

STUDIES ON BLOOD SPECTRUM

I. BLOOD SPECTRUM AS AN AID TO THE APPRAISAL
OF GENERAL CONDITION

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(Received June 2, 1956)

Progress in the quantitative analytic technique of biochemistry during the last two decades¹⁾ had culminated in invention of many convenient instruments, such for example as photoelectric colorimeter,¹⁾ which had simplified the performance of concurrent determination of the various chemical constituents with a small amount of blood in a short period of time and with a degree of accuracy required for clinical diagnosis. Attempts have been made for clinical application of the biochemical knowledge and techniques to bed side practice, as evidenced by several excellent textbooks recently published.²⁻⁴⁾

Introductoin of *blood spectrum* is especially noteworthy from the viewpoint of active utilization of data obtained from systematic blood chemical studies for every day clinics. In 1949 *Shibata*⁵⁾ designed a graphical representation of six chemical constituents of blood, namely blood hemoglobin, serum protein, icteric index, sodium chloride (AgNO₃ reaction), blood sugar and *Gros*' reaction, and obtained a connecting line of their values, which was observed to vary in shape in accordance with the difference of the general conditions of patients. He accordingly applied this connecting line as diagnostic aid to medical patients, designating it as *blood spectrum*.⁶⁾ Subsequently it was introduced into gynecology and obstetrics by *Okazaki*,⁷⁾ into pediatrics by *Fukuyama*⁸⁾ both with a certain degree of satisfactory results. Ever since it was used for clinical purpose, the blood spectrum has undergone a considerable improvement and the fields of its use enlarged until three years ago, when the determined values of twelve constituents of blood placed on a graph were subdivided into five parts for easy scrutinizing.^{4,9,10)} These blood constituents are blood hemoglobin, serum protein, albumin-globulin ratio, and blood sugar; icteric index and serum bilirubin; cephalin cholesterol flocculation test, and cholinesterase; alkaline phosphatase, cholesterol and phenol turbidity test, and non-protein nitrogen. After carefully studying this renovated blood spectrum, *Shibata*¹⁰⁾ has formulated the view as follows:- (1) The blood hemoglobin, serum protein, albumin-globulin ratio and blood sugar are helpful in the appraisal of patient's

general conditions, (2) the icteric index and serum bilirubin are of course useful for the detection of jaundice, (3) the cephalin cholesterol flocculation test, albumin and globulin in the serum, and serum cholinesterase will aid in discovering the parenchymatous damage to the liver, and (4) the serum alkaline phosphatase, cholesterol, and phenol turbidity test for revealing the biliary obstruction, whereas (5) non-protein nitrogen is useful for the diagnosis of a fairly advanced renal disturbance. Based on these views, *Shibata* concluded that the graphically represented line connecting these chemical constituents would enable the clinical biochemists to diagnose the diseases from a purely biochemical standpoint without any contact with the individual patients, if a satisfactory record of morbid history were available. Recently *Saito* and his associate¹¹⁾ successfully introduced the blood spectrum into dermatology.

For the past three years the data for blood spectrum have been accumulating in our laboratory with the total of 2003 medical, surgical, gynecological and other cases. Thorough examination of the data with special reference to those observations which were not hitherto made by *Shibata*¹⁰⁾ was therefore undertaken in the hope that the uses and limitations of blood spectrum in the clinical diagnosis might be evaluated more concretely and precisely. In the present paper the graph for the appraisal of general conditions alone will be dealt with for the sake of convenience.

METHODS

Shibata's connecting line for the appraisal of general conditions consisted of the points which represented the values of blood hemoglobin (Hb), serum protein (Sp), blood sugar (BS) and albumin-globulin ratio (A/G) as depicted in Figure 1. Of the four parallel horizontal lines in this figure the three pertaining to Hb, Sp and BS were graduated with the increased values to the right, while the one representing A/G was scaled to the left (in the direction opposite to the other lines). Since there is a difference in the normal range of hemoglobin concentration between the two sexes, the line of Hb was duplicated, and the graduation was adequately arranged so that the upper and the lower limits of the normal ranges of each ingredients might be arranged perpendicularly to the parallel horizontal lines, producing a rectangular space which indicated the normal area. A healthy person gave a connecting line which ran from the top to the bottom in the normal area, as shown by chart N in the figure, as all the ingredients fell into the normal range. In diseased person, on the contrary, the connecting lines become variously curved, some parts or all parts protruding beyond the normal area, as some of the blood constituents were abnormal in concentration. The line showed a L-shaped bending when A/G was subnormal (Chart L), a Z-shaped curve when both Hb and A/G were subnormal (Chart Z), or fell obliquely

downward from the upper left to the lower right when Hb, Sp and A/G were all subnormal (Chart F), and so forth, depending on the nature and extent of the alteration of blood constituents. These variations in the shape of connecting

