simple but effective method could prove of help.

From the Hektoen Institute for Medical Research of the Cook County Hospital, Chicago 12, Illinois.

Supported by a grant from the Dr. Leonard H. and Louis Weissman Medical Research Foundation.

Submitted Dec. 11, 1950.

MATERIALS AND MEDIA

Strains reaching the Salmonella—Shigella Typing Center of this institute from patients in Cook County Hospital were tabulated between April 1, 1948 and November 25, 1950, when their total number reached 600. During the same period of time Salmonella strains were received from two small hospitals and two private laboratories in Chicago. No comparison is being made in this paper with Salmonella and Shigella types which reached the center from other counties or states.

In order to detect Salmonellae, Shigellae and parasites in the stools of the patients, the following laboratory procedures were carried out:

Stools were received by the diagnostic laboratory within 30 minutes after evacuation. If the specimens were not expected to reach the laboratories within this period of time, preservatives were used. The employment of a preserving fluid was considered imperative for all rectal swabs and proctosigmoidoscopic specimens, since drying could cause false negative results. Mueller's tetrathionate broth was used originally for the preservation of the bacterial flora. Later, however, Selenite-F medium tinted with enough 1:1,000 aqueous methylene blue to "mark" the fluid, served for this purpose. In order to present the entire procedure, it should be mentioned that part of the stools which was destined for parasitologic examination, was collected fresh or preserved in 10 per cent formalin, or D'Antoni's iodine, or, lately, also in polyvinyl-alcohol fixative (5). Equipment was available for proctologists who wished to collect material with a sterile swab, streak it to two slides, dump the slides into a coplin jar containing either Schaudinn's fluid or polyvinyl-alcohol fixative and then send them to the parasitologic laboratory. Details of the parasitologic examination which consisted of the study of direct saline suspensions, iodine tinged smears, flotation and slides stained with Mallory's hematoxylin, are being published in a different article (6).

Fresh specimens for bacteriologic studies were streaked to one eosin methylene blue (Difco, Inc.) and two S. S. agar plates (Difco, Inc.). Material was also inoculated into tetrathionate broth (Difco, Inc.); lately into Selenite-F fluid (B. B. L.). The next day suspicious colonies were picked from the plates to triple sugar iron agar (B. B. L.); and two S. S. plates were inoculated from the Selenite-F tube. Colonies were fished from these plates one day later,

Organisms causing alkaline slant and changed (acid or acid and gas) butt in triple sugar iron medium were transferred to one tube of each:

Tryptone broth
Semisolid mannitol
Semisolid sucrose

The next day, motility and fermentation of the carbohydrates was read. An indole test was also performed.

Organisms showing alkaline slant and acid or acid and gas in the butt of triple sugar iron agar, negative indole reaction and no fermentation of sucrose but which broke mannitol were examined with polyvalent Salmonella sera, using the spot test method. If agglutination occurred, a preliminary report was sent to the hospital ward. The culture was transferred to agar slants and tryptone broth, then typed with specific sera (7).

Cultures which did not react with polyvalent Salmonella sera were inoculated into lactose, salicin and Voges—Proskauer medium, to observe delayed fermentation and the formation of acetyl methyl carbinol. Salmonellae do not break lactose or salicin and give a negative Voges—Proskauer test (8).

Cultures showing alkaline slant and acid butt but no gas were tested with polyvalent Salmonella sera (possible typhoid, S. gallinarum or other non-gasforming Salmonellae), then, if not motile, with Shigella sera, using the spot test method:

Mannitol negative, indole negative: Sh. Shigae and Sh. sachsi sera.

Monnitol negative, indole positive: Sh. schmitzi and Sh. sachsi sera.

If the serologic reactions were negative, a urease test was performed, to exclude non-motile Protei.

Mannitol fermenting organisms were tested with these sera:

Indole negative: polyvalent Sh. paradysenteriae (Flexner and Boyd) and polyvalent Sh. sonnei.

Indole positive: polyvalent Sh. paradysenteriae (Flexner) and polyvalent Sh. alkalescens.

Tubes of rhamnose and dulcitol broth were also inoculated, since the diagnosis of Shigellae is always based on both serologic and biochemical properties of the cultures.

Further serologic examination was carried out with absorbed specific sera, using the growth from nutrient agar slants inoculated with the organisms.

While this method is rather slow, it proved efficient in dealing with the large numbers of cultures encountered at Cook County Hospital.

RESULTS

Table I lists the frequency of Salmonella strains isolated in patients from Cook County Hospital, according to the source of their first isolation. The table was compiled to conform with the Kauffmann-White schema of Salmonellae.

