Differential-Diagnostic Algorithm As a Teaching and Diagnostic Method in Cardiological Practice

Leonid B. Naumov, MD, PhD, DScMed
Center for Medical Decision Making, Faculty of Health Sciences, Ben-Gurion University of the Negev, Aesculapius Medical Expert Systems Ltd. *Beer-Sheva, Israel.*

Principles and features of Differential-Diagnostic Algorithms

The term "diagnostic algorithm" used incorrectly very often, when the "algorithm" is used for the only disease diagnosis, e.g. myocardial infarction [1], aspergillosis [2], anorexia nervosa [3] traumatic aortic injury [4], gastric cancer [5], oral cancer [6], pulmonary embolism [7], venous thromboembolism [8] diabetes [9], ectopic pregnancy [10], chronic tonsillitis [11], etc. It is obvious that above mentioned and many similar cases are the final diagnoses, i.e. the results of a diagnostic problem decision, but not initial conditions, when a patient with unknown diagnosis appears, and primary differential diagnosticis is needed. It is impossible in principle to develop a diagnostic algorithm for the only disease.

Since the ambiguous serious situation takes place with the term and the meaning of the algorithm, it is necessary to consider the four main characteristics of the true algorithm. This task has not a theoretical or terminological sense but carries a very important practical clinical meaning.

"Differential diagnostic algorithm (DDA) and Algorithmization of Diagnostic Decision-Making (DDM) is the exact comprehensible prescription for stepwise fulfillment of elementary intellectual operations and actions in the optimal sequence for establishing of diagnosis of all or majority of the most important diseases, manifesting by given leading syndrome.

The true Differential Diagnostic Algorithm (DDA) has the following main features:

Yazışma Adresi: Leonid B. Naumov, MD, PhD, DScMed Center for Medical Decision Making, Faculty of Health Sciences, Ben-Gurion University of the Negev, Aesculapius Medical Expert Systems Ltd. Beer-Sheva, Israel.

1. Definiteness, i.e. simplicity and having a single meaning of its intellectual operations step-by-step.

2. Mass character, i.e. given algorithm should be applicable to all diseases manifesting by given leading syndrome.

3. Efficiency i.e. obligatory establishing of the diagnoses of all diseases, for which the given algorithm is designed (under the condition of correct recognizing of symptoms/signs contained in the algorithm).

4. Partition of process of diagnostic thinking on elementary clear intellectual diagnostic operations located in an optimal sequence.

Listed features of an algorithm require some explanations, taking into account the previous experience and publications [12-14, 15-24].

1. Medical information is not simple and has not a single meaning. For example, you could ask a group of the students or doctors to examine patient and to establish the diagnosis. The task can be simpler, e.g., to carry out the auscultation of a heart and to interpret diagnostically the heard signs. The different members of the group will present various results.

Such situation is observed frequently in practice of medical group consultations when even experienced doctors have detected different symptoms/signs (s/s) and have established the different diagnoses at the same patient.

2. Nosologic classification of illnesses is unsuitable for universal mass diagnostics of the whole class of diseases. It is impossible to create a DDA for diagnostics of the e.g. acute MI, although, just this surprising situation has been presented in the literature.

For this reason, the syndromic principle of diagnostics is the only basis for development and use of DDA. Each class of diseases is precisely designa-

ted by given concrete syndrome. The different classes of illnesses are precisely differentiated (intersyndromic differential diagnostics). Then the same task for diagnostics of the AMI looks completely different. Not as the DDA for the AMI diagnostics but as the "Differential diagnostics of diseases manifested by acute chest pain". As such, decision-making of a diagnostic problem by means of algorithm will recognize all diseases, accompanying by this syndrome including of the AMI as well.

3. It is generally known, that the diagnostic efforts of a doctor can remain without result, i.e. the diagnosis is not established (zero result) despite of spent efforts, time, many of different examinations, etc., or the diagnosis has appeared wrong (erroneous result). In any case a required result (correct complete diagnosis) has not been achieved.

DDA provides the efficiency of a task decision, i.e. establishment of the final correct diagnosis. The only basic requirement is a correct detecting in a patient the s/s, which are presented in the algorithm. It is clear; if the s/s are detected incorrectly then the diagnosis will be erroneous.

4. The partition of a complex process of diagnostic thinking to the elementary consecutive operations is one of the most important conditions of the successful decision of typical tasks. The diagnostic decision process has been divided up to such small simple elementary steps-signs, that the opportunity of a mistake at any decision level is very small. As a whole the successful decision of very complex intellectual diagnostic task is reached step by step in optimal sequence.

A DDA is not something completely new in clinical medicine. Its creation is based on the well-known standard examinations, symptoms and diagnoses of diseases. However, a DDA is the qualitative new achievement in a clinical thinking. That is why the use of the algorithm for practical diagnostics of diseases gives the new unusual results in principle.

The new quality in optimization of clinical thinking is reached by three large-scale transformations of the habitual classification, symptomatic, and diagnostic structure. All three transformations are unusual and require the certain intellectual and psychological strain from doctor and student.

Transformations necessary for a Differential-Diagnostic Algorithm development and use

For a DDA development (1,2,3,) and use (1a,2a,3a) the following three transformations are necessary.

For a DDA development:

1. Optimal regrouping of diseases from nosological to syndromic classification + (plus)

2. Selection of the minimum decisive symptoms and signs + (plus)

3. Optimal sequence of detecting and interpreting of decisive s/s.

For a DDA use:

1a. Differential diagnostics of many various diseases into each separate syndrome + (plus)

2a. Differential diagnostics of diseases on the basis of the minimum decisive s/s + (plus)

3a. Differential diagnostics of diseases manifested by given syndrome by the shortest way

The nosological grouping of illnesses is based on the description of each concrete cardiovascular disease. The syndromic grouping includes leading syndrome of the majority of disorders of all organs and systems, which can be manifested by the appropriate syndrome. Thus, syndromic differential diagnostics is not limited by the cardiovascular pathology but covers all appropriate diseases irrespective of their localization and etiology (pulmonary, mediastinal, gastrointestinal, diaphragmatic, liver, infection disorders, etc.).The second and third transformations will be convincingly presented in the sample of the DDA below (Table 1).

In the previous article [24] the three intellectual systems ensuring the diagnostic decision-making optimal effectiveness were emphasized.

a)Evidence based (syndromic) diagnostic decision.

b) Minimum decisive symptoms and signs detection (principle of optimal diagnostic expediency).