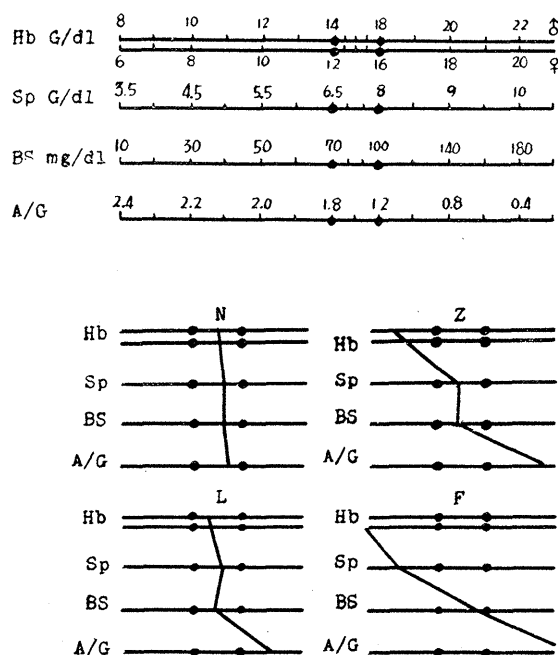


Fig. 1. Graph for the appraisal of general conditions and the patterns of the connecting lines (N: normal, L: L-shaped, Z: Z-shaped, and F: falling-sideways).

line were referred to as patterns N, L, Z and F by *Shibata*,^{4,10)} who has claimed the intimate correlation between the connecting line and general conditions of the patients, that is, the patterns N, L, Z and F correspond respectively with the impaired, the slightly or moderately impaired, the moderately or severely impaired, and the severely impaired general conditions in the order listed.

However, it is obvious that the connecting line may assume innumerable variegated forms, quite beyond the restriction of the four patterns; for this reason subpatterns were proposed by *Shibata*.^{4,10)} On that account the present author has instituted the following classification of connecting line: (1) group with normal (or abnormal) Hb and normal A/G, (2) group with normal Hb and subnormal A/G, (3) group with subnormal Hb and A/G, but with normal Sp, and (4) group with subnormal values of all Hb, Sp and A/G. The groups (1) to (4) thus defined will be designated in this paper as groups N, L, Z and F, since they comprized not only the patterns N to F as their typical cases

individually, i.e. the pattern N in the group (1), the pattern L in the group (2), etc., but also all the connecting lines of possible shape.

Blood hemoglobin, serum protein and albumin-globulin ratio were determined on 2003 cases (Table I) in order to construct the connecting line in a group

TABLE I

Diseases observed in this study

Diseases of organ system as classified on the basis of the principal sites of illness		Diseases commonly encountered in this study	
Liver	259 cases	Gall stone	147 cases
Stomach and duodenum.....	243	Infectious hepatitis	137
Lungs	211	Cancer of the stomach	135
Biliary tract	161	Pulmonary tuberculosis	113
Abdominal cavity excluding the liver, stomach and duodenum	158	Liver cirrhosis	79
Kidneys	149	Gastroduodenal ulcer	74
Heart	91	Enterocolitis	
Skin	86	(including dysentery)	63
Central nervous system.	85	Uterine cancer	59
Pancreas	85	Diabetes mellitus	55
Female genital organs	71	Circulatory failure	53
Others	404	Others	1008
Diseases as classified on the basis of the character of pathological lesion		Total..... 2003 cases	
Inflammation	855 cases	(including 1905 cases of the chronic diseases)	
Cancer.....	428		
Others	720		

of blood spectrum, and it was compared with the general conditions of the patients which were studied by the experts in internal medicine, surgery, gynecology, obstetrics and other specialties. Correlation tables were made with the patterns (or groups) of connecting lines and the general conditions which were graded as the slightly impaired, the moderately impaired and the severely impaired, as shown in Figure 2, and the coefficients of contingency¹²⁾ were calculated for correlation between them. In addition the correlation table was divided into the areas of hit and miss which referred to the favorable (H) and unfavorable (M) cases for conjecture of the general conditions from the patterns of the connecting line according to the conception of *Shibata*,^{4,10)} and the rate of hit

$$\frac{H}{H+M} \times 100\% \text{ was computed.}$$

The procedures employed for the determination of blood hemoglobin, serum protein, albumin-globulin ratio and blood sugar were cyan-hemoglobin method, refractometric method with HITACHI's protein meter,¹⁴⁾ sodium-sulfate-salting-

out method coupled with the colorimetry with biuret reagent¹⁵⁾ and colorimetric alkaline-copper-sulfate-arseno-molybdate method¹⁶⁾ respectively.

PATTERNS (OR GROUPS) OF CONNECTING LINES

	N	L	Z	F
slight				
moderate				
severe				

DEGREE OF IMPAIRMENT
IN GENERAL CONDITION

Fig. 2. Correlation table between the patterns (or groups) of the connecting lines and the general conditions. White and shaded areas represent the hit and the miss in the conjecture of general conditions by the graph.

RESULTS

The frequency distribution of the connecting lines in the severely ill patients who died within two weeks following the last examination of blood chemistry is depicted in Figure 3, in which the groups F and Z overwhelmingly outnumber the groups L and N. The same fact is further corroborated by scrutinizing Figure 4 which summarizes the correlation between the forms of connecting line and the general conditions of 2003 patients with various diseases (A and A'). The groups Z and F are therefore characteristic of the severely impaired general conditions, and they do not commonly appear in the slightly ill cases, which are usually separated in the groups N and L. The moderately impaired conditions which are rather more intimately associated with the groups Z and F than with groups N and L bear the intermediate character.

