Problems Of Diseases Manifested By X-ray Local Opacity Syndrome, And Differential Diagnostic Algorithm For Its Solution

L Naumov

Citation


Abstract

Objective: Efficiency of traditional and algorithmic diagnostics comparison; Differential Diagnostic Algorithm creation for effective X-ray differential diagnostics of diseases accompanied with local opacity. Methods: Comparative evaluation of X-ray traditional and algorithmic diagnostics has been performed by principle of other equal conditions. The first stage of independent diagnostics has reflected the results of traditional medical education. The same radiograms have been used by the same examinees in the same time for repeated diagnostics with original innovative diagnostic algorithm on the second stage. Results: X-ray diagnostic algorithm significantly decreased of errors obtained at independent diagnostics. Conclusion: Traditional X-ray diagnostics based on nosological thinking is ineffective. Syndromic algorithmic X-ray diagnostics used innovative the most effective intellectual activity, therefore, optimized results radically. Definition: Differential Diagnostic Algorithm or diagnostic algorithm is the exact comprehensible to all determination about step-by-step of elementary intellectual operations and actions in the certain sequence for establishment of a diagnosis of each of all diseases manifested by the given leading syndrome. Syndrome – is a group of symptoms/signs similar for any diseases of different organs and systems, irrespective from etiology and pathogenesis of diseases (e.g., a chest pain, heart murmurs, a fever, a local opacity on chest X-ray, etc.) Leading syndrome – is a predominant syndrome among several syndromes, which are available at the given patient. Abbreviations – DDA – Differential Diagnostic Algorithm; s/s - symptoms/signs;

INTRODUCTION

The data presented in this article have been collected over 30 years ago at the Department of Pedagogics and Optimization of the Higher Medical Education, which the author founded in 1970 in Novosibirsk medical institute, USSR, and where for 15 years he served as the Head of the department. During this period, 3020 teachers almost from all medical institutes of the USSR were trained in our department. The author developed 15 original scientific-methodical trends, and 70 concrete methods and means of training optimization. Hundreds of students participated in different pedagogical experiments. These old data is being presented to the western reader today because the problem of effective X-ray diagnostics remains actual, and this data essentially expands literary concepts of the problem.

Results received later in Israel have submitted here separately. Methodically the same comparative experiment has carried out with Israeli family doctors. They have received the western medical education, have trained with the best American textbooks, and work many years in the Israeli polyclinics. The same results have received with them, as well as in Russia. It testifies to two phenomena. The first, unsatisfactory quality of X-ray diagnosis is widely distributed that shows literature data as well. The second, various diagnostic algorithms developed by the author, are highly effective and sharply reduce number of diagnostic mistakes at the doctors who have received both Soviet, and western medical education. It defines the actuality of given article and the new diagnostic algorithm developed and tested by the author in Israel.

Teachers of higher medical school, students and doctors are sure, that X-ray diagnostics is easy and simple object. Therefore, each family doctor examines roentgenograms independently, and not always reads diagnostic conclusion of radiologist.

In a reality, it is one of the most complicated problems of medical professional training. However, between a standard
opinion, official curriculums, and the reality exists the serious contradiction. This contradiction is caused by discrepancy between complexity of a subject of training, on the one hand, and method of training, on the other hand.

The Novosibirsk medical institute, in which majority researches presented in given article have been executed, was one of the best in the USSR. Teachers of clinical disciplines had high medical qualification.

The author has developed the new DDA for diseases manifested by local opacity, which has published in this article, recently. This DDA has been published for the first time.

Medical diagnostics in general, and X-ray diagnostics, in particular, represents great clinical, methodological, economic, social, psychological problems. There are hundreds diseases of various organs manifested by various X-ray shadows on chest, and dozens diseases, manifested by local opacity on chest X-ray. Therefore, an optimizing of fast differential-diagnostic process remains actual today. Although greatest technical achievements have appears in X-ray diagnostics, there is a large field in a physician’s activity that must be improve significantly. It is intellectual differential-diagnostic abilities of a doctor optimization. This article is devoted just to this problem, which has been studied insufficiently.

Diagnostic and training problems have been mentioned here briefly.

