Algorithms aiding the diagnosis of the most common stomatitises in children - a basis for the „*SmartOralHerpeticDiagnostic*" computer programme

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Summary:
Dental informatics is a quickly developing field in dental science and practice. The first Bulgarian computer programme "aiding decision-making" - *SmartOralHerpeticDiagnostic* – is created through developing special diagnosing aiding algorithms – a finite number of accomplishable opretations leading to the solution of a certain clinical task. Here are the basic types of algorithm developed:

- Algorithm aiding the diagnosis of primal herpetic infection caused by VHS-1;

- Algorithm aiding the diagnosis of oral lesions in the case of herpetic gingivostomatitis;

Algorithm aiding the diagnosis of oral viruses diseases.
The block-schemes of the algorithms are shown and their usage in the process of diagnosing is commented.
Key words - Dental informatics, algorithm, block-scheme, primal herpetic infection, oral mucose lesion.

Introduction. Motivation

Dental informatics is a quickly developing field in dental science and practice. It represents an application of computer and infromation technologies in the administration of the dental practice, in the improvement and advancement of the clinical practice, in the educational process in dental medicine and in different scientific researches [7,9].

The most interesting part of the clinical computer programme products are the so called "Programmes aiding clinical decision making". This type of programme aids decision-making in both diagnosing and treatment. The new computer programmes are a manifestation of intellectual potential, clinical experience and contemporary computer technologies. They enrich the process of diagnosing, as well as the process of taking specific clinical decisions [10].

Clinical experience is the oldest and most important possession of medicine. It is the epitome of professionalism software products can make available to every practitioner. This is especially important in the case of diagnosing more complicated clinical cases.

The computer programmes under consideration can be active or passive, in accordance with the type of solution they offer: active programmes only give guidelines, the expert being the one to take the final decision, while passive programmes offer ready-made decisions on the basis of concrete clinical data [7].

The programme products that only "aid clinical decision-making" are relatively rare in the world's dental practice. Such applications use information resourses that are pret-

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ty hard to get transformed into a software product [10].

Such a type of programme was created in our country in 2007. It is the ***SmartOral HerpeticDiagnostic*** programme. It is the first Bulgarian computer programme "aiding clinical decision-making", its authors being Maria Georgieva and Maya Rashkova. The computer programme deals with diagnosing the oral mucous pathology in children. Stomatitises are conditions that are not that common in the dental practice and are more difficult to diagnose because of the unclear, in most cases, etiology [11,13].

Method of working out the "decision-making aiding" programme - *SmartOralHerpeticDiagnostic*

How to turn clinical experience and knowledge into a software product?

The first step was the collection, systematisation and statistical processing of a great data-base with clinical material. This task was accomplished within a scientific work entitled "Oral herpetic infections and recurrent aphthae in children" [12, 14, 15, 16, 17].

The second step was the development of algorithms. Now that we live in the age of computer technologies and internet communication the term algorithm is a household word. Experts know that the concept is a pretty specific one, though. Algorithms are a sequence of accomplishable operations bringing about the solution of a problem. The word is of Arab origin and is ascribed to the Asian mathematician Mohammed ibn Mousa al Horesm who lived in the first half of the IX c. In the first half of the XII c. his book reached Europe under the title "The Indian art of computing, an opus by al Horesm. As a pattern of thinking, algorithms can be applied not only in mathematics but also in every field of human activity. Every field of human activity can be algorithmatised – broken up into simple and easily accomplishable actions, this making possible algorithms-based decision-making.

As we studied the method of diagnosing in medicine it turned out that the process of diagnosing can be algorithmatised through the use of concrete information and data from clinical observation. Clinical diagnostics is a very specific medical activity. However complicated it is, it can be reduced to a system of simple clinical questions evoking the arrival at consecutive partial decisions bringing about a final decision – the arrival at a correct diagnosis [13].