Inversely the frequency distribution of the three degrees of impairment of the general conditions in the individual patterns of connecting line changes from N to F through L and Z with advance in the degree of impairment of the general conditions. This tendency of correlation between the groups of connecting line and the general conditions of the patients is somewhat more evident in chronic cases than in acute cases, as can be seen from the comparison of (A) and (A') with (B) and (B') in Figure 4. The latter two represent 1905 patients

examined excluding the acute cases. The coefficients of contingency similarly confirm the concrete correlation, being 0.36 and 0.42.

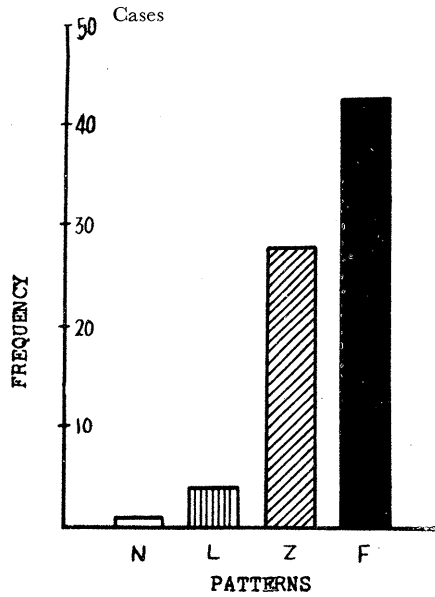


Fig. 3. Patterns encountered in the fatal cases of chronic diseases.

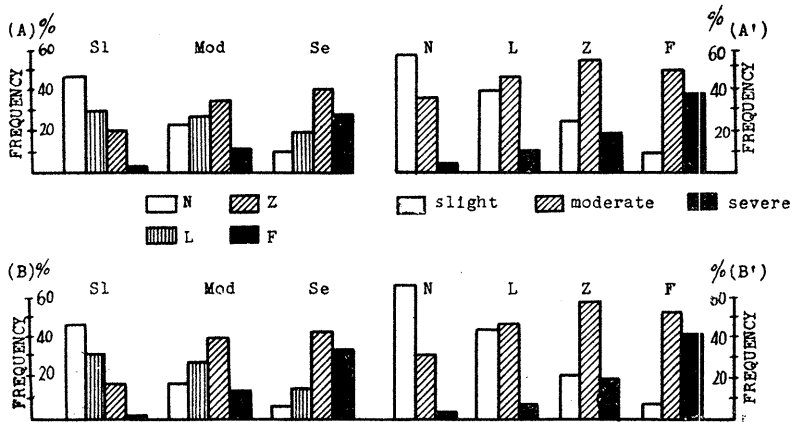


Fig. 4. Correlations between the patterns of connecting lines and the general conditions in various diseases. (A) and (A'): 2003 cases including acute and chronic conditions. Contingency index 0.36. Rate of hit 69.6%. (B) and (B'): 1905 cases with chronic diseases. Contingency index 0.42. Rate of hit 74.0%.

DISCUSSION

The result described above apparently sustain the view of *Shibata*^{9,10} who emphasizes the usefulness of the blood spectrum in diagnosis of the general conditions, but the relatively low value for the coefficients of contingency computed in the preceding section seems to require more cautious consideration. By calculating the rate of hit for estimation of general conditions from the connecting lines, assuming that the groups N,L, Z and F point to (1) slight, (2) slight or moderate, (3) moderate or severe, and (4) severe impairment of the general conditions, we obtained approximately 70 per cent hit. The hit rate for 2003 patients including all the cases observed in this study was 69.6, and for 1905 patients excluding the acute cases was 74.0% (Figure 4). Needless to say, the contingency coefficient varies to a certain extent with the different diseases. It was relatively high in the diseases of hepatobiliary system, the lungs, the bones and eyes, while it was low in the disorders in the domain of psychiatry, neurology, and of the pancreas and the thyroid gland (Table II). The coefficient

TABLE II

The contingency coefficients between the general condition conjectured by the connecting lines and that assessed by clinical expert, in conjunction with the rates of hit of the conjecture

	<i>Contingency coefficient</i>	<i>Rate of hit</i>
(Contingency index >0.4 and rate of hit >70 %)		
Diseases of the bones	0.58	78
Diseases of the muscle & subcutaneous tissue	0.58	75
Diseases of the liver	0.47	73
Diseases of the lungs	0.45	84
Diseases of the eyes	0.43	80
Diseases of the biliary tract	0.43	72
(Contingency index <0.4 or rate of hit <70 %)		
Diseases of the blood	0.59	65
Diseases of the heart	0.36	75
Diseases of the skin	0.36	75
Diseases of the abdominal organs excluding the liver, stomach and duodenum	0.35	64
Diseases of the female genital organs	0.33	73
Diseases of the kidneys	0.32	60
Diseases of the ears	0.27	73
Diseases of the central nervous system	0.26	53
Diseases of the thyroid gland	0.23	75
Diseases of the pancreas	0.21	59

was also large in hepatitis, gastroptosis, peritonitis, circulatory failure, hypertension, preurisy, pulmonary tuberculosis, bone fracture osteomyelitis, inflammation

of the urinary tract, cancer (uterus, breast and urinary tract), intoxication and the ophthalmologic diseases, although it was somewhat small in liver cirrhosis, rheumatism, enterocolitis (including dysentery), diseases of the thyroid gland, degenerative and inflammatory diseases of the brain, diabetes mellitus, nephrosis, renal tuberculosis, uremia, thoracic empyema, and the pancreatic diseases (Table III).