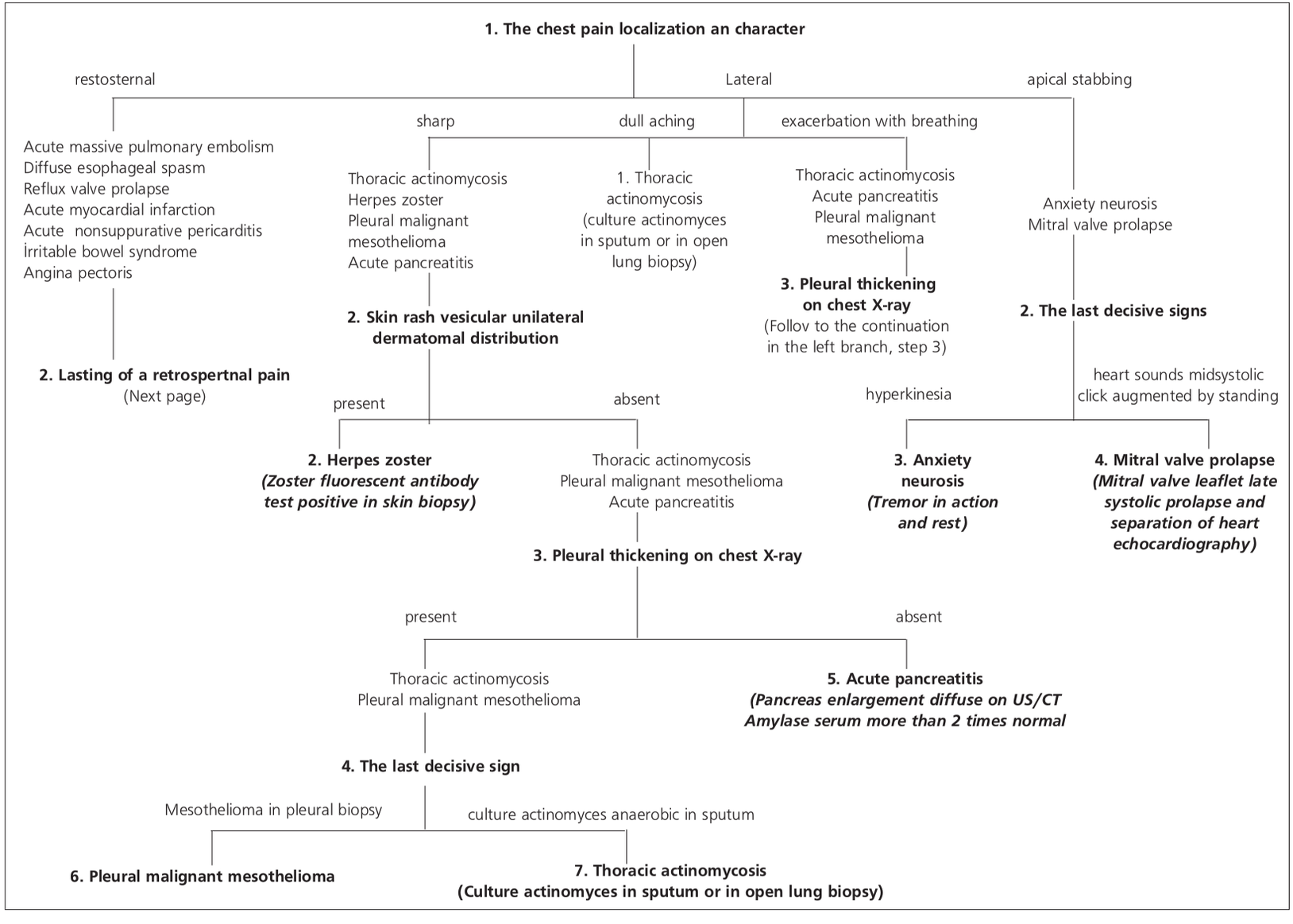
c) Differential-Diagnostic Algorithm.

It is reasonable to consider general features of every mentioned principle of diagnostic-decision making, and the difference between them.

It is a popular myth that the diagnostic process is a creative intellectual process requiring a certain decision in every case. But this is completely wrong. At rational organization of a doctor's thinking, a diagnostics of illnesses is basically decision of the similar tasks. The classes and types differ among themselves only by localization and contents of leading syndrome.

Diagnostics of illnesses must be reliable, economic, effective, and steady irrespective of creative potential of each doctor. For this reason the the-

Table 1: DIFFERENTIAL DIAGNOSTIC ALGORITHM FOR DISEASES ACCOMPANIED BY ACUTE CHEST PAIN (the fragment of the DDA for 13 disorders only) (In the brackets under diagnoses are indicated the desirable additional examinations for final clinical diagnoses proof)