The third step in the development of the computer programme was the description of the algorithms with the help of a programme language. Turning the algorithms into a software product is the most complicated part of the collaboration between the programmer and the clinical specialist. Thus the ideas and conceptions of the clinical dental specialist can be objectivised in terms of a computer language with the help of a software expert. Applying ***SmartOralHerpeticDiagnostic*** to a very specific field of dental medicine diagnosing, namely to oral mucous pathology diagnosing, makes it possible for the dental specialist to arrive at a correct diagnosis by means of only following and marking the answers deemed probable. The descriptions of the specific oral mucous lesions – indicative of specific medical conditions – are what the process of decision-making is based on [11].

Development of algorithms for clinical diagnosing of oral mucoses diseases in children

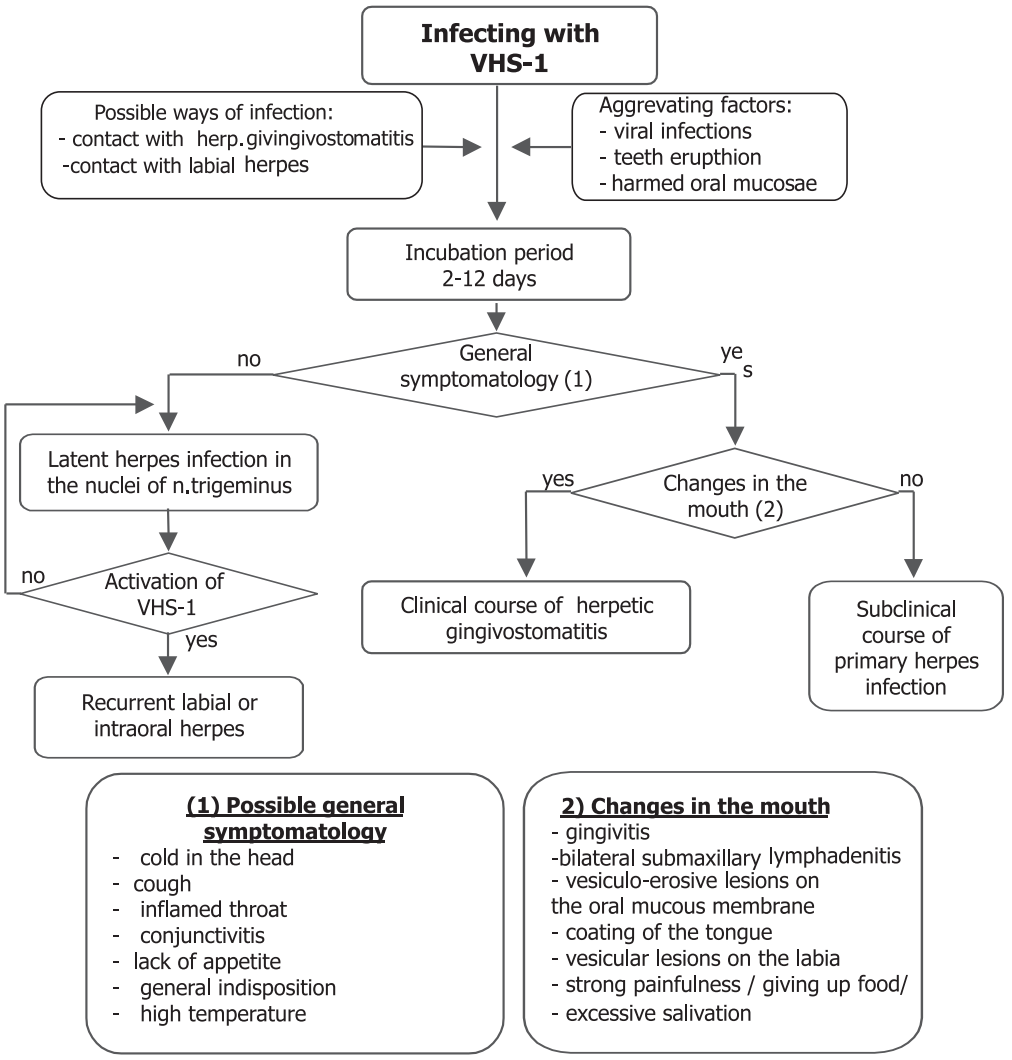
The clinical diagnosing of the most common illnesses of the oral mucous membrane in children is generalised in three algorithms, the block-schemes of which are described in the present article. The development of each algorithm followed the steps comprising the clinical process of though. So that a correct diagnosis could be arrived at, the circle of possible causes for each condition was narrowed, possible but incorrect diagnoses being systematically discarded. If an algorithm is to be developed proofs for all possible variants of diagnosis must be available, the degree of likelihood being redetermined with the analysis of each newly emerged symptom. Here are the basic types

of algorithm developed:

- Algorithm aiding the diagnosis of primal herpetic infection, caused by Virus Herpes Simplex (VHS-1).
- Algorithm aiding the diagnosis of oral lesions in the case of primal herpetic gingivostomatitis.
- Algorithm aiding the diagnosis of oral viroses.

1. Algorithm aiding the diagnosis of primal herpetic infection caused by VHS-1

Ther first block scheme is an algorithm aiding the diagnosis of primal herpetic infection [1]. This infection is at the basis of primal herpetic gingivostomatitis. In the case of the algorithm under consideration sharp herpetic gingivostomatitis is considered from the point of view of the cause for the infection, i.e. from the point of view of VHS-1. Sharp herpetic gingivostomatitis is collated with the other two variants of clinical manifestation or lack of manifestation of the primal contact of the herpetic virus with the child's organism. As a result, a comprehensive clinical picture of the sharp herpetic gingivostomatitis is arrived at, the specific symptoms being infered from previous clinical examinations of ours [3, 5, 8].



Block scheme No. 1 - Algorithm aiding the diagnosis of primal herpetic infection caused by VHS-1

Fig. 1. Children with primal herpetic infection caused by VHS-1

The algorithm shows that the detal doctor has to take three basic steps to arrive at the right diagnose.

The first step is detecting the beginning of the condition, i.e. finding the sourse of infection – the herpetic virus.

Considering that the incubation period is 2-12 days, the presence of VHS-1 must be determined, along with the presence of some factors that in combination with VHS-1 can contribute to the probability of clinical occurrence of the infection. The presence of at least one positive answer in the two groups of questions within the 2-12 day period before the early symptomatology allows taking the second step in the block-scheme.

The second step aims at finding out whether the infection with herpetic virus has caused a clinical picture typical for sharp herpetic gingivostomatitis or for the other possible condition caused by the virus: the subclinical or labial course of infection. At this stage, all possible positive answers from the first step are divided into two basic groups:

The first group includes the cases with no symptomatology. This is the so called latent form of herpetic infection. The virus here stays in a latent condition in the nuclei of n.trigeminus without causing any clinical manifestation of the illness. In such cases, when the conditions are right, the virus can be activated any moment. There we can usually see recurrent labial herpese and, more rarely, intraoral herpes.

The second group includes the cases in which we can give a positive answer to the question for symptomatology [1]:

- cold;
- cough
- inflamed throat;
- conjunctivitis;

- lack of appetite;
- general indisposition;
- high temperature.

The third step in the process of diagnosing is ascertaining the typical changes in the mouth[2]:

-gingivitis;

-bilateral submaxillary lymphatitis;

- vesiculo-erosive lesions on the whole oral mucous membrane;
- whitish coating of the tongue;
- vesicular lesions on the labia;
- strong painfulness /giving up food/;
- excessive salivation.

In accordance with the answers to the questions [2], the cases bifurcate once again: If the answer is negative, i.e. there are no changes in the oral mucous membrane, it can be assumed that the primal herpetic infection is going off subclinically. Because of the not typical symptomatology, the subclinical course of the primal herpetic infection is hard to ascertain. It is a fact, though, that in 90% of adults antibodies against VHS-1 are ascertained. Hence the possibility for an infection taking its course, as the relevant literature has is.

In the case of a positive answer at the third step, when all the enlisted changes in the mouth cavity are present, sharp herpetic gingovostomatitis can categorically be diagnosed. Once a clinically manifested primal herpetic infection, with oral lesions, has been ascertained, the process of diagnosing must go to its next stage – the diagnosing of the oral lesions in sharp herpetic gingivostaomatitis.