TABLE III

The contingency coefficients between the general condition conjectured by the connecting lines and that assessed by clinical experts, in conjunction with the rates of hit of the conjecture

	<i>C.I.</i>	<i>Rate of hit</i>		<i>C.I.</i>	<i>Rate of hit</i>
Contingency index > 0.40 and rate of hit > 70%					
Cancer of the breast	0.67	81	Preurisy	0.52	83
Bone fracture and osteomyelitis...	0.65	91	Inflammation of the		
Peritonitis	0.65	72	urinary tract	0.50	75
Hepatitis.....	0.62	83	Intoxication	0.50	72
Cancer of the biliary tract	0.61	79	Pulmonary tuberculosis	0.47	81
Cancer of the urinary tract.....	0.55	76	Gastroptosis	0.47	74
Hypertension	0.53	78	Circulatory failure	0.47	74
			Cancer of the uterus.....	0.45	80
			Ophthalmologic diseases	0.43	80
0.40 > Contingency index > 0.3 or 70% > rate of hit > 60%					
Cancer of the bone	0.59	62	Malignant neoplasm or inflammation		
Febrile diseases	0.40	63	of the muscle & subcutaneous tissue		
Banti's syndrom	0.39	75	0.32	68
Pulmonary cancer	0.35	65	Gastroduodenal cancer	0.32	67
Psychosis.....	0.33	62	Glomerulonephritis	0.31	57
			Gall stone	0.30	71
0.3 > Contingency index or 60% > rate of hit					
Degenerative diseases			Rheumatism	0.28	73
of the brain	0.65	48	Uremia	0.28	61
Hepatic cancer... ..	0.59	57	Thoracic empyema	0.25	79
Intoxication of the pregnancy.....	0.54	50	Liver cirrhosis	0.25	58
Gastroduodenal ulcer	0.44	57	Diabetes mellitus	0.24	64
Inflammatory diseases of			Enterocolitis		
the brain.....	0.38	40	(including dysentery)	0.24	62
Abdominal cancer	0.37	54	Nephrosis	0.20	38
Pancreatic diseases			Diseases of the thyroid gland ...	0.16	74
(inflammation & cancer).....	0.31	50			
Renal tuberculosis	0.29	62			

Discrepancy in the estimation of general conditions based on the inspection of the connecting line patterns as contrasted to the clinician's estimate is unavoidable in almost all diseases without regard to the magnitude of contingency coefficient. The estimation, for instance, frequently deviates falsely to the unimpaired side as compared with the purely clinical appraisal of general conditions in the diseases of the cardiology, psychiatry, neurology, dermatology, otolaryngology,

while it often fluctuates to the more severely impaired side in the diseases of kidneys and in gynecologic and obstetric disorders (Table IV). Similarly the

TABLE IV

Discrepancy in the estimation of general conditions based on the inspection of the connecting line patterns as contrasted to the clinician's estimate

	Cases in which connecting line deviated to unimpaired side as compared with the purely clinical appraisal of general conditions		Cases in which connecting line deviated to impaired side as compared with the purely clinical appraisal of general conditions	
	N-Se*	N-Mod L-Se	F-SI	F-Mod Z-SI
All cases	2 %	13 %	1 %	14 %
Chronic cases	1	11	1	13
Cancer	2	11	1	18
Inflammation	2	15	1	12
Others	2	15	2	14
Dermatologic diseases	1	36	1	4
Neuropathy and psychosis	11	25	1	11
Diseases of the circulatory system	2	15	0	8
Otolaryngology	3	7	0	7
Diseases of the muscle and subcutaneous tissue	0	17	0	8
Diseases of the biliary tract	0	17	0	11
Ophthalmologic diseases	0	12	0	8
Diseases of the thyroid gland	0	15	0	10
Diseases of the pancreas	2	20	1	18
Diseases of the bones	0	13	0	10
Diseases of the abdominal organs excluding the liver, stomach and duodenum	0	16	0	18
Diseases of the stomach and duodenum	3	14	2	16
Diseases of the lungs	1	8	0	11
Diseases of the blood	0	17	2	15
Diseases of the spleen	0	7	0	12
Diseases of the kidneys	0	15	5	19
Diseases of the liver	0	9	2	17
Diseases of the female genital organs	0	6	0	21

* NOTATIONS: N, L, Z and F refer to the pattern of connecting lines, while SI, Mod and Se indicate the general conditions impaired slightly, moderately and severely, respectively.