TABLE I

SALMONELLA TYPES ISOLATED FROM PATIENTS AT COOK COUNTY HOSPITAL

Age group	Children				Adults				
Source of first isolation:	Stool	Blood	Other	Together	Stool	Blood	Other	Together	Sum
S. paratyphi B	2			2	3	1		4	6
S. typhimurium	48	4	53s,o.w	57	28	1	4e,l,s,u	33	90
S. chester	1			1					1
S. derby	2			2	1			2	3
S. california	1			1					1
S. bredeney					1	1		1	2
S. choleraesuis	2			2	2			2	4
S. thompson	2			2	2		1u	3	5
S. virchow					1			1	1
S. oranienburg	18	1		19	5		1u	6	25
S. bareilly					2			2	2
S. montevideo	16		1j	17	14		1e	15	32
S. tennessee	1			1					1
S. newport	9			9	6			6	15
S. muenchen	1			1	1	1	1s	3	4
S. manhattan	1			1	1			1	2
S. typhosa	20	12	1j	33	18	2		20	53
S. enteritidis	3	1		4	5			5	9
S. berta	1			1					1
S. eastbourne					1			1	1
S. sendai							1w	1	1
S. panama	2			2					2
S. pullorum					1			1	1
S. give	1			1	1			1	2
S. anatum	5			5	4			4	9
S. lexington	1			1					1
S. newington	1			2					2
S. senftenberg					1		1l	2	2
S. solt	1			1					1
S. wichita	1			1					1
S. cubana	1			1	1			1	2
S. cerro					1			1	1
S. minnesota					1			1	1
S. urbana					1			1	1
S. champaign					1			1	1
	142	18	7	167	103	6	10	119	286

Notes:

e = from otitis media
j = from arthritis
l = from pneumonia
o = from osteomyelitis
s = from cerebrospinal fluid
u = from urine
w = from wound

TABLE II
SHIGELLA TYPES ISOLATED FROM PATIENTS IN COOK COUNTY HOSPITAL

Age group		Children			Adults				
Source of strain:		Stool	Other	Together	Stool	Other	Together	Sum	%
Sh. sachsi		3		3	2		2	5	3.15
Sh. ambigua		1		1	3	1[a]	4	5	
Sh. flexneri	I	3		3	1		1	4	
	II	18		18	20	1[b]	21	39	
	III	3		3	3		3	6	
	IV	23		23	35		35	58	36.66
	V	1		1				1	
	VI	2		2	3		3	5	
Sh. boydi					2		2	2	
Sh. alkalescens		14	1[u]	15	27	1[u]	28	43	13.69
Sh. sonnei		105		105	33		33	138	43.95
Sh. dispar		4		4	3	1[w]	4	8	2.55
		177	1	178	132	4	136	314	100.00

Notes:
a = from perinephritic abscess
b = from bile
u = from blood and urine
w = from wound

Thirty-five types of Salmonella were encountered. S. typhimurium infections were the most numerous, followed by S. typhosa, S. montevideo, S. oranienburg, S. newport, S. enteritidis and S. anatum, while S. paratyphi B, S. derby and S. choleraesuis and other types were less frequent.

Of the Salmonellae rarely diagnosed in man, the isolation of S. pullorum was of special interest. The case history of this patient has been published (9) as well as the finding of another poultry-borne Salmonella, S. cubana (10).

Unusual Salmonella types were seldom encountered. They included S. eastbourne, S. solt and S. cerro.

Infection with two Salmonella types in the same patient were the following: one child each with typhimurium and S. enteritidis, S. typhimurium and S. oranienburg, S. muenchen and S. senftenberg; two children each with S. typhimurium and S. newport in the stools; one child with S. typhosa and S. eastbourne in the blood stream; and, one child with S. typhosa and S. montevideo in arthritis of the knee joint (11). Among adult patients, double infections found on stool examinations included one combination of S. typhimurium and S. typhosa and one of S. montevideo and S. oranienburg. From the ears of one patient both S. typhimurium and S. montevideo were isolated. Finally, one adult harbored in his intestines at the same time S. typhimurium, S. newport and S. thompson.

Table II shows Shigella infections which came to the attention of the laboratory. They were slightly more numerous than the cases of salmonellosis. Sh. sonnei was the most frequently seen type, followed by Sh. paradysenteriae Flexner IV, Sh. alkalescens and Sh. paradysenteriae Flexner II. With the exception of two strains, all Flexner II cultures were indole negative.

