GROUND OF MODEL FOR THE GENERALIZED CRITERION FORMING AT DIFFERENTIAL DIAGNOSTICS OF DERMATOLOGICAL DISEASES

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Abstract: The basic methods of decisions making in multi-criterion conditions are considered, from which the method of the weighed total for calculation of diagnostic indexes significance in differential diagnostics of dermatological diseases is chosen.

Keywords: dermatology, differential diagnostics, method of the weighed total, multi-criterion task.

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Introduction

The external cover of human body – skin – is the difficult arranged organ which executes protective and physiological functions. A skin is constantly exposed to influence of various physical, chemical, biological factors of external environment that is why pathological processes are developing in its. Quite often rise of dermatopathology is related to influence of endogenous factors or with rise of allergic reactions, or in other words with the increased sensitiveness of organism in relation to some matters [Беренбейн, 2000]. All this, and also wide prevalence of skin's diseases among the population is cause to actuality of differential diagnostics problem of dermatological diseases.

Urgency of the problem

Differential diagnostics of skin illnesses is based on complex estimation of anamnesis data, features of morphological changes of skin and mucous membranes, common state of patient and his subjective feelings. In everyday clinical practice the dermatologists quite often run into a situation, when discerning of reliable clinical diagnosis is difficult. It is explained by as by plenty of possible clinical displays of skin's pathology, by variety of the conducted laboratory researches, by existence rarely meeting symptoms and pathologies, so that many symptoms are characterizing diseases with different etiology and pathogenesis. A different importance of the symptom is not equal for different diseases, that still more complicates differentiation of diagnoses [Ананьев, 2005]. So in order to define a correct diagnosis it is necessary to take into account plenty of different diagnostic information, or in other words it is necessary to decide a multicriterion task.

Determination of significance of diagnostic indexes

Normative (formal) methods, which assume that an expert know the definite rational method of correct decision choice, are basic methods of decisions making in multicriterion conditions [Брахман, 1984]. Depending on the role of an expert in forming and grounding of importance of alternative diagnostic decision all formal methods divide by axiomatic, lines, methods of compensation, methods of thresholds of incomparableness and man-machine methods. From these methods for task of differential diagnostics of dermatological diseases direct methods are most useful. Due to such group of direct methods an expert can formulate of resulting significance of the given symptom for each disease as dependence on its estimations on private criteria without the theoretical grounds, and the parameters of this dependence (weight and expressed of symptom) are formed directly by the method of expert estimations [Кац, 2004]. For every disease there is the set of diagnostic indexes which fully describe one. A primary task is arrangement of criterions due to its importance.

The method of lexicographic arrangement of criteria is most simple. Thus the diagnosis which has more high estimation on the most essential criterion is most probably existing, that is far not always is true. Also this method does not allow take into account equivalent of some criterions.

The generalized importance as quantitative estimation of diagnostic index preference exists as most reliable. To find this value it is necessary to ground a deciding rule, due to which importance of index in space of private criteria $f(x_i)$ is formed on, i.e. to decide the tasks both of structural and parameters identification of function of importance:

$$U(x) = G\left[f_i(x)\right], \tag{1}$$

where G is operator determining the type of dependence,

$f_i(x)$ are private criterions characterizing expressed of one or another diagnostic index for patient,

$i = \overline{1,n}$,

n is number of diagnostic indexes.

Structural identification of any mathematical model, including functions of importance, supposes the necessity of decision of two associate tasks:

– selection of meaningful factors which influence on output data of these models;

– determination of structure or type of operator establishing a connection between input and output model data.

Parameters identification consists of determination of concrete quantitative parameters of model.

The decision of task of structural identification of model is related to formulation and verification of some hypothesis. In the case of differentiation of skin's diseases the type of function of generalized importance of diagnostic index $x \in X$ is determined by the values of private criteria $f_i(x), i = \overline{1,n}$, which characterize the decision, and in common case these descriptions are not equivalent, i.e. they have a different weight for an expert-physician. It does not eliminate that in special case weight of some criteria can be identical. It is also necessary to take into payment that diagnostic indexes are heterogeneous. Every diagnostic index has the dimension, intervals and scales of measuring, i.e. indexes are not comparable. Then a formula (1) can be written as:

$$U(x) = G\left[k_i, f_i(x)\right], \tag{2}$$

where,

k_i are isomorphic parameters i.e. parameters with mutual univocal correspondence, bringing heterogeneous private criterions $f_i(x)$ into the single metrics and taking into account their weight.

The isomorphic parameters are set directly by an expert-physician in a numeral view by the expert estimations method.