The notation N-Se is concerned with the patients whose general condition was assessed as the severely impaired by the clinical experts, whereas the connecting line of their graph was N in pattern.

N-Mod, L-Se, F-SI, F-Mod and Z-SI are to be interpreted similarly.

so-called hepatic disturbances, gastroduodenal ulcer, hypertension, enterocolitis (including dysentery), degenerative diseases of the brain, psychiatric diseases,

encephalitis, meningitis, diabetes mellitus, and the inflammation and the malignant neoplasms of the skin and subcutaneous tissue are liable to falsely designate better general conditions than actually, although liver cirrhosis, thoracic empyema, peritonitis, cancer of the uterus, nephrosis, uremia, and pancreatic diseases are prone erroneously to be represented as showing more unfavorable general conditions than actually (Table V).

TABLE V

Discrepancy in the estimation of general conditions based on the inspection of the connecting line patterns as contrasted to the clinician's estimate

	Cases in which connecting line deviated to unimpaired side as compared with the purely clinical appraisal of general conditions		Cases in which connecting line deviated to impaired side as compared with the purely clinical appraisal of general conditions	
	N-Se *	N-Mod L-Se	F-SI	F-Mod Z-SI
Inflammation & the cancer of the skin	0 %	32 %	0 %	0 %
Hypertension	5	16	0	3
Encephalitis & meningitis	20	27	0	13
Diabetes mellitus	4	25	0	7
Psychiatric diseases	7	24	2	5
Degenerative diseases of the brain	14	19	0	19
So-called hepatic disturbance	0	20	0	12
Gastroduodenal ulcer	5	22	1	15
Enterocolitis	2	24	0	13
Cancer of the bone	0	26	0	11
Cancer of the biliary tract	0	14	0	7
Pulmonary tuberculosis	2	9	0	9
Preuricy	0	18	0	8
Renal tuberculosis	0	23	0	15
Gall stone	0	17	0	12
Circulatory failure	0	15	0	11
Abdominal cancer	2	20	0	24
Glomerulonephritis	0	23	0	20
Cancer of the breast	0	9	0	9
Cancer of the urinary tract	0	12	0	12
Rheumatism	3	8	0	17
Diseases of the thyroid gland	0	10	0	11
Intoxication of the pregnancy	0	21	0	29
Pulmonary cancer	4	8	0	23
Hepatic cancer	5	10	5	14
Gastroduodenal cancer	3	9	2	19
Febrile diseases	6	6	6	20
Hepatitis	0	7	1	10
Uremia	0	13	4	22
Thoracic empyema	2	4	0	17
Liver cirrhosis	0	9	3	30
Pancreatic cancer & inflammation	0	10	3	37
Cancer of the uterus	0	2	0	19
Peritonitis	0	3	0	30
Nephrosis	0	7	21	35
Bone fracture	0	0	0	10

* Notations are the same as in Table IV.

General conditions as appraised from the connecting line pattern is accordingly not quite identical to the diagnosis made by clinical experts, but they agree with each other sufficiently to remain within the limits of usefulness to clinical medicine. Now, if we allow for illustration Hb, Sp and BS to be placed at the shoulder, the sides, the feet respectively of the letters representing the groups as shown in Figure 5, and let the black dots be placed to the right or left relevant

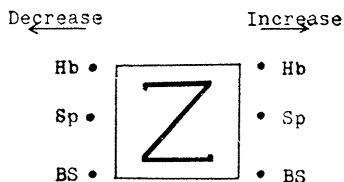


Fig. 5. Symbolization of the subpatterns of the connecting lines.

portions according to super or subnormal values of these blood chemical constituents, then a connecting line of the group Z which is composed of subnormal Hb, A/G and BS, and supernormal Sp will have the notation $\cdot Z$ in which dots placed on the right side and at the left foot signify an increase and decrease concentration of the serum protein and blood sugar respectively. In this manner it will be possible that all the probable patterns of connecting line are simply symbolized.

TABLE VI

Subtypes of the connecting line observed in various pathological conditions

PATTERNS	DISEASES											Total
	N	·N	N.	·N.	N·	·N	:N	N;	·N	·N	Others	
Cancer	24	18	3	8	2	1	3	2	2	1	6	70
Acute infect.	89	16	31	9	12	7	6	8	1	2	13	194
Chron. infect.	51	12	12	6	6	6	2	3	4	1	9	112
Others	154	55	52	22	20	20	18	14	11	12	24	402
Total	319	101	98	45	40	34	29	27	18	16	52	728

PATTERNS	DISEASES								Total
	L	L.	L·	·L	L;	·L	Others		
Cancer	52	22	14	4	4	3	10	109	
Acute infect.	92	51	27	14	10	5	16	215	
Chron. infect.	56	17	29	8	7	2	7	126	
Others	121	67	34	18	11	17	10	268	
Total	321	157	104	44	32	27	43	728	

PATTERNS	DISEASES										Total
	Z	Z.	·Z	Z·	Z;	Others	Total	F	F.	·F	
Cancer	103	52	16	7	4	2	184	62	28	6	96
Acute infect.	108	40	16	10	7	3	184	23	9	6	38
Chron. infect.	45	15	11	19	3	4	97	11	4	1	16
Others	137	56	14	17	8	2	234	66	26	11	103
Total	393	163	57	53	22	11	699	162	57	24	253

