ON THE STATISTICAL INVESTIGATION OF DIAGNOSIS IN THE INTERNAL MEDICINE

By SIGEKI SAKINO and UMEJI HIRATA

(Received February 10, 1955)

1 Introduction

The purpose of this paper is to apply a statistical method to the analysis of anamnesis and to construct the patterns of diagnosis from symptoms obtained by patient's appeals. They may be very useful not only for the analysis and forecasting of diagnosis, but also for the projection and improvement of items in anamnesis as shown in the former paper.

Therefore, our problem in this paper is to construct the patterns of diagnosis, so that the results may characterize the clinical medicine, and be useful for analysing the empirical phenomena.

In the following section, we shall construct the patterns of diagnosis using the symptoms efficients for diagnosis.

2 Forecasting of diagnosis by the patterns.

We have to reconsider the method of clinical diagnosis before we construct the patterns. For example, if a patient consults a doctor saying that he has symptoms "stomach-ache", "abdominal enlargement" and "eructation", the doctor will ask the patient: "Do you have symptoms high temperature and diarrhoea?" If the patient has these symptoms, the doctor will say to him: "Your disease seems to be the simple intestinal disturbance." If the patient has neither of them, the doctor will say to him: "Your disease seems to be the disturbance of digestive organs other than intestive." And the doctor will inquire whether he has other symptoms of disturbance of digestive organs other than intestive or not. Thus, the doctor reduces gradually the domain of diagnosis. Furthermore, the doctor examines by clinical tests whether his diagnosis is reliable or not.

By such an idea, the doctor makes a diagnosis to the patient, but statistically, by such an idea we determine the disease so as to minimize the two kinds of errors which will be mentioned below.

The data which we have analysed are the anamneses of the 2276

patients sent to the Tokyo Communication Hospital from January, 1947 to June, 1954. From these anamneses we must detect the symptoms which are statistically efficient for diagnosis. For this purpose, we must detect the symptoms which are not independent of diseases, that is, the symptoms which are found frequently in some specific diseases. As the result, we obtained the following 7 symptoms: "sense of strangulation or anxiety in the side", "palpitation or dyspnoea", "edema or abnormal urine", "abdominal symptoms (which consist of symptoms such as diarrhoea, stomach-ache, etc.)," "disturbance of nervous systems (which consist of unconsciousness, cramp, physico-disturbance and paresthesia)," "pain in the side" and "hemoptoe".

Because any other symptoms appear in proportion to the increase of the patient's number with respect to each disease, we can not adopt these symptoms as the conditions of diagnoses. In practice, when we are taken ill, we will be able to detect symptoms high temperature, exhaustion, etc. in all diseases, and therefore these symptoms are not efficient for diagnoses.

We want to construct the patterns, using the above 7 symptoms, and the idea of the constructing method is as follows. If neither sense of strangulation nor anxiety in the side appears (negative), neither palpitation nor dyspnoea appears (negative), and abdominal symptoms appear (positive) etc., the doctor says to the patient, "Perhaps your disease is disturbance of digestive organs". According to this way of diagnosis, we shall make the 2^7 combinations of the above symptoms, and from among these combinations we shall select the patterns of "disturbance of digestive organs or peritonitis", "disturbance of respiratory organ (which consists of tuberculosis, pneumonia, pleuritis, bronchitis and cold)", "heartdisease or kidneydisease", "neuropathia (which consists of hypertension, cerebral hemorrhage, cerebral tumor and encephalitis)". When we judge the patient's disease to be disease i or not, referring to n_i combinations which correspond to disease i, we consider statistically the two kinds of errors:

1. the error of the first kind with the rate α_{in_i}, where

$$\alpha_{in_i}=\frac{\text{the number of patients judged not to have disease } i \text{ among those having disease } i}{\text{the number of patients having disease } i}$$

2. the error of the second kind with the rate β_{in_i}, where

$$\beta_{in_i}=\frac{\text{the number of patients without disease } i \text{ and judged to have disease } i}{\text{the number of patients judged to have disease } i}$$