**DIAGNOSTIC PROBLEMS**

There is a dramatic contradiction between the principles of diagnostic reasoning a doctor, which has taught in medical school, and the principle of diagnostic thinking, which a doctor must actually use in the clinical practice. Important significance has serious demerits of generally accepted approach to traditional medical diagnostics.

1. It is based on the nosological intellectual system;
2. It is oriented to maximal memorization of special information;
3. It starts with disease diagnosis (disease name) and goes to the etiology and pathogenesis, s/s of the disease, complications, treatment, etc;
4. In real life, the opposite situation takes place – from revealed s/s through of differential diagnostics to diagnosis, i.e. vice versa. Students, doctors and even teachers-clinicians not always can make revolutionary opposite transformations in the brain independently at constant deficiency of time;
5. Many diseases have been manifested by the same or similar s/s;
6. Excessive amounts of medical examinations have been used 12;
7. Superfluous s/s have used frequently 3;
8. Ineffective intellectual diagnostic process of diagnosis 4;
9. Significant efforts of physicians during diagnosing process 3;
10. Relatively long time spend in determining a diagnosis 3;
11. Frequent diagnostic errors, at least in the primary health care setting 5678910;
12. High cost of reliable diagnosis 1112131415;
13. A strongly marked decreasing of diagnostics quality at remote medical establishments and patients, in rural sites, in particular.

These problems are quite typical at X-ray diagnostics, at the local opacity syndrome particularly. Therefore, it is important to find a non-standard approach and methodology that can improve X-ray diagnostic results significantly, be widely used, and also be economical and more efficient. The best achievements in optimal diagnostics must be accessible for remote physicians and citizens.

Dissatisfaction by diagnostic results and high cost of diagnosis encourages the search for non-traditional ways of improving these results.

It is desirable to find a common a working tool, which could solve above-mentioned problems at the bottom steps of public health services quickly and cheaply. A DDA can become such universal tool. Our previous experience has revealed the outcomes that many times better than traditional diagnostics.
THEORETICAL PECULIARITIES OF CLINICAL DECISION-MAKING IN DIAGNOSTIC PROCESS

The DDA creation and use is based on a new original approach to a diagnostic intellectual process optimization (a new paradigm of diagnostic decision-making)\(^\text{16}\).

Three optimal principles of diagnostic decision-making used for the most effective diagnostics. This approach essentially differs from traditional diagnostic decision-making and provides optimal diagnostic outcomes\(^\text{17,18}\).

It is based on:

- Syndromic diagnostic decision;
- Minimum decisive symptoms/signs detection;
- Differential Diagnostics Algorithm.

Only the combination of all three principles (a+b+c) provides the best results in the intellectual diagnostic process.

Diagnostic decision making by syndrome is very important and promising because many various diseases with different pathologic processes have the same or very similar clinical, laboratory, X-ray, etc. s/s. Moreover, the same disease may be present with different syndromes or large s/s. Therefore, in each case it is very important to select a leading syndrome. From such leading syndrome starts a differential diagnostic process as syndromic thinking. It is possible to begin the process of syndromic diagnostics with a combination of two or more manifestations, e.g., local opacity + cough + sputum, etc.

The nosological and three optimal principles are not antagonistic, but synergistic. The integrated clinical diagnostic decision-making (DDM) contains the following components for optimal diagnostics of diseases manifested by local opacity and for the DDA development.

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

The new methods directly lead to algorithmization of DDM\(^\text{19,20}\). These methods provide some elementary operations that do not require great skill from a physician and exclude superfluous examinations and tests. These features permit important and productive practical steps for making optimized diagnostic decisions. Minimum examinations and signs are necessary for precise diagnoses that decrease the costs of diagnosis significantly. These principles essentially differ from general accepted clinical thinking. These differences cause the main general and particular features and advantages of this new system of DDM in comparison with generally accepted one.

Thus, diagnostic problems solution can be achieved by means of the innovative intellectual approach to medical diagnostic decision-making (DDM).

PROBLEMS OF TRAINING

Didactic systems and a level of training define the learning efficiency. Didactic System (DS) is a certain complex of methods and tools of the management by cognitive activity of EVERY separate learner in given learner group.