Table VI shows the frequency distribution of various pattern thus symbolized and classified. It is apparent from the table that in every group the patterns which have no accompanying dots outnumber those accompanied by dots, although group N is varied most in pattern, groups L and Z less, and group F least. Patterns N, L, Z and F will therefore be considered as the types of the patterns, and these will be distinguished from the others which may be regarded as their variations or subtypes. In this case the difference in the clinical interpretation or typical and atypical patterns in the individual groups of the connecting line becomes a matter of serious concern. Figure 6, which illustrates

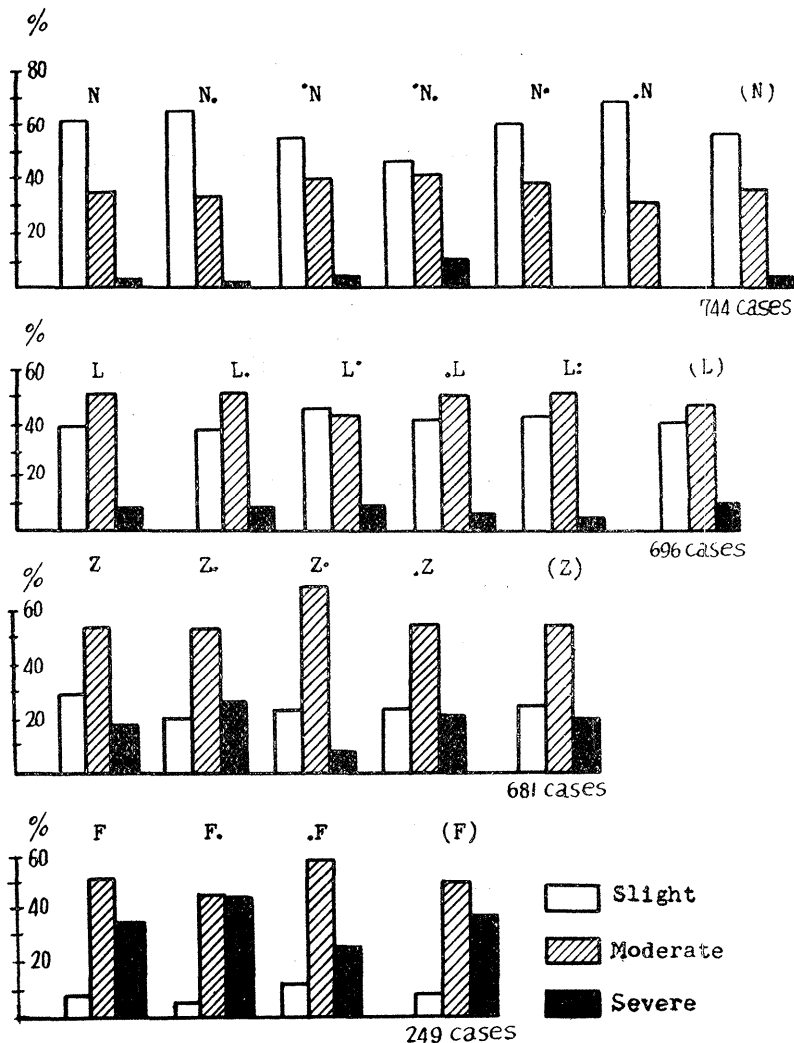


Fig. 6. The types and the subtypes of the connecting lines as compared with the general condition of patients. Letters in the bracket-(N), (L), (Z) and (F) - indicate the total cases of the relevant group including the type and the subtype patterns.

the correlation, discloses that the types and the subtypes are substantially the same with a few exceptions. But attention must be called to the fact that the subtype 'N. refers to the most impaired of the N. group, almost equaling the group L, and subtype 'N is also a little similar to it, while the subtype L is the most unimpaired of the group L, being nearly equal to the subtype 'N. Generally the patterns in the group N approach the group L when their accompanying dots are more than two, but in the groups L and Z no special significance is attached to the number of dots (Figure 7). The connecting line will therefore

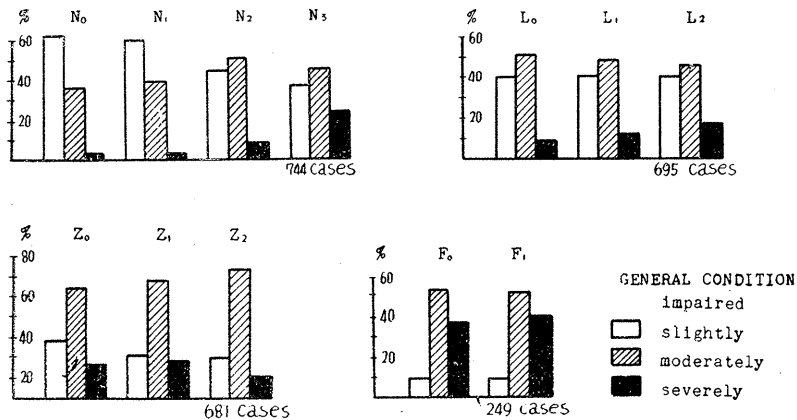


Fig. 7. Number of dots of the subtypes of the connecting lines in relation to the general condition graded as the slightly, the moderately and the severely impaired. The suffix of the notations N, L, Z and F indicates the number of dots.

be evaluated more adequately as an aid to the appraisal of the general conditions, if allowance is made for these exceptions.