Of the unusual strains, Sh. dysenteriae Sachs Q 771 was isolated twice from children and once from an adult, while type Q 1030 was found once each in an adult and a child. The two Boyd strains were D 19 and P 274, respectively.

In children, two infections with two Shigella strains were observed. In one Sh. paradysenteriae Flexner II, in the other Sh. paradysenteriae Flexner IV were found together with Sh. sonnei. One adult and one child harbored Sh. paradysenteriae Flexner IV and S. typhimurium in the stools.

Less frequent localizations of Salmonella infections were two lung infections (one chronic pneumonia caused by S. senftenberg and one lung abscess with S. typhimurium), one osteomyelitis (S. typhimurium), one arthritis (S. typhosa and S. montevideo), one otitis media (S. typhimurium and S. montevideo) and two phlegmonous skin affections (S. typhimurium and S. sendai, respectively). S. typhimurium, S. thompson and S. oranienburg, respectively, were isolated also from three cases of pyelonephritis in adults.

Clinical symptoms seen in cases suffering from salmonellosis will be described in a subsequent paper.

Shigellae were isolated from the blood and urine in two instances (Sh. alkalescens in both), once from a perinephritic abscess (Sh. ambigua), once from a cholecystitis (Sh. paradysenteriae Flexner II) and once from a suppurating wound of the hand (Sh. dispar).

TABLE III
MOST FREQUENT SALMONELLA TYPES FROM COOK COUNTY HOSPITAL AND OTHER SOURCES IN CHICAGO

Type	From CCH	%	From outside	Together	%
S. typhimurium	90	31.47	23	113	32.10
S. paratyphi B	6	2.97	2	8	2.27
S. oranienburg	25	8.74	5	30	8.52
S. montevideo	32	11.19	6	38	10.79
S. newport	15	5.24	15	30	8.52
S. typhosa	53	18.53	6	59	16.76
S. enteritidis	9	3.15	1	10	2.84
S. anatum	9	3.15	2	11	3.10
Others	47	15.56	6	53	15.10
	286	100.00	66	352	100.00

CCH = Cook County Hospital.

Table III shows a comparison of frequently encountered Salmonella strains isolated from patients in Cook County Hospital and cultures received from other sources in Chicago. The small number of organisms submitted from other Chicago institutions does not permit their evaluation at this time. Added to the statistics of Cook County Hospital, they do not cause a significant change in the percentual distribution of the Salmonella types, with the exception of that of S. newport. Thus the frequency of the most common Salmonella strains is, in decreasing order: S. typhimurium, S. typhosa, S. montevideo, S. oranienburg or S. newport, S. anatum, S. enteritidis and S. paratyphi B. No other strain occurred in more than 2 per cent of the cases.

DISCUSSION

Salmonellosis in those parts of the world where adequately treated water supplies are available is a disease transferred primarily from man to man and from animals to man. S. typhosa is an organism which is seldom propagated by patients suffering from typhoid fever, but is spread in urban areas of the United States by carriers, especially by food handlers and only seldom by water (4,12). Fifty-three typhoid cases observed during the 32 months of this study in only one large hospital constituted, however, a rather surprising number, when compared with formerly published data which were considerably lower. E. g., of 3,419 patients admitted to Illinois state hospitals in 1943, only 5 carried E. typhosa (3). Organisms from 6 cases of typhoid fever were typed by this center while receiving material in 1942 to 1944 from Illinois state hospitals and 2 in 1945 to 1947 while identifying organisms from a 320 bed hospital in Cook County, surveying 520 food handlers and 270 students.

Comparative tabulations published by Kessel et al. (13), Edwards et al. (14), the writers (15) and others show that the distribution of salmonellosis in man in the United States follows to a certain extent (and with the exception of S. typhosa, S. choleraesuis and S. pullorum) the distribution of Salmonellae in fowl. Edwards et al. (14), Hinshaw et al. (16), Darby and Stafseth (17) and Bidwell and Kelly (18) proved that most cases of salmonellosis in poultry in the United States are caused by S. typhimurium, S. pullorum, S. bareilly, S. oranienburg, S. montevideo, and S. anatum. S. thompson is not infrequent in dehydrated eggs (14). S. typhimurium and S. newport are, however, frequently present not only in birds but also in animals and human carriers. Numerous authors (references listed in 14 and 15) described cases and outbreaks of human salmonellosis which were proven to be caused by the consumption of infected poultry meat and eggs. Data presented in this paper, especially in Table I, show a decline of animal-borne salmonellosis as compared with poultry-borne infections. The authors of this paper never found Salmonella in pasteurized milk (15). S. choleraesuis, which is a purely meat-borne organism, and which caused 8 of the 190 outbreaks observed by the writers between 1943 and 1948 in the Middle West (4), was seen now only 4 times among 352 strains from the same area. While this may still be the result of random sampling, one would like to believe that postwar return to legitimate, federally inspected meat supplies played a part in the reduction of salmonellosis originating from the consumption of pork. Unfortunately, much of the poultry eaten by the public reaches the American table without the benefit of proper postmortem inspection by a competent veterinarian or other trained inspector. (4,15). Thus the infection rate with Salmonellae from fowl did not decrease as yet.