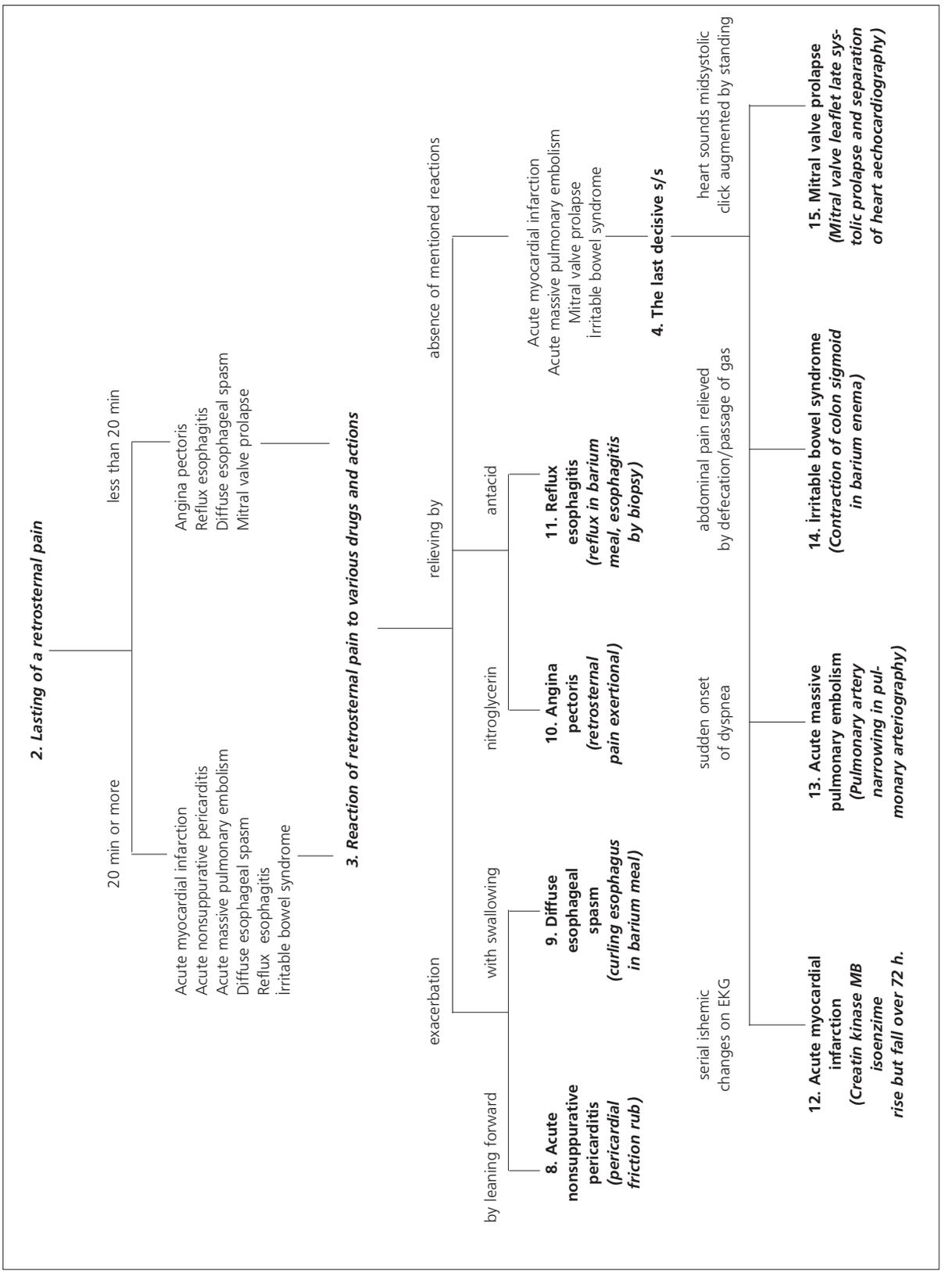
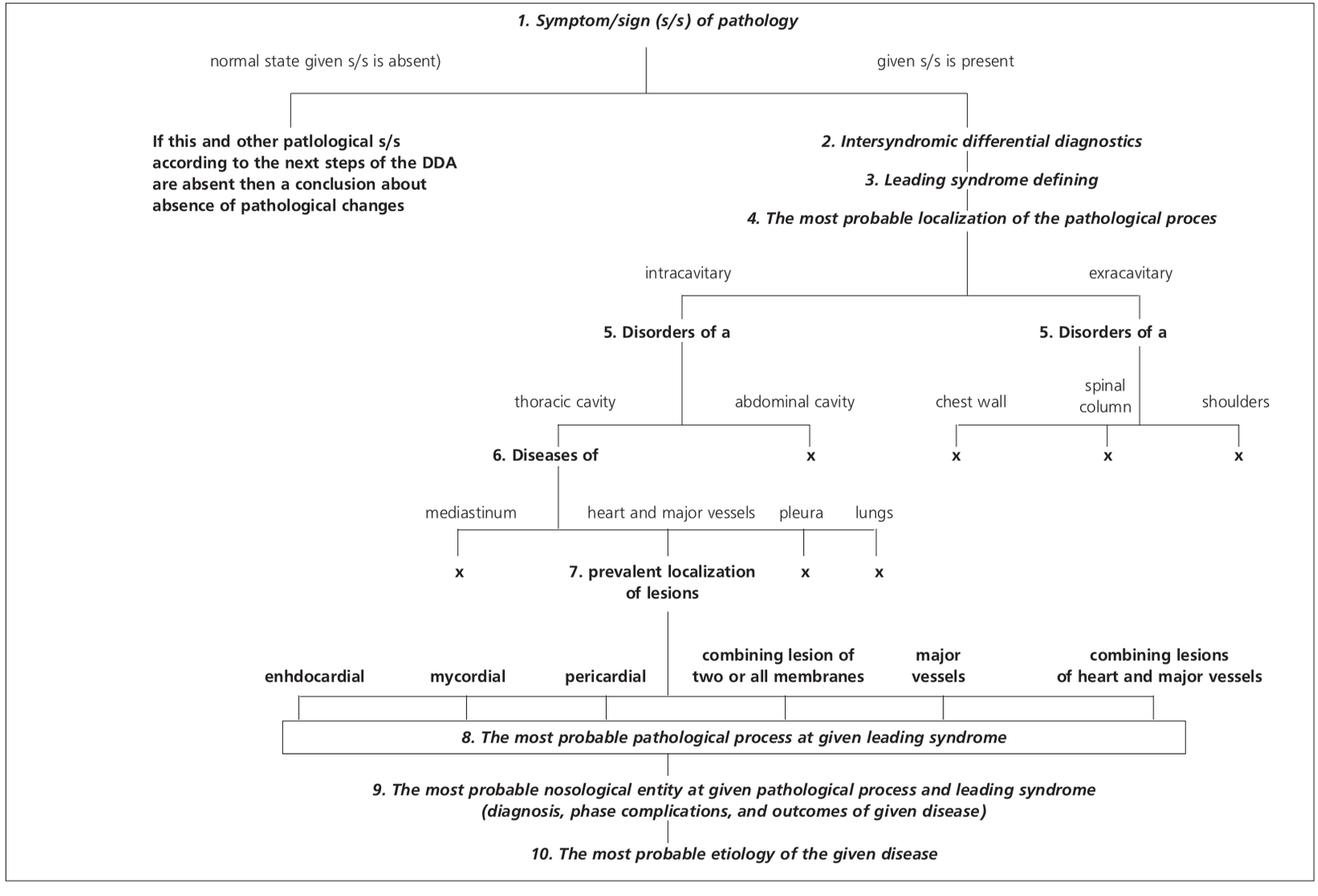