Another important question concerns the fact that *Shibata's* classification of connecting lines has not taken into consideration the extent of the variation in the blood constituents. Among the type Z connecting lines there may be those which show a marked decrease in the Hb and A/G ratio and thus represent the model Z type, while there may be those which show only a slight decrease in Hb value, so that they resemble the group L rather than Z. There may be still others which Hb and A/G are both so close to their lowest limit of normal range that they may appear to belong more properly to the group N than Z. Whether or not all these groups should be included in the type Z seems certainly questionable. Consideration should be given to the degree of variation in the concentration of these blood chemical constituents in correcting the defect in the above classification.

The results of this corrected interpretation when compared with the clini-

cian's estimate showed 0.45 (coefficient of contingency) and 80% (the rate of hit) which is a significant improvement over the previous result shown in Table IV (Table VII). These figures are large enough to insure the reliability of the connecting line as the biochemical means for diagnosing the general condition of

TABLE VII

The results of the corrected interpretation of spectrum compared with the clinician's estimate

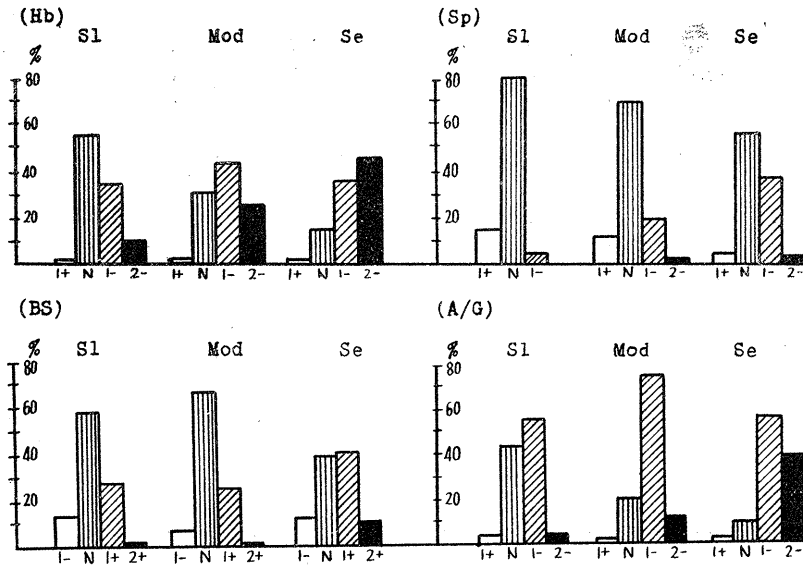
	Cases	Contingency index	Probable error	Rate of hit
All cases	2003	0.44	0.02	79%
Chronic cases	1789	0.47	0.03	80%
Cancer	428	0.45	0.01	80%
Inflammation	855	0.45	0.04	78%
Others	720	0.42	0.04	78%

patients, although they are not, of course, so significant as to substantiate the satisfactory agreement between the biochemical (blood spectrum) and the purely clinical diagnosis. A value of 80 per cent will not be too low for the rate of hit, if an allowance is made for the fact that clinical appraisal of general condition may not absolutely be trustworthy, as it is based on the instinctive and subjective interpretation of the clinical manifestations.

It will consequently be permissible to conclude that the blood spectrum furnishes a clinical biochemist who works in the laboratory with a useful means of diagnosing the general condition of patients without coming into contact with them. The interpretation advocated by *Shibata*^{9,10} that groups N, L, Z and F refer to the healthy or slightly impaired, the slightly or moderately impaired, the moderately or severely impaired, and the severely impaired states of general condition will contribute to clinical diagnosis, provided caution is properly paid to its limited exactitude.

There are some theoretical backgrounds for the possibility of diagnosing the general condition by the blood spectrum. Figure 8 shows the variations of Hb, Sp, BS and A/G, classified as slight and the considerable alterations, in the patients with slightly, moderately and severely impaired general conditions. It will be apparent from the figure that A/G undergoes an appreciable decrease even in the slightly ill patients, and falls rapidly with the increase in the aggravation of general condition. The change in Hb is similar, but less marked: the low Hb is uncommon in mild cases, although it is very common in moder-

ately or severely ill patients. The Sp either adheres to the normal range, or lies over the normal limits until the patients become seriously ill. Subnormal Sp is encountered in severe diseases, and it is exceptional in mild diseases. A/G affords



REFERENCE TABLE

	<2-	1-	N	1+	2+ <
Hb (G/dl)	<11	11-14	14-18	18-21	21 <
Sp (G/dl)	< 5.0	5.0-6.5	6.5-8.0	8.0-9.5	9.5 <
BS (mg/dl)	<40	40-70	70-100	100-160	160 <
A/G	< 0.6	0.6-1.2	1.2-1.8	1.8-2.1	2.1 <

Fig. 8. Frequency distribution of the fluctuation of Hb, Sp, BS and A/G in patients variously impaired in general condition. Sl, Mod and Se represent the general conditions impaired slightly, moderately and severely. (See Reference Table for the notations 1-, 2-, N, 1+ and 2+).

accordingly the most sensitive, Hb the moderately sensitive, and Sp the least sensitive indicator of the impaired general condition. Subnormal Sp is often an indication of serious illness.