There are three levels of training: I level – «knowledge-acquaintance», II level – «knowledge-copies», III level – professional training «knowledge mastering – a task - the optimal professional decision making (effective professional practical activity»). Practical diagnostics demands a III level of training.

Among 8 existing DS four ones no feedback, and cannot ensure of professional learning on III level in principle. Four cyclic two-ways DS could provide learning on III level. However, organizational and economical limitations do not allow using them for mass professional training. Only one the most advanced 8\(^\text{th}\) DS can ensure mass professional learning practically.

In general, the demerits of mass professional medical education caused, mainly, by:

1) Ineffective the I\(^\text{st}\) DS used of traditional training «one teacher – many students» without effective constant feedback to every student/doctor. It forms to EACH student only mentioned above I-II levels of training;
2) Effective intellectual diagnostic doctor's work, i.e. knowledge mastering of III level is impossible to form by
methods of I-II study levels in principle. Therefore, diagnostic mistakes appear as the result from standard traditional training permanently.

By means of 8th DS with syndromic algorithmic transformation and appropriate logic schemes, it is possible to provide a professional self-training on III level for EVERY learner.

Just these combined innovative approaches and methodologies present the instrument for the major mentioned problems successful solution.

Traditional generally accepted training has been conducted on the principle of «a situation – an example». Tests to check the assimilation of knowledge have been organized on the principle of «a question – an answer». These principles form and consolidates I-II levels of learning, i.e., at best, acquaintance with the subject and the repetition of its contents. A professional work requires learning at a different level - «professional challenge - the best decision». With regard to our case – any pathological shadow in lung – the identification of signs – effective differential diagnostics – correct diagnosis – the optimal treatment. These intellectual operations demand only III level of training – knowledge mastering.

METHOD

A comparative evaluation of results in traditional and algorithmic training of pulmonary X-ray diagnostics has been undertaken. Popular division of examinees into basic and control groups was unsuitable for this purpose. The problem is that professional mental abilities, which are non-comparable in different people, have been compared. Therefore, the author has developed a technique of professional work comparison at the same people with different methods of training.

The principle of other equal conditions (ceteris paribus) has been observed strictly: the same examinees, the same radiograms, at the same time. The single difference was different method of training: 1) Traditional training; 2) Training by original innovative diagnostic algorithms for each X-ray syndrome.

The technique of comparative experiments was performed in two stages. At the first stage, there was independent diagnostics of radiograms with diagnoses written. This stage of independent diagnostics results of traditional training has fixed. Then records with diagnoses were selected from examinees, and the second stage of experiment was started at once, with repeated diagnostics of the same radiograms utilizing the DDA. Records with new diagnoses at the second stage were selected, then results of the first independent and the second innovative stages of the experiment have been compared.

In our two-stage comparative experiment between the first and second stage was a break always. Forthcoming work of examinees with the algorithm was performed for the first time in their lives. Therefore, after the selection of self-diagnostic conclusions a detailed explanation of how to diagnose by the algorithm has been carried out. In small group the instruction was carried out with the book and the roentgenogram. My book with algorithms was before eyes of each examinee. In a big lecture hall a demonstration of the roentgenogram and algorithm was carried out simultaneously and in parallel on two big screens from two projectors. The demonstration and interpretation of each sign in consecutive movement on algorithm has been shown in details. Such demonstration of diagnostics using the algorithm has been carried out on two-three roentgenograms within 15-20 minutes. Independent diagnostics with algorithm began only after affirmative answer to a question, whether all have understood a new method of work. If even one examinee said, that he has not understood, the slow explanation with demonstration of everyone stage of the DDA and a corresponding sign on the roentgenogram repeated on another example of the same syndrome.

The objects of comparison were medical students of IV-VI years, doctors in the former USSR, and Israeli family doctors.

MATERIALS

There are various approaches and methods of differential diagnostics at a pulmonary pathology. These are well-known clinical, instrumental and laboratory methods of examinations. Nevertheless, the most simple, fast and reliable method of recognition and differential diagnostics pulmonary diseases is X-ray diagnostics.