There is no explanation for the lesser frequency of S. paratyphi B infections. This organism has been found in animals, birds and human carriers, thus it is difficult to explain why it is less often encountered. S. paratyphi A has been seen once by the authors from the northern part of the United States. This is in agreement with the findings of other Salmonella centers (Seligman et al., 19). One keeps wondering why paratyphoid A is still being sought by many laboratories and textbooks in this area, while other Salmonellae which are so frequently seen, as S. oranienburg, S. montevideo and S. newport, do not even merit an honorable mentioning.

Among the Shigella strains, Sh. dysenteriae Shiga was not encountered during this survey, as it was absent in other studies conducted during previous years (3,20). Sachs and Boyd strains were seen, even if seldom. Sh. sonnei remained the leading cause of bacillary dysentery. Of the Flexner types, II (formerly W) and IV (formerly Boyd 103) led the list. These types have been predominating during the past years. Sh. alkalescens did not lose its importance, either. If unusual strains are disregarded and the relatively lesser frequency of the laboratory diagnosis of shigellosis conceded as a fact due to the use of antibiotics and sulfonamides prior to stool collection for bacteriologic examination, little change can be seen in the distribution of Shigella strains at present.

Grouping of patients according to age did not prove to be of much significance. Nevertheless, the tables list the patients according to age groups, to show the frequency of salmonellosis and shigellosis in children.

ACKNOWLEDGEMENT

The authors are indebted to Drs. Edwards and Ewing for the typing of several unusual strains.

SUMMARY

Two hundred eighty-six Salmonella and 314 Shigella strains from patients in the Cook County Hospital in Chicago were identified. The most frequently encountered Salmonellae were (in decreasing order) S. typhimurium, S. typhosa, S. montevideo, S. oranienburg, S. newport, S. anatum, S. enteritidis and S. paratyphi B, while often encountered Shigellae were classified as Sh. sonnei, Sh. paradysenteriae Flexner IV, Sh. alkalescens and Sh. paradysenteriae Flexner II. The occurrence of rare types is reported. There seemed to be a shift in the frequency of Salmonella strains, as compared with previous studies in the same geographic area but the distribution of Shigellae did not change. The importance of carriers and poultry in human salmonellosis were discussed.

REFERENCES

1. Felsenfeld, O. and Young, V. M.: Occurrence of Members of the Genus Salmonella in Inhabitants of State Hospitals of the Greater Chicago Area. J. Lab. & Clin. M., *29*: 375-382, 1944.
2. Young, V. M.: Salmonella Types Isolated in a Mental Hospital for Children. J. Bact., *48*: 29-30, 1944.