2. Lasting of a retrosternal pain
20 min or more
less than 20 min
Acute myocardial infarction
Acute nonsuppurative pericarditis
Acute massive pulmonary embolism
Diffuse esophageal spasm
Reflux esophagitis
irritable bowel syndrome
Angina pectoris
Reflux esophagitis
Diffuse esophageal spasm
Mitral valve prolapse
3. Reaction of retrosternal pain to various drugs and actions
exacerbation
relieving by
absence of mentioned reactions
with swallowing
nitroglycerin
antacid
Acute myocardial infarction
Acute massive pulmonary embolism
Mitral valve prolapse
irritable bowel syndrome
by leaning forward
9. Diffuse esophageal spasm (curling esophagus in barium meal)
10. Angina pectoris (retrosternal pain exertional)
11. Reflux esophagitis (reflux in barium meal, esophagitis by biopsy)
4. The last decisive s/s
serial ishemic changes on EKG
sudden onset of dyspnea
abdominal pain relieved by defecation/passage of gas
heart sounds midsystolic click augmented by standing
8. Acute nonsuppurative pericarditis (pericardial friction rub)
12. Acute myocardial infarction (Creatin kinase MB isoenzime rise but fall over 72 h.
13. Acute massive pulmonary embolism (Pulmonary artery narrowing in pulmonary arteriography)
14. İrritable bowel syndrome (Contraction of colon sigmoid in barium enema)
15. Mitral valve prolapse (Mitral valve leaflet late systolic prolapse and separation of heart aechocardiography)

Table 2: GENERAL SCHEME OF THE ALGORITHM FOR DIFFERENTIAL DIAGNOSTICS OF CARDIOVASCULAR DISEASES
(By symbol X has been indicated the break of diagnostic branches which are not related directly to cardiovascular pathology, and will be differentiated by appropriate branches or algorithms)



oretical and practical approach to diagnostics of diseases as the algorithmic problem is necessary.

The general comparative evaluation is presented in the Fig. 1. Of course, a complete detailed reliable way of intellectual process for diagnostic problem decision is unknown. However, hoping for some clearing of going exclusively difficult problem, the author presents the most important intellectual operations during usual nosological clinical thinking, on the one hand, and syndromic intellectual activity, on the other hand (Fig. 1).

The correct diagnosis can be made only if on each stage of thinking the doctor will find the correct decision. However, the diagnosis will be failed even if one mistake happens on the intellectual way of the diagnostic decision-making. If the mistake is made on the second, third and more stages of thinking (slanting dashed lines on the Fig. 1) then making the correct diagnosis is impossible in principle.

There is a probability to make a mistake as well, while using the algorithm. But here, as a rule, mistakes are happened only on the two initial stages of detecting and perception of a symptom. At all subsequent stages on a way to the diagnosis a doctor's idea has been directed by the algorithmic instructions, and the new mistakes are not made any more. Therefore, the general quality of diagnostics by means of algorithm is much higher, than at traditional nosological diagnostics.

Since, at nosological principle mistakes are made at many stages of thinking, the frequency of correct diagnosis decreases, and the frequency of diagnostic mistakes accrues. Probability of the erroneous diagnosis accrues also respectively. Although only the combination of all mentioned methods of diagnostics can ensure the best diagnostic results, each method has its own function.

The classical nosological and three optimal principles are not antagonistic, but are synergistic. The integrated clinical diagnostic decision-making

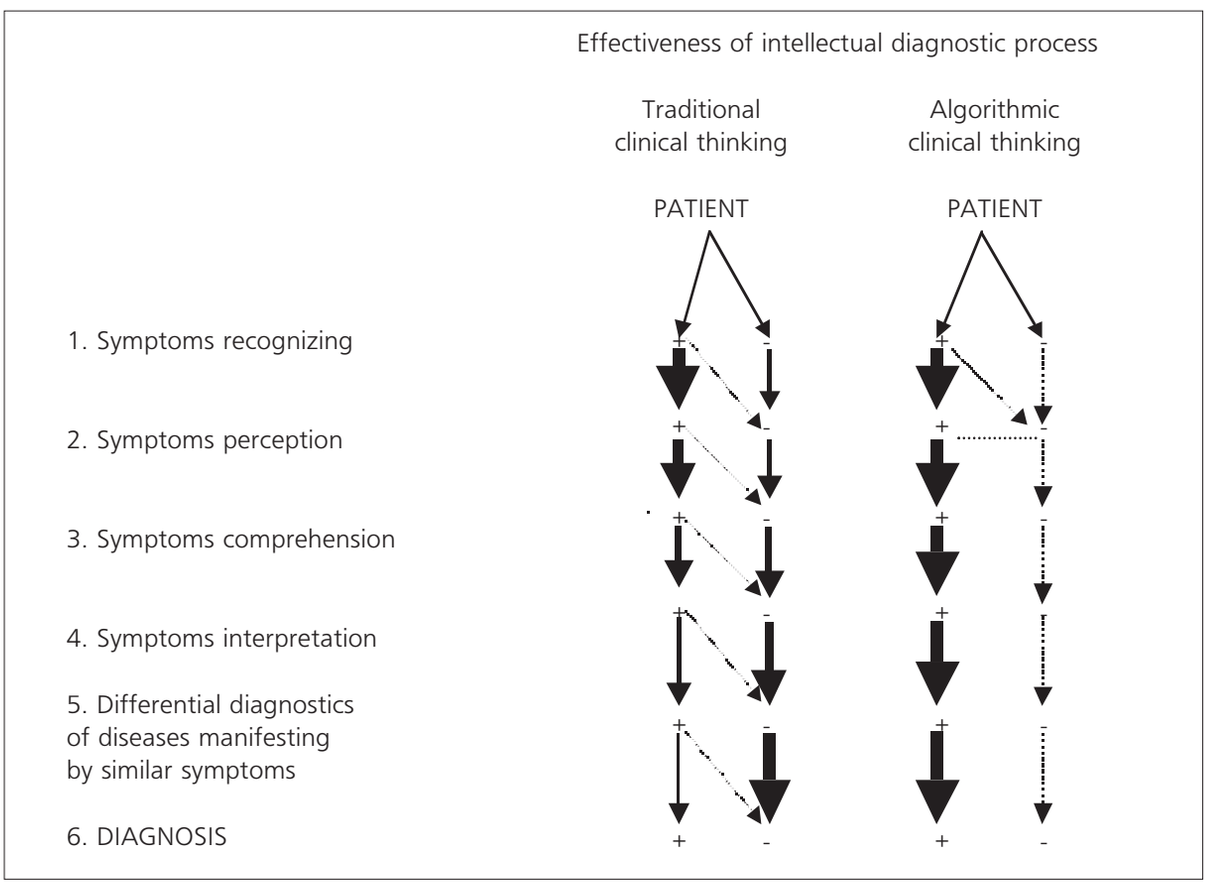


Figure 1: Principle and result of differential diagnostic algorithm using (from the right) in comparison with usual nosological principle of diagnostics (from the left). + Correct decision, - Erroneous decision.