Determination of structure – in other words type of operator establishing a connection between input (for example, weight and expressed of symptom) and output (for example, importance) data is a next step. For authentication of operator's type additive and multiplicative forms are most widely used [Петров, 2003].

Because the isomorphic parameters are constants multiplicative form of G operator authentication

$$U(x) = \prod_{i=1}^{n} k_i f_i(x) \tag{3}$$

is possible to represent in view

$$U(x) = \prod_{i=1}^{n} k_i \prod_{i=1}^{n} f_i(x). \tag{4}$$

$\prod_{i=1}^{n} k_j$ is a permanent scale multiplier and consequently all criterions become equally important, that is not true.

Thus a multiplicative form does not allow taking into consideration information about private criterions preference.

Inadmissible of complete indemnification of one parameters of other is another feature of multiplicative form. If even one of multipliers is equal 0, all multiplicative function takes on a zero value. And in the case of differential diagnostics of dermatological diseases the unexpressed at the patient of one or another diagnostic index which usually are characteristics for this pathology does not eliminate this pathology from consideration. It shows that

the multiplicative form of G operator identification is inapplicable at determination of diagnostic indexes importance in dermapathology.

In contrary of multiplicative form, additive form of operator dependence index's importance from its weight and expression for a patient

$$U(x) = \sum_{i=1}^{n} k_i f_i(x) \tag{5}$$

does not have the afore-named demerits. However formula (5) is correct only in case when k_i are considering both as weight of i-th diagnostic index and the coefficients of isomorphism. In common case determination of such coefficients is complex difficult task. This trouble can be overcame if to represent an additive function in a form

$$U(x) = \sum_{i=1}^{n} \delta_i f_i^H(x), \tag{6}$$

where δ_i are dimensionless coefficients characterizing weight of i-th diagnostic index for concrete pathology for which limitations are executed for:

$$0 \le \delta_i \le 1, \tag{7}$$

$$\sum_{i=1}^{n} \delta_i = 1; \tag{8}$$

$f_i^H(x)$ are normalized, i.e. the private criterions represented in isomorphic view [Ларичев, 1996]. In the case of dermatological differential diagnostics, estimations of emphasis of one or another diagnostic index at a patient can be considered as criterions $f_i^H(x)$. Isomorphism of private criterions means that they have an identical dimension and interval of possible values. Cause on determination δ_i are dimensionless coefficients, a dimension $f_i^H(x)$ must coincide with a dimension of $U(x)$, i.e. $f_i^H(x)$ characterizes local importance of i-th diagnostic index x for concrete pathology:

$$f_i^H(x) = p_i(x). \tag{9}$$

In accordance with (9) a function (6) will take view:

$$U(x) = \sum_{i=1}^{n} \delta_i p_i(x). \tag{10}$$

Method of private criterions importance determination based on application of dependence operator in additive form named the method of the weighed sum.

As well as for all direct methods, for the method of the weighed total rigorisms to the experts are characteristic, especially on the initial stages of work at forming of expert estimations.

The model of evaluation (10) is just only in case when the weight coefficients δ_i of private criterions $f_i^H(x)$ are set by the exact quantitative values. As it was already marked, experts-physicians are such data carriers, and it means that some procedures of its receipt are needed, i.e. parametrical identification of model is required. In order to decide this task principle of associative, method of communications between symptoms and syndromes, method of causal communications of symptoms with syndromes on contiguity in time is applied. For the decision this problem the most effective is complex application of different methods of analysis and account of knowledge of experts-physicians.

If on some reasons receipt of exact quantitative information about diagnostic index it is not possible, in general case the evaluation has to be produced in the conditions of greater or less degree of uncertainly. It is possible in the case of differential diagnostics in the group of rare insufficiently known diseases of skin. In this case the general model of determination of generalized importance of index $x \in X$ has the view:

$$U(x) = G\left[J(\alpha_i), p_i(x)\right], \tag{11}$$

where,

$J(\alpha_i)$ - information about mutual importance of private criterions.

Conclusion

It is possible to do a conclusion, that a plenty of methods of decision of the multicriterion tasks oriented to the concrete problem situations is presently developed. Application of one or another method is conditioned by the expert's role in forming and ground of alternatives value.

For estimation of significance of diagnostic indexes at differential diagnostics of dermatological diseases the additive weighed total method is recommended to use.

Adduction of all indexes to isomorphic view is the feature of this method.

Application of this method will allow to and to improve quality of differential diagnosis discerning and facilitate working tasks of doctor-dermatologist.

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