3. Felsenfeld, O. and Young, V. M.: Significance of Single and Multiple Shigella Infections in Institutionalized Children. J. Pediatrics, *25*: 56-67, 1944.
4. Felsenfeld, O. and Young, V. M.: Study of Human Salmonellosis in North and Souh America. Am. J. Trop. M., *29*: 483-491, 1949.
5. Goldman, M.: Use of Polyvinyl Alcohol to Preserve Fecal Smears for Subsequent Staining. Sci., *106*: 42, 1947.
6. Young, V. M., Felsenfeld, O., Shlaes, W. H., Yoshimura, T. and Steigman, F.: Laboratory Diagnosis of Intestinal Amebiasis with the Aid of Hematoxylin Stained Slides and the Zinc Sulfate Technic. Am. J. Digest Dis., *18*: 126-130, 1951.
7. Felsenfeld, O.: An Outline for the Identification of Salmonellas. Am. J. Clin. Path., *19*: 106-118, 1949.
8. Gradwohl, R. B. H.: Clinical Laboratory Methods and Diagnosis. 4th ed., C. V. Mosby, St. Louis, 1948.
9. Morrow, W. S., Lomberg, F. and Schroeder, W. F.: Salmonellosis. A Case of Human Gastro-Enteritis Attributed to S. pullorum. Am. Pract., *1*: 969-970, 1950.
10. Felsenfeld, O.: Notes on Salmonella cubana. Poultry Sci., *28*: 217, 1949.
11. Gordon, H. S., Hoffman, S. J., Schultz, A. and Lomberg, F.: Serous Arthritis of the Knee Joint. J. A. M. A., *141*: 460-461, 1949.
12. Felsenfeld, O.: The Salmonella Problem. Am. J. Clin. Path., *15*: 584-608, 1945.
13. Kessel, J. F., Parrish, M. and Cavell, K.: Shigella and Salmonella Encountered in Southern California. J. Bact., *49*: 552-523, 1945.
14. Edwards, P. R., Bruner, D. W. and Moran, A. B.: The Genus Salmonella. Kentucky Agric. Expt. Sta. Bull. No. 525, 1948.
15. Felsenfeld, O., Young, V. M. and Yoshimura, T.: A Survey of Salmonella in Meat, Eggs and Milk. J. Am. Vet. M. Ass., *116*: 17-21, 1950.
16. Hinshaw, W. R., McNeil, E. and Taylor, T. J.: Avian Salmonellosis. Am. J. Hyg., *40*: 264-278, 1944.
17. Darby, C. W. and Stafseth, H. J.: Salmonella Infections Common to Man, Animals and Birds. Proc. 46th Ann. Meet. U. S. Livestock San. Assoc., 189-202, 1942.
18. Bidwell, M. H. and Kelly, C. B.: Ducks and Shellfish Sanitation. Am. J. Publ. Health, *40*: 823-928, 1950.
19. Seligman, E., Saphra, I. and Wassermann, M.: Salmonella Infections in the U. S. A. J.: Immunol., *54*: 69-85, 1946.
20. Young, V. M.: Geographical Distribution of Shigella. Am. J. Trop. M., *27*: 293-299, 1947.

THE EFFECT OF DETERGENT COMPLEX ON THE RATE OF SECRETION OF GASTRIC JUICE AND ITS COMPONENTS IN TOTAL POUCHES OF THE STOMACH

OTTO E. LOBSTEIN AND SAMUEL J. FOGELSON, Chicago, Ill.

A COMPLETE change of the pattern of gastric juice secretion was demonstrated in unoperated dogs injected with histamine and fed detergent complex orally (1). The detergent complex was in direct contact with the gastric juice and cells lining the stomach. The present report is based on work performed to discover what would happen if a part of the stomach was completely separated from the gastro-intestinal tract, and the detergent complex still administered orally. In this case the detergent complex was never in direct contact with the gastric juice nor with the secretory cells of the part of the stomach from which collections were made.

The pouch used for the experiment was the Fogelson modification of a total Heidenhain pouch. In the preparation of such a pouch the stomach is cut across about 2/3rds up in the fundic region. The distal end is inverted, the proximal end narrowed and anastomosed to the jejunum to maintain the continuity of the alimentary canal. A second cut is made across the pylorus. The distal end is inverted and the proximal end (pylorus) brought out through the incision, through which gastric juice is collected.

The dogs were stimulated with histamine solution prepared as follows: 1 ml of Imido "Roche" 1:1000 solution of histamine dihydrochloride was added to 40 ml water, and about 0.5 ml of this dilution was injected subcutaneously into the necks of the dogs every 10 minutes. One and a half hours later gastric juice was collected at 20 minute intervals. If the first two or three collections were less than 3 ml, then 0.5 to 1.0 ml of the 1/40 diluted histamine solution was injected till an average of 3 ml of gastric juice was obtained for four consecutive collections. Histamine injections were continued throughout the entire experiment. After a constant level of secretion had been obtained, detergent

TABLE I

time, hours	Volume, ml	pH	n/10 HCl (tot.)	Pepsin units	Lysozyme/ml	Lysozyme total.	Medication mg RD11
1	27		39				
2	13		45				774
3	33		25				
1	13		14				2g on day
2	0		0				before, and
3	8		0				774
1	15	-10	8	33			1.5g on day
2	15	-8	20	43			before, and
3	9	-4	28	40			600
1	29	-10	7	0			1.5g on day
2	40	-10	35	24			before, and
3	35	0	43	48			600
1	-20	0	-25	0	25	22	
2	0	-15	-7	-41	9	10	600
3	4	23	0	-23			plus another
4	16	39	0	0			1.5g
4½	32	27	16	27			

Each figure represents the average of at least three determinations and is expressed as a percentage of the control values obtained before medication was started.

From the Departments of Chemistry and Surgery, The Medical School of Northwestern University, Chicago, Illinois.
Submitted Jan. 3, 1950.