Table 1

	Sence of strangulation or anxiety in the side	Palpitation dyspnoea	Edema, abnormal urine	All abdominal symptoms	Disturbance of nervous system	Pain in the side	Hemoptoe
Disturbance of digestive organs	−	−	−	+	−	−	−
	−	−	+	+	−	+	−
	−	−	+	+	−	−	−
	−	−	−	+	−	+	−
Disturbance of respiratory organ	+	+	−	+	−	+	+
	+	+	−	+	−	−	+
	−	+	−	+	−	+	+
	+	+	−	−	−	+	+
	+	−	−	+	−	+	+
	+	+	−	−	−	−	+
	−	+	−	+	−	−	+
	−	−	−	+	−	+	+
	−	+	−	−	−	+	+
	+	−	−	+	−	−	+
	+	−	−	−	−	+	+
	−	−	−	−	−	+	+
	−	−	−	+	−	−	+
	−	+	−	−	−	−	+
	+	−	−	−	−	−	+
	−	−	−	−	−	−	+
	−	+	−	−	−	+	−
	−	−	−	−	−	+	−
	−	−	−	−	−	−	−
heartdisease kidney-disease	−	+	+	+	+	+	−
	−	+	+	+	+	−	−
	−	+	+	+	−	−	−
	−	+	+	−	−	−	−
	−	+	+	−	−	+	−
	−	+	+	−	+	+	−
	−	+	+	+	−	+	−
	−	+	+	−	+	−	−
	+	+	+	+	+	+	−
	+	+	+	+	+	−	−
	+	+	+	+	−	+	−
	+	+	+	−	+	+	−
	+	+	−	+	+	+	−
	+	−	+	+	+	+	−
	+	+	−	−	+	+	−
	+	+	+	−	−	+	−
	+	−	−	+	−	−	−
	+	−	+	+	+	−	−
	+	−	−	+	+	−	−
	+	−	+	+	−	−	−
	+	+	−	−	−	−	−
	+	−	+	−	−	−	−
	+	−	−	+	−	−	−
	+	−	−	−	+	−	−

Table 1 (Continued)

	Sence of strangulation or anxiety in the side	Palpitation dyspnoea	Edema abnormal urine	All abdominal symptoms	Disturbance of nervous system	Pain in the side	Hemoptoe
	+	−	−	−	−	+	−
	+	−	−	−	−	−	−
	+	+	−	+	+	−	−
	+	+	−	+	−	+	−
	+	−	+	−	+	+	−
	+	+	−	+	−	−	−
	+	−	+	+	−	+	−
	+	−	+	−	+	−	−
	+	−	−	+	−	+	−
	+	+	−	−	+	−	−
	+	−	+	−	−	+	−
	+	+	+	−	+	−	−
Neuropathia	−	+	−	−	+	−	−
	−	−	−	−	+	−	−

Then $(1-\beta_{in_i})$ represents the success rate of diagnosis as disease i when we say to the patient, "Your disease seems to be disease i, because your symptoms show one of the n_i combinations concerning disease i".

Now, we want to select n_i combinations for the patterns of disease i such that they minimize the errors α_{in_i}, β_{in_i}. Then we obtain the patterns as shown in table 1. We make a diagnosis using the patterns of the table 1, saying "Your disease seems to be one of pneumonia, pleuritis, tuberculosis, bronchitis, cold", or "Your disease seems to be either heartdisease or kidneydisease", etc.. The relations between

Table 2

diagnosis by physician / diagnosis by patterns	disturbance of digestive organs	disturbance of respiratory organ	heart-disease kidney-disease	neuro-pathia	re-maind-er	coinci-dence number with patterns	α	β
disturbance of digestive organs	707	39	25	7	49	827	0.164	0.145
disturbance of respiratory organ	66	547	18	23	61	715	0.213	0.235
heartdisease kidneydisease	17	23	136	14	31	221	0.458	0.385
neuropathia	6	3	12	153	9	183	0.362	0.164
subtotal	844	696	251	240	245	total 2276	mean 0.241	0.207

diagnoses by our patterns and diagnoses by physicians and the errors α, β are shown in table 2. For instance, the number of patients is 827 whose symptoms showed the patterns of the disturbance of digestives, and then the success number is 707, so $\beta=1-\frac{707}{827}=0.145$, $\alpha=1-\frac{707}{844}$ $=0.164$. Therefore, we could have the mean success rate 79.3 %, when we make a diagnosis using our patterns, if they should hold in general. This 79.3 % value is the maximum value we can make on the basis of patients' appeals. The sum of the success numbers on the diagonal is 1543, so the success rate is truely 67.8 % (=1543/2276).

3 Conclusion

We constructed such patterns of diagnoses as minimize the errors of the 1st kind and of the 2nd kind. Therefore, if the form of symptoms in some patient's disease should coincide with some of the above patterns, we could forecast it with the mean success rate 79.3 % saying "Your disease seems to be one of pneumonia, pleuratis, tuberculosis, etc." or "Your disease seems to be either heartdisease or kidneydisease,".... If the patterns in table 1 should hold generally, these patterns are applicable to general clinicians. But these results are of only 2276 patients, so it is necessary to test whether the patterns in the above table hold generally or not. This also depends on the future medical experiments.

THE INSTITUTE OF STATISTICAL MATHEMATICS
THE TOKYO COMMUNICATION HOSPITAL

REFERENCE

S. Sakino: On the forecasting of prognosis in pediatrics by a quantifying method. *Annals of the institute of statistical mathematics*, Vol. VI, No. 2.

ERRATA

These Annals Vol. VI, No. 3

P. 233, 1st line: read "Sense of Strangulation"
instead of "Sence of Strangulation ··· "

Vol. VII, No. 2

P. 70, 7th line from bottom: read "when the risk is allowed to be greater than 0.02 and Theorem II is preferable for large n."
instead of "when the risk is required to be ··· for large n."