(DDM) is the basis for optimal diagnostics of diseases, manifested by any of the same leading syndromes, and for appropriate algorithms development.

1. Recognition of leading manifestations (evidence based principle of DDM use);
2. Detection of decisive signs and symptoms (principle of optimal diagnostic expediency use);
3. Differential diagnostics and final diagnosis of a disease (differential diagnostic algorithm use);
4. Confirmation of the disease diagnosis (nosological approach use).

There is a paradoxical phenomenon in the process of a DDA development and using. The meaning of the paradox is that the most effective DDA development is very difficult process, and very limited number of scientists and medical teachers could work out the DDA. The real ability to transform the own intellectual diagnostic activity from nosological to syndromic thinking, the ability to divide the whole diagnostic process to minimum small separate steps, the ability to find the optimal sequence of the symptoms/signs use are obligatory intellectual conditions to the DDA developers.

However, the paradoxical fact for DDA users is opposite. Every medical student and doctor can use diagnostic algorithm successfully and very easily. The only condition is required. Each symptom/sign (s/s) included in the algorithm must be recognized correctly. Therefore, for the best outcomes in algorithms using, developers of DDA should avoid including in the algorithm the s/s that are difficult to detect, or could interpret variously by different doctors, e.g. an abdomen palpation, auscultative signs of rare and combined heart murmurs, etc.

Let's suppose that it is necessary to differentiate of 10 diseases. There are two ways for a division of the complete intellectual diagnostic process to separate operations. The first one is a designing of the s/s in the DDA for consequence exclusion step-by-step of each one disease. In this variant 10 diagnoses will be established within the 10 steps in the best case. At the second variant several diseases have been divided simultaneously on the each next step. It is clearly that the second way is shorter, faster, and cheaper, so, it is preferable (Table 1).

In the Table 1 the fragment of the real algorithm presents differential diagnostics of disorders, manifested by acute chest pain. To demonstrate of the effectiveness the shortest, fastest and cheapest diagnostics, the following objectives and features have been pursued here.

To show

♦ The fitness of the same one algorithm for differential diagnostics of the disorders of various organs and localizations; which are shown by the same syndrome, in given case, by acute chest pain. The example of the efficiency of evidence based principle using for Diagnostic Decision-Making (the syndromic diagnostic approach).

♦ The real possibility to establish reliable diagnosis using minimum s/s. The example of the efficiency of the principle of optimal diagnostic expediency using.

♦ The best combination of optimal methodologies of diagnostic decision-making, when the sum of syndromic diagnostic approach + optimal diagnostic expediency + optimal sequence of decisive s/s provides the possibility of developing and using a very effective DDA.

♦ The probability to make a mistake recognizing the simple s/s is very low. A real possibility of the most effective preliminary reliable diagnoses at the first contact with a patient at his home, in outpatient clinics, emergency room, etc. The shortest time (from seconds to several minutes) is needed for diagnosis. The most precise diagnoses using additional examinations and signs, indicated in the brackets under the diagnoses, could be continuing later when a danger of probable chest catastrophe is excluded or established, and necessary treatment has been executed.

♦ The synergism of the combination of optimal and the classical methods of clinical thinking. The intellectual process of the effective diagnostic decision-making has been provided by three optimal methods. Final diagnosis, i.e. the result of the diagnostic process is expressed in usual conventional form. The methodology of the DDA designing is based on the simplest s/s. Therefore, a fast reliable differential diagnostics is possible. The most precise verification of the final algorithmic diagnoses could be performed on the next steps by more complicated examinations.

♦ The easiness of the DDA using in daily practice. It is necessary to emphasize that even somebody use the printed algorithm, they in real diagnostics very quickly turn to their own algorithmic intellectual activity, and reading the printed algo-

rithm becomes soon already unnecessary. In my previous article a phenomenal effectiveness of mass independent diagnostics after only single algorithmic diagnostics was shown.

The presented DDA has some important features. The algorithm is designed artificially in the most complicated variant. The following different five groups and 15 diseases are included in the DDA for creation of the greatest difficulties of differential diagnostics.

4 cardiovascular diseases: 1. Acute myocardial infarction; 2. Angina pectoris; 3. Acute nonsuppurative pericarditis; 4. Mitral valve prolapse (twice on various branches of the DDA).

1 pulmonary disease: 5. Acute massive pulmonary embolism;

2 pleural and thoracic wall diseases: 6. Pleural malignant mesothelioma; 7. Thoracic actinomycosis (twice on various branches of the DDA);

4 digestive system diseases: 8. Reflux esophagitis; 9. Diffuse esophageal spasm; 10. Irritable bowel syndrome; 11. Acute pancreatitis

2 miscellaneous disorders: 12. Anxiety neurosis; 13. Herpes zoster;

Thus, look the Table 1 "Differential Diagnostic Algorithm for diseases accompanied by acute chest pain (a fragment)".

Making comments of the algorithm, it is easy to predict that the reader can deny the s/s and diagnoses presented in the algorithm, since these s/s are encountered in other diseases as well. It is necessary to pay attention of the reader that the indicated s/s are the most informative and valuable (decisive) just and only for differential diagnostics of the combination of mentioned selected diseases. In other combination a quantity of diseases, other s/s, and appropriate other diagnoses will be presented in other DDA. It is also easy to object that e.g. for acute pancreatitis the acute abdominal pain in epigastrium and not a chest pain is typical. However, a family doctor works in daily reality, not in statistic probabilities. Therefore, even if rare atypical clinical picture takes place in a patient, the algorithm should provide appropriate differential diagnostics and precise definite diagnosis.

If the leading syndrome will be the "Acute pain in epigastrium", then the algorithm intended to this syndrome will include both typical acute pancreatitis, and atypical acute MI, and other appropriate diagnoses accompanying by this syndrome.

To each of separate algorithms will enter not only cardiovascular disorders but also diseases of any other organs and systems accompanying by appropriate syndromes and s/s (See the Table 2).