2. Algorithm aiding the diagnosis of oral lesions in the case of herpetic gingivostomatitis

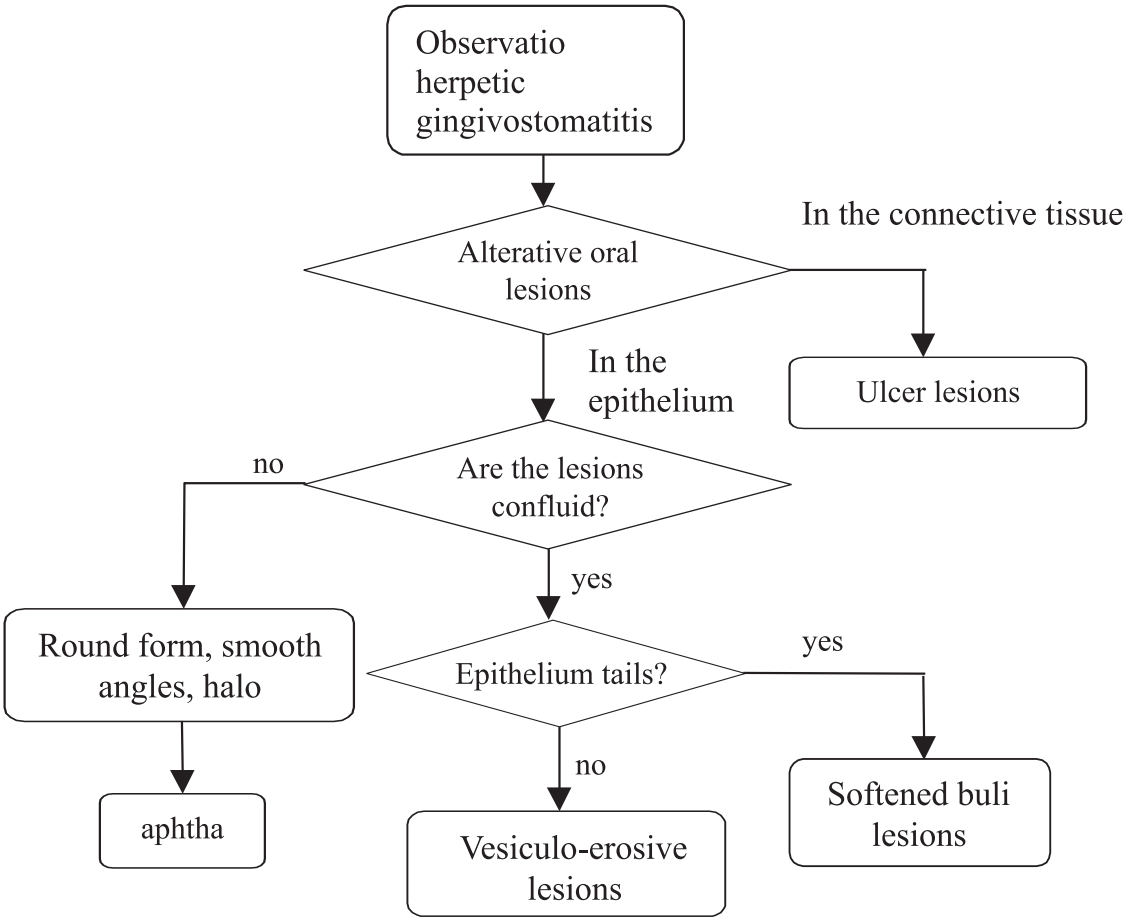
This algorithm aids the assessment of the type of oral lesion, this being the most important clinical decision if the differential diagnosing of herpetic gingivostomatitis is to take the right course. According to the type of inflammation reaction, the oral lesions can be exudative (vesicular or buli), alterative (erosions, ulcers or aphthae) and hyperplastic. In the case of herpetic oral infection the initial lesion is vesicular. Because of undergoing softening within the process of chewing in the mouth cavity the lesion gets disrupted and turns into erosion. The lesions in herpetic stomatistises are secondary alterative lesions and are called vesiculo-erosive.