Unfortunately, X-ray diagnostics has common faults mentioned for nosological approach to diagnostics of illnesses. Besides, the description of diseases has been separated on different classifications, e.g., pneumonias, tuberculosis, neoplasms, etc. It strongly complicates of differential diagnostics and an establishment of the diagnosis at revealing any pathological shadows on the radiological
pulmonary image.

For simplification of differential diagnostics, we have offered essentially other classification of pulmonary illnesses, having grouped them on radiological syndromes. It has considerably facilitated logic of intersyndromic differential diagnostics, but reliable intrasyndromic X-ray diagnostics represents a serious problem as well. This problem has been caused by a plenty of the diseases shown by the same radiological syndrome (Table 1). Therefore, intrasyndromic differential diagnostics requires the further optimization. This article is devoted just to this problem.

**Figure 1**

Table 1: Differential diagnostics of pulmonary diseases as a syndromic problem.

<table>
<thead>
<tr>
<th>X-ray syndrome (manifestations) of pulmonary diseases</th>
<th>Approximate number of diseases in this X-ray syndrome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total opacity</td>
<td>15</td>
</tr>
<tr>
<td>Lobular/segmental opacity</td>
<td>00</td>
</tr>
<tr>
<td>Round shadow</td>
<td>00</td>
</tr>
<tr>
<td>Ring-shaped shadow (cavity)</td>
<td>40</td>
</tr>
<tr>
<td>Nodules in a single specified site or local dissemination</td>
<td>15</td>
</tr>
<tr>
<td>Wide-opened dissemination</td>
<td>150</td>
</tr>
<tr>
<td>Lymph nodes hilar, mediastinal and tracheobronchial adenopathy</td>
<td>20</td>
</tr>
<tr>
<td>Local/recurrent/local licency</td>
<td>20</td>
</tr>
<tr>
<td>Long-pattern abnormality: interstitial, reticular pattern, honeycomb pattern, line shadows</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>410</td>
</tr>
</tbody>
</table>

The number of diseases that corresponds to different radiological syndromes is approximate. E.g., one diagnosis in the DDA “pneumonia” can turn into of one from 40 diagnoses of pneumonias various etiology, as shown in the Table 2. However, these diagnoses it is impossible to detail radiologically, because here is the border of a radiological method. Numerous acute and chronic pneumonias of various etiologies frequently have an identical radiological picture. In such cases, the final diagnosis has been established by additional bacteriological, serological analyses, bronchoscopy, IT, biopsy data, etc. The DDA contains necessary recommendations in corresponding places.

Presented DDA provides successful differential diagnostics of 36 diseases, manifested by local X-ray syndrome. The list of 47 extrapulmonary diseases + 40 pneumonias has been presented below as well.

**Figure 2**

Table 2: Clinical types, forms, etiological causes of acute and chronic pneumonias manifested by a radiological local opacity syndrome (from lobar to subsegmental opacities)