Thus, the comments are related only to this algorithm, to this combination of the s/s and the diagnoses. However, all similar algorithms related both to any part and to whole cardiovascular pathology will have the same features and advantages, which are presented in this fragment of the DDA for an acute chest pain.

In the algorithm total 15 diagnoses are presented (two identical diagnoses 1 and 7, 4 and 15 are indicated twice on different branches of the algorithm because various s/s could be observed). In fact, 18 diagnostic conclusions, counting of the breaking off the second branch 3. Pleural thickening on chest X-ray with repeated three diagnoses (## 5,6,7).

Of course, more precise, complicated and expensive methods could be used, e.g. pulmonary or coronary arteriography, oesophagus manometry, etc. However, clinical realism must be taken into account always, and the most expensive and complicated methods should be used if more accessible ones do not ensure a reliable diagnosis. Considering a problem of accessibility of various methods for diagnostics of diseases, it is useful to remember that diagnostics of illnesses is similar to the proof of a geometrical theorem, when only those arguments should be used, which are necessary and are sufficient.

It is easy to see that presented DDA allows providing exhaustive differential diagnostics during several minutes and even seconds using the simplest methodological means as complaints, history, and auscultation.

Every reader can try to use the algorithm in real daily practice of diagnostics. However, it is necessary to warn that there should not be a disappointment at clinical testing of the offered algorithm. In real practice there will be many diseases accompanying by acute chest pain, which are not presented in the algorithm. Certainly, in these cases correct diagnosis will not be established because neither the appropriate s/s nor the diagnoses are included in the algorithm. For example, the acute retrosternal pain accompanies more than 40 diseases, whereas in the sample of algorithm only 8 diseases are presented with a such symptom.

Therefore, retrospective clinical algorithmic diagnostic testing will be more convincing and reliable. Then the algorithm will be checked up in those patients, in whom any of mentioned 15 diagnoses given in the algorithm are already established and proved. In these cases it is easy to check up the following parameters:

1) A coincidence or a discrepancy of the usual and algorithmic diagnoses. Checking whether the conventional diagnoses are verified by means of gold standard methods to prove a reliability of the diagnoses.

2) Number and variety of the medical examinations used for traditional and algorithmic disease diagnostics.

3) Number of the s/s, written down in the case history, and number of the s/s in the algorithm, ensuring establishment of the given diagnosis.

4) Time of usual and algorithmic diagnostics.

These four basic parameters will allow carrying out a convincing comparative evaluation of traditional and algorithmic diagnostics of the same diseases. Only after such own retrospective comparative diagnostics, a usual prospective algorithmic diagnostics could be used for new real patients. Obviously, above mentioned warning and limitations should be taken into account.

Main practical advantages of Differential-Diagnostic Algorithms (efforts, money, time, stress).

Let's consider the contents of the examinations, symptoms/signs, approximate a time and a cost effectiveness of algorithmic diagnoses. By means of the DDA for diseases manifested by a chest pain (Table 1) it is possible to establish the 15 diagnoses using the following 9 examinations: 1. Talk with a patient (complaints and history); 2. Physical examination; 3. Heart auscultation; 4. Chest X-ray; 5. X-ray esophagus in barium meal; 6. ECG; 7. Amylase serum; 8. Culture actinomyces anaerobic in sputum; 9. Pleural biopsy. So, the total informative costs of the 15 diagnoses are in total only 9 methods. Consideration regarding financial costs is presented below.

By #1-15 are indicated the diagnoses enumerated in the DDA Table 1. By [3-10] are indicated the methods of the examinations listed just above. By (1/1, etc.) are indicated the number of used methods and signs respectively. Below the algorithmic path, used examinations, s/s, and final diagnoses (D-s) are presented.

1. 1. Right side lateral dull aching chest pain. D-s: Thoracic Actinomycosis (1/1) [3]

2. 1. Left lateral sharp chest pain; 2. Skin rash vesicular unilateral dermatomal distributed. D-s: Herpes Zoster (2/2) [2, 3].

3. 1. Chest pain apical stabbing; 2. Hyperkinesia – tremor in action and rest. D-s: Anxiety Neurosis (2/2) [1,2]

4. 1. Chest pain apical stabbing; 2. Heart sounds midsystolic, click augmented (increased) by standing D-s: Mitral Valve Prolapse (2/2) [3, 4]

5. 1. Chest pain lateral right side sharp; 2. Skin rash absent; 3. Pleural thickening on chest X-ray absent; 4. Amylase serum more than 2 times normal. D-s: Acute Pancreatitis (4/4) [2, 3, 7,13]

6. 1. Chest pain lateral sharp right side; 2. Skin rash absent; 3. Pleural thickening on chest X-ray; 4. Mesothelioma in pleural biopsy. D-s: Pleural Malignant Mesothelioma (4/4) [2, 3 ,7, 10]

7. 1. Chest pain lateral right side sharp; 2. Skin rash absent; 3. Pleural thickening on chest X-ray present; 4. Culture actinomyces anaerobic in sputum. D-s: Thoracic Actinomycosis (4/4) [2, 3 ,7, 14]

8. 1. Retrosternal chest pain; 2. Lasting of the pain more than 20 min.; 3. The pain exacerbates by leaning forward. D-s: Acute Nonsuppurative Pericarditis (1/3) [3]

9. 1. Retrosternal chest pain; 2. Lasting of the pain more than 20 min.; 3. The pain exacerbates with swallowing; 4. Curling esophagus in barium meal. D-s: Diffuse Esophageal Spasm (2/4) [3, 9]

10. 1. Retrosternal acute chest pain; 2. Lasting of the pain less than 20 min.; 3. The pain is relieved by nitroglycerin. D-s: Angina Pectoris (1/3) [3]

11. 1. Retrosternal acute chest pain; 2. Lasting of the pain more than 20 min.; 3. The pain is relieved by antacid, and does not exacerbate by leaning forward and swallowing. D-s: Reflux Esophagitis (1/3) [3]

12. 1. Retrosternal acute chest pain; 2. Lasting of the pain more than 20 min.; 3. The pain is unrelieved by nitroglycerin, antacid, and does not exacerbate by leaning forward and swallowing. 4. Serial ishemic changes on EKG. D-s: Acute Myocardial Infarction (1,4) [3, 12]

13. 1. Retrosternal acute chest pain; 2. Lasting of the pain more than 20 min.; 3. The pain is

unrelieved by nitroglycerin, antacid, and does not exacerbate by leaning forward and swallowing. 4. Sudden onset of dyspnea. D-s: Acute Massive Pulmonary Embolism (1/4) [3]