Analogous results were obtained by several authors¹⁷⁻¹⁹⁾ who studied the protein metabolism in mal-nourished individuals. They observed that the inversion of A/G associated with the reduction in albumin concentration was the first of the phenomena which came into view when a person (or an animal) was

placed on a poor diet, the decrease in Hb concentration was the next, and diminution of the serum protein the last. Compensatory increase in globulin presumably resulting from the decrease in albumin was responsible for maintenance of normal protein concentration in the serum. Serum protein commenced to drop below the lower limit of normal range in an extreme malnutrition (cachexia) in which a compensatory increase in globulin was lost or no longer effective. It is therefore natural to suppose that malnutrition will advance in the order of patterns L (subnormal A/G), Z (subnormal Hb and A/G) and F (Hb, Sp and A/G are all subnormal), if the blood spectrum is applied to its study. In a sense the general condition is another aspect of nutritional state and vice versa. The connecting lines N, L, Z and F of the blood spectrum are thus reflecting the nutritional state as well as the general condition of patients. The fact that the contingency coefficient of connecting lines to general condition was higher in the chronic diseases which might entail malnutrition than in the acute illness which associated with little disturbance in nutrition will be accounted for from the same viewpoint.

SUMMARY AND CONCLUSION

Two thousand and three patients with medical, surgical, gynecological, and other diseases were examined for the concentration of blood hemoglobin, serum protein, blood sugar and the albumin to globulin ratio. Connecting lines were drawn in the graph according to the idea of *blood spectrum*. They were classified into the four groups, N (albumin to globulin ratio was normal), L (hemoglobin was within normal limits, but albumin to globulin ratio was subnormal), Z (both hemoglobin and albumin to globulin ratio were in subnormal range, whereas serum protein was maintained normal) and F (hemoglobin, serum protein and albumin to globulin ratio were all below the lower limit of normal range) to be compared with the impairment in general condition which was graded as slight, moderate and severe, and the following conclusions were arrived at:-

(1) Groups N, L, Z and F approximately correspond to the healthy or slightly ill, the slightly or moderately ill, the moderately or severely ill, and the severely ill conditions, respectively,

(2) Each of the four groups contained various patterns (a type and its subtypes) which nearly equivalent in clinical implication, but there were a few exceptions: patterns subtype 'N' and subtype L equaled the groups L and group N, respectively, as an indicator of general condition.

(3) In interpreting the grade of impairment in the general condition from the pattern of connecting line, a careful consideration must be paid to the degree of deviation of each constituent (hemoglobin, serum protein or albumin to globu-

lin ratio) from its normal range, construing larger deviation as being related to a more seriously impaired condition and vice versa: Contingency coefficient of 0.45 and the rate of hit of 70 per cent were obtained in this way between the connecting line and the clinically assessed general conditions.

(4) The rate of hit varied to a certain extent with the difference in the kind of diseases: it was satisfactorily high in the diseases of the liver and biliary tract, the lungs and, the blood and hematopoietic organs, especially in hepatitis, hepatic cancer, cancer of the biliary tract, and pulmonary tuberculosis, although it was relatively low in the diseases of the pancreas and the thyroid gland as well as in the patients belonging to psychiatry, neurology and otolaryngology. Gastroduodenal ulcer, hypertension, enterocolitis (including dysentery), cancer of the breast and diabetes mellitus were generally diagnosed by the blood spectrum as the more favorable than by the purely clinical examination; but liver cirrhosis, gastroduodenitis, thoracic empyema, peritonitis, uterine cancer, nephrosis, uremia, and pancreatic cancer were, on the contrary, showed a tendency to be judged as the severer than clinically,

(5) The blood spectrum is considered to provide the clinical biochemist with a useful means of diagnosing the general condition, even though he is in the laboratory without any information on the clinical manifestations of the patients. However, it is not beyond criticism, particularly regarding the slight ailment. The assured fact that the group N, instead of L, connecting line was associated with a considerable number of moderately ill patients, is an example. Indicators which are more sensitive to the slight illness than the albumin to globulin ratio is required to improve the efficiency in clinical diagnosis.

Grateful acknowledgements are due to Prof. Senji Uchino of the Department of Biochemistry, Kyoto University School of Medicine, for the preparation of manuscript, to Prof. Akira Matsumoto and Prof. Susumu Shibata of the Yamagu Medical College for their kind directions during the course of this study. Cordial gratitude is also expressed to the author's colleagues in the Department of Clinical Pathology, especially to Dr. Hiroshi Takahashi, Dr. Wataru Mizuta and Dr. Iwao Iuchi, for their help in collecting the materials.

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