This block-scheme is the key to the differential diagnosis of oral lesions. So that a diagnosis of herpetic gingivostomatis can be made, the oral lesions must answer certain criteria. In the first place the oral lesions in viral stomatitises are characterised by superficial secondary alteration of the oral mucous membrane. Depending on their depth, the oral lesions are lesions of the epithelium and lesions of the connecting tissue. If the oral lesions are in the connecting tissue, they are ulcer lesions. They are usually specific of the ulcero-necrotic gingivostomatitises.

Changes in the gingivae prevail here as a result of a bacterial fuso-spiral simbiosis, which is the etiological factor for the condition.

If the oral lesions are in the epithelium, we proceed to the second step at which we ascertain the size, form and angles of the lesions, these features being indicative of a process of confluence. If the oral lesions are not confluent - are round with smooth angles and a red halo around - and are localised mainly on the movable mucous membrane, we diagnose aphtha[2, 4].

If the oral lesions show signs of confluence – irregular outlines, lack of halo, have a common red base and are discovered all over the mucous membrane – we proceed to the third step – determining the size of the lesions and the presence of bigger tails – the result of ruptured epithelium. If such tails are discovered and are localised mainly in the vestibule of the mouth cavity, we assume the presence of softened bullous lesions, characteristic of the dermato-bulloses, which are often found



Block scheme No. 2 – Algorithms aiding the diagnosis of oral lesions in the case of herpetic gingovostomatitis

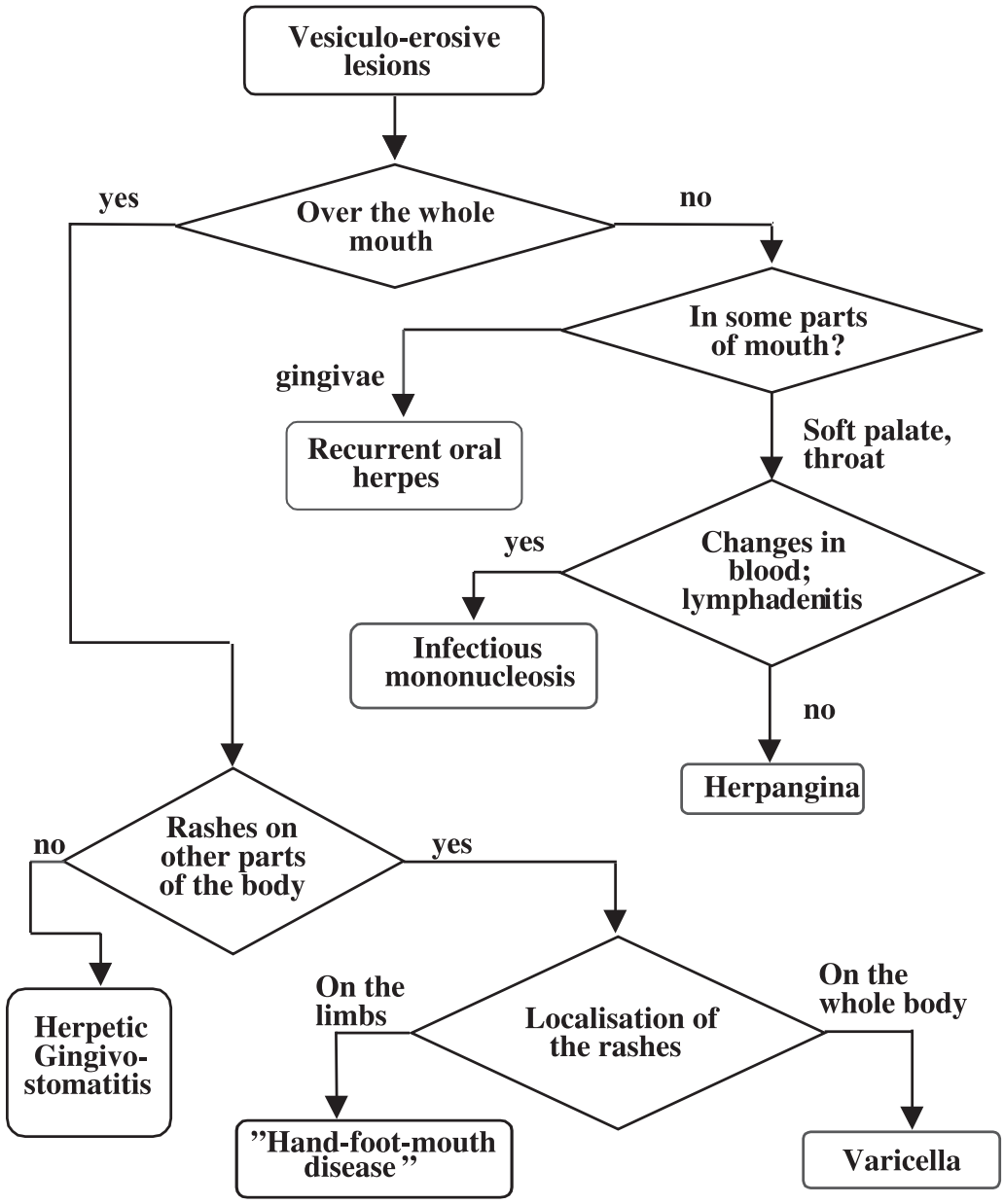
in the mouth too. If tails are absent and oral lesions are found on smaller eroded surfaces throughout the whole oral membrane, the following diagnose can be made – vesiculo-erosive lesions, characteristic of a big group of oral viroses, the sharp herpetic gingivostomatitis inclusive. Hence the question: How to to distinguish between the different illnesses in the group of oral viroses?