14. 1. Retrosternal acute chest pain; 2. Lasting of the pain more than 20 min.; 3. The pain is unrelieved by nitroglycerin, antacid, and does not exacerbate by leaning forward and swallowing; 4. Abdominal pain relieved by defecation/passage of gas. D-s: Irritable Bowel Syndrome (1/4) [3]

15. 1. Retrosternal chest pain; 2. Lasting of the pain less than 20 min.; 3. The pain is unrelieved by nitroglycerin, antacid, and does not exacerbate by leaning forward and swallowing; 4. Heart sounds midsystolic, click augmented (increased) by standing. D-s: Mitral Valve Prolapse (2/4) [3, 4]

Summarized result is the following. For 15 various diagnoses total only 9 methods, and 47 s/s were used. It is very important that the simplest examinations were used for diagnoses achievement. For 15 diagnoses the talk with a patient (complaints and history) was used; for 5 diagnoses-the physical examination; for 2 diagnoses the heart auscultation; for-2-the chest X-ray; in 1 case the X-ray esophagus in barium meal; in 1 case the ECG; 1 the amylase serum; 1 the culture actinomyces anaerobic in sputum, and for 1 diagnosis the pleural biopsy using.

There are obvious advantages of algorithmic clinical thinking in diagnostics and professional training in comparison with traditional ones. It is easy to see the other advantages of usual and algorithmical work from the same comparative evaluation (diagnosis cost-effectiveness, an expended time, efforts of medical staff, stress of patients during various examinations, especially invasive ones, etc.)

The designing of the algorithm and the consecutive order of the detecting s/s are strategically important. The differential diagnostics begins from the most dangerous diseases, which could be due to a chest catastrophe (the left branch – retrosternal pain). In a few seconds (questions-answers + elementary actions) most of probable diseases are excluded. It starts with the most dangerous MI, when the ECG is absolutely necessary. Additional exams may be performed, when the fastest differential diagnostics is completed with a high probability of the established reliable diagnoses.

It is important as well that the definitive diagnoses could be established by minimum gold standard methods (indicated in the brackets in the Table 1) that are intended only to those selected patients, in whom just these methods are need for a final clinical proof of reliable diagnosis. Such approach excludes superfluous examinations, which are performed very often and uselessly in a daily medical practice.

It is necessary to pay attention to diagnosis cost effectiveness. It is well known a very high cost of diagnosis that grows constantly. The main cause of this situation is a «blind» use of superfluous expensive examinations, which are not necessary for reliable diagnosis in majority of cases. Our special experiments show enormous financial advantages of algorithmic and computerized diagnostics in comparison with usual diagnostics.

For example, students received the list of the clinical symptoms, and later the laboratory examinations and signs with the task to establish of the diagnosis. They must mark by circle only those methods and s/s that they need personally, and are sufficient for the diagnosis. Although all 49 foreseen methods and s/s had been requested, the correct diagnosis was not established. One-two minutes later, the same students had established the diagnosis with my "Fever" computer-assisted system. Only three s/s were enough for establishment of the correct diagnosis of "Infectious mononucleosis" (two clinical and one laboratory s/s). Thus, we have 3 s/s and reliable computerized diagnosis versus 49 s/s with erroneous diagnosis by traditional diagnostics. My computerized expert systems are based on the preliminary developed DDA, therefore, both DDA and Expert Systems provide the same advantages, diagnostic and cost effectiveness.

The very impressive diagnostic and economical advantages are obvious.

What kind of the differential diagnostic algorithms could be developed for a whole cardiological pathology? The approximate answer is presented in the Table 2.

1) The algorithms for the whole cardiovascular disorders should contain all leading syndromes and all or majority of diseases manifested by these syndromes, independently of localization, character, pathogenesis, and etiology of pathological process.

2) The algorithms should be developed for every syndrome, existing in cardiological practice.

3) Every disease, manifested by each leading syndrome must be included to this syndrome inde-

pendently whether this disease presents cardiovascular pathology or any other one.

4) If appropriate clinical picture exists in a patient, then strategically optimal should be differential diagnostics first of the most dangerous diseases, which could cause the chest, brain or abdominal catastrophes, independently of the localization and etiology of a sudden disorder.

5) The following ways should be studied for quickly diagnostics of appropriate fatally dangerous diseases.

5.1. Acute chest pain syndrome (for the fastest diagnoses of the 1. Acute Myocardial Infarction (AMI); 2. Pneumothorax spontaneous or traumatic; 3. Pulmonary embolism; 4. Aortic dissection).

5.2. Acute pain in epigastrium syndrome (1. Incarcerated hiatal hernia; 2. Perforated high gastric ulcer; 3. Occlusion of the abdominal aorta and its branches; 4. AMI).

5.3. Sudden dyspnea syndrome (1. AMI; 2. Cardiac asthma; 3. Pulmonary embolism; 4. Foreign body aspiration. 5. Effusive pericarditis).

5.4. Sudden loss of consciousness syndrome (1. Sudden cardiac death; 2. Cerebral embolism/ hemorrhage; 3. Pulmonary embolism; 4. AMI; 5. Aortic dissection).

5.5. Diffuse cyanosis syndrome (1. Pulmonary embolism.).

5.6. Algorithm for ECG diagnostic interpretation (1. AMI).

5.7.Algorithm for CVS X-ray diagnostic interpretation (1. Pulmonary edema; 2. Massive effusive pericarditis. 3. Aortic aneurysm with probable dissection).

5.8. Myocardial lesions syndrome (1. AMI; 2. Cardiac asthma).

5.9. Acute left ventricular failure syndrome (1. AMI; 2. Pulmonary embolism; 3. Paroxysmal tachycardia).

5.10. Acute right ventricular failure syndrome (1. Pulmonary embolism; 2. Spontaneous pneumothorax; 3. Massive effusive pleuritis).

5.11. Algorithm for differential diagnostics of AMI complications (1. Clinical death; 2. Cerebral embolism; 3. Asystolia; 4. Ventricular tachycardia; 5. Ventricular fibrillation; 6. Atrial flutter; 7. Atrial fibrillation; 8. Heart tamponade; 9. Rupture of muscle(s) papillary(ies); 10. Rupture of septum interventricular; 11. Beginning of myocardial rupture, 12. Repeated AMI; 13. Acute reactive pericarditis; 14. Acute heart failure).

6) It is necessary to distinguish the terms "diagnosis" and "diagnostic conclusion". The same one diagnosis, e.g. acute myocardial infarction will be established as minimum by means of 8 algorithms (5.1, 5.2, 5.3, 5.4, 5.6, 5.8, 5.9, 5.11). Thus, eight diagnostic conclusions will mean the same diagnosis established by different examinations at different syndromes and s/s of illness.

It is very important that after determination of every appropriate syndrome not only mentioned the most dangerous diseases but all or majority disorders accompanying by these syndromes will be recognized.

7) The sequence of the stages presented in the Table 2 is optimal theoretically. If a reliable distinguishing of process localization and its character is possible, then, of course, the next differential diagnostics inside of this syndrome, localization, and process is much easier than chaotic trials to guess a diagnosis. However, a clinical realism can limit such approach. Then, a leading syndrome and minimum of the most informative s/s that allow providing the best distinguishing and the most reliable final diagnoses will become the working reality.

Conclusion

Enormous achievements obtained by development of the newest medical diagnostic technology (engineering, equipment, etc.) are almost exhausted. Very undesirable consequence of this direction is a multiple rise of cost of a diagnostics, and decreasing of the accessibility of a medical aid for a population. It is necessary to define the ways where the most successful break-through can be achieved now.

The algorithmization of the intellectual diagnostic process presents the most effective new way. As it is obviously seen in this article, a true DDA completely answers to the principle "Using the minimum to obtain the maximum". Therefore, a true algorithm provides the most reliable diagnosis in the shortest and the most efficient way, using minimum medical examinations, minimum signs, least efforts from physicians, the shortest time, efficient financial costs of diagnosis, the most effective fast self-training. The best professional diagnostic self-learning could be ensuring both by means of expert system, and/or electronic-books.

The algorithmization of clinical diagnostics allows a solving of diagnostic and training problems relatively fast and cheaply. Use of algorithms for diseases differential diagnostics and training is very easy and simple task. Working out and using of DDA in daily medical practice has a paramount importance and should be applied widely. Therefore, the true optimal differential-diagnostic algorithms in cardiology and in any other field of diagnostics, medical education, and continuing education should be considered as a serious acquirement of a medical society.

References

1. Plebani M, Zaninotto M. Diagnostic strategies in myocardial infarction using myoglobin measurement. Eur Heart J 1998; 19 (Suppl): N12-5.
2. Eaton T, Garrett J, Milne D, Frankel A, Wells AU. Allergic bronchopulmonary aspergillosis in the asthma clinic. A prospective evaluation of CT in the diagnostic algorithm. Chest. 2000; 118: 66-72.
3. Birmingham CL, Stigant C, Goldner EM. Chest pain in anorexia nervosa. Int J Eat Disord 1999; 25: 219-22.
4. Fishman JE. Imaging of blunt aortic and great vessel trauma. J Thorac Imaging 2000; 15: 97-103.
5. Portnoi LM, Denisova LB, Stashuk GA, Nefedova VO. Magnetic resonance imaging in the diagnosis of gastric cancer: X-ray versus MRI anatomic findings. Vestn Rentgenol Radiol 2000; 1: 26-40.
6. Wang CY, Chiang HK, Chen CT, Chiang CP, Kuo YS, Chow SN. Diagnosis of oral cancer by light-induced autofluorescence spectroscopy using double excitation wavelengths. Oral Oncol 1999; 35: 144-50.
7. Greaves SM, Hart EM, Brown K, Young DA, Batra P, Aberle DR. Pulmonary thromboembolism: spectrum of findings on CT. Am J Roentgenol 1995; 165: 1359-63.
8. Perrier A, Desmarais S, Miron MJ et al. Non-invasive diagnosis of venous thromboembolism in outpatients. Lancet. 1999; 353: 190-5.
9. Herlihy OM; Perros P. Elevated serum growth hormone in a patient with Type 1 diabetes: a diagnostic dilemma. Diabetes Metab Res Rev 2000; 16: 211-6.
10. Mol BW, van-Der-Veen F, Bossuyt PM. Implementation of probabilistic decision rules improves the predictive values of algorithms in the diagnostic management of ectopic pregnancy. Hum Reprod 1999; 14: 2855-62.
11. Zabolotnyi DI, Melnikov OF, Kishchuk VV. Immunodiagnosis of chronic tonsillitis. Vestn Otorinolaringol 1999; 5: 17-20.
12. Lindenbraten LD, Naumov LB. Roentgenological syndromes and diagnostics of lung diseases. Programmed manual for physicians. Moscow: Meditsina; 1972. p.472
13. Lindenbraten LD, Naumov LB. Medical Roentgenology. Textbook for medical students. Programmed course with diagnostic algorithms. Moscow: Meditsina; 1974. p.480
14. Lindenbraten LD, Naumov LB, Medical Roentgenology. Textbook for medical students. Programmed course with diagnostic algorithms. 2d edition. Moscow: Meditsina; 1984. p.383
15. Naumov LB. Revolutionary changes - to professional education (the new paradigm of professional education). EKO (Economics and Organization of Industrial Production) 1979; 5: 92-106.
16. Naumov LB. Diagnostic algorithms and teaching programs. Novosibirsk; 1972. p.91
17. Naumov LB. Optimization of teaching at medical institute. Programmed guide for teachers of Medical Institutes. Novosibirsk; 1978. p.420
18. Naumov LB. Methodical principles of diagnostic thinking. In: Naumov LB, Optimization of teaching at medical institute. Programmed guide for teachers, Novosibirsk; 1978. p.41-124.
19. Naumov LB. Is it easy to become a doctor? Tashkent: Meditsina; 1983. p.463
20. Naumov LB, Diagnostics and cybernetics. Klinicheskaya Meditsina 1965; 1 : 11-22.
21. Naumov LB. Algorithm, diagnostic. Great Medical Encyclopaedia. 3rd ed. Moscow: 1974.
22. Naumov LB, Teaching algorithm: the principles of using, and some results of algorithms applying. EKO (Economics and Organization of Industrial Production) 1979; 5: 112-22.
23. Naumov LB. Active training is basis of optimization of higher education. Coll. Perfection of educational process. Cheliabinsk: Cheliabinsky Polytechnic Institute; 1981. p.75-103.
24. Naumov LB. Main problems of modern medicine in diagnostics and learning. Ways to optimal solution. Anatol J Cardiol 2001; 1: 166-78.