3. Algorithm aiding the diagnosis of oral viruses diseases

The third algorithm helps us get the answer to that question. By means of it, a differential diagnose is made of specific different oral viral conditions.

The first step of this block-scheme allows us to ascertain whether the whole oral mucous membrane is covered with vesiculo-erosive lesions. If the answer is negative, the concrete localisation of the lesions must be ascertained. If the lesions are in the gingivae, recurrent intraoral herpes is diagnosed. If the vesiculo-erosive lesions are localised mainly on the soft palate and the throat, changes in the blood count and the presence of generalised lymphatitis must be looked for. If the last two symptoms are not present, the condition we diagnose is herpangina. If the last two symptoms are present, what we have is infectious mononucleosis[6].

If the vesiculo-erosive lesions cover the whole mucous membrane, the left arm of the block-scheme is followed the second step requireng a answer to the question: Are there rashes on other parts of the body? If the



Block scheme No. 3 - Algorithm aiding the diagnosis of oral viruses diseases

lesions are only in the mouth, sharp herpetic gingivostomatitis is diagnosed and treatment can be started.

If vesicular rashes are found in other parts of the body too, the third step is taken – localisation of the rashes. If the rashes cover the whole body, the child is suspected of varicella. If the rashes are on the palms of the hands and on the feet, what we have is "Hand-foot-mouth" disease.

Conclusion

Sticking to the algorithms proposed - aimed at aiding the diagnosing of the most common illnesses of the mucous membrane in children, each dentist can arrive at the right diagnosis and then conduct the right treatment.

It was our aim to transform subjective clinical diagnosing into a consistent system of consecutively applied objective criteria and indexes, thus reducing to a minimum the possibilty of making a mistake due to a subjective assessemnt of the facts.

Illnesses of the oral mucous membrane are the result of a disturbance in the complex balance between the organism and the environment. Because of the diversity of similar clinical symptoms, which moreover change within the process of development of the condition, the oral mucous lesions are difficult to diagnose.

Oral mucous lesions have frequently specific individual characteristics that can only be underestood and classified with the help of a long clinical experience.

The drawing up of the present complex system of oral pathology, of objective criteria and indexes, as well as their systematisation for programming is the basis for the next step – the working out of ***SmartOral HerpeticDiagnostic*** computer programme. The programme itself and the work with it will be the object of our next publication. The programme and the guide to it can be found with the monograph „Oral herpetic lesions in children and adolescents"(author: M. Rashkova).

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