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Synonym</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virus acute pneumonia</td>
<td>Q-fever acute pneumonia</td>
</tr>
<tr>
<td>Tuberculosis acute pneumonia</td>
<td>Allergic acute pneumonia</td>
</tr>
<tr>
<td>Leptharal tuberculosis</td>
<td>Leptor exophthalmic acute pneumonia</td>
</tr>
<tr>
<td>Pulmonary infection and infarction pneumonia</td>
<td>Bronchocardiostatic perifocal pneumonia</td>
</tr>
<tr>
<td>Influenza virus acute pneumonia</td>
<td>Hemithorax pneumonia</td>
</tr>
<tr>
<td>Paramycococal pneumonia</td>
<td>Trichophthalmus pneumonia</td>
</tr>
<tr>
<td>Pulmonary cystic pneumonia</td>
<td>Taelma pneumonia</td>
</tr>
<tr>
<td>Staphylococcal acute pneumonia</td>
<td>Eubacterococal pneumonia</td>
</tr>
<tr>
<td>Streptococcus pyogenes acute pneumonia</td>
<td>Actinomyoccal pneumonia</td>
</tr>
<tr>
<td>Cytomycovirus pneumonia</td>
<td>Coccidicymosis and other mucotic acute pneumonia</td>
</tr>
<tr>
<td>Hepes zeoter pneumonia</td>
<td>Takemisia pneumonia</td>
</tr>
<tr>
<td>Klebysla pneumonia</td>
<td>Leukoma acute pneumonia</td>
</tr>
<tr>
<td>Gram-negative pneumonia (non Klebysla)</td>
<td>Hemophantis acute pneumonia</td>
</tr>
<tr>
<td>Hemoperhapsis acne pneumonia</td>
<td>Lupomagnosporias acute pneumonia</td>
</tr>
<tr>
<td>Aspiration acute pneumonia</td>
<td>Varetocia pneumonia</td>
</tr>
<tr>
<td>Hemorouspoccal pneumonia</td>
<td>Puegue pneumonia</td>
</tr>
<tr>
<td>Legionella</td>
<td>Talaracia acute pneumonia</td>
</tr>
<tr>
<td>Priticosis (Pueet-tweet) and other</td>
<td>Leukoma acute pneumonia</td>
</tr>
<tr>
<td>Catgumus acute pneumonia</td>
<td>Tuberculosis pneumonia</td>
</tr>
<tr>
<td>Chlamydia puncta acute pneumonia</td>
<td>Meliobacteros acute pneumonia</td>
</tr>
<tr>
<td>Syphilis pneumonia</td>
<td>Leoptosporias acute pneumonia</td>
</tr>
</tbody>
</table>

Besides, to the local opacity concerns 47 extrapulmonary diseases located in a chest wall, pleura, mediastinum, diaphragm (Table 3).

The list of the diseases, which have caused local opacity syndrome, contains 60 illnesses, whereas the appropriate DDA provides differential diagnostics only 36 diseases. It can explain by the following cause.

Quantitative discrepancy of the full list of pulmonary pathology and the reduced list of illnesses in the local opacity DDA can be illustrated on the example of extrapulmonary diseases at local opacity syndrome. The algorithm has provided 9 diagnoses of extrapulmonary diseases. But in the below-mentioned full list with 4 topographical localizations, and 63 47 diagnoses of the extrapulmonary illnesses have been listed.

So, the algorithm provides differential diagnostics of smaller number of illnesses, than present in the full list ones. However, the algorithm provides strategic and tactical differential diagnostics. More exact specification of the diagnosis made by means of additional examinations.

Table 3: Extrapulmonary diseases manifested by local opacity syndrome (frequent diseases written by bold italic font)

I. Formations located in a chest wall (21 diseases).
Problems Of Diseases Manifested By X-ray Local Opacity Syndrome, And Differential Diagnostic Algorithm For Its Solution

1. Anomalies of development of ribs (splitting of the forward end of rib, synostosis between ribs, expansion of the forward end of a rib like a spade, etc.).

2. Diseases of ribs (a swelling of the forward ends of ribs at a rickets, an osteomyelitis or a tuberculosis, solitary cyst or giant cell tumor of bone, osteochondroma, hemangioma, a malignant tumor of a rib).

3. Damages of ribs as a result of a trauma or operations (synostoses after fractures of ribs, reclaims after a partial resection of ribs, partial thoracoplasty).

4. Diseases of a backbone (perifocal and wandering abscesses at spondylitis, the tumours which are starting with vertebrae elements, a spinal cord and its environments, from roots of spinal nerves).

5. Tumours or inflammatory infiltrates soft tissues of a chest wall and the big tumours or infiltrates in breast.

6. Foreign bodies and calcifications in soft tissues of a chest wall.

II. Formations located in a pleura and a pleural cavity (12 diseases).

1. Free or encapsulated congestion of a liquid in a pleural cavity of various nature (transudation, exudation, blood, lymph, bile, contrast mass);
   a) Parietal (costal) effusion;
   b) Interlobar effusion;
   c) Mediastinal effusion;
   d) Diaphragmatic effusion;
   e) A combination of congestions of a liquid in different parts of a pleural cavity (parietal and interlobar, mediastinal and diaphragmatic one, etc.).

Pleural stratifications and pleural thickening in various localization and origin (fibrinogenous pleurisy, adhesive pleurisy, calcifications of the pleura, combined pleural pathology).

Tumors of pleura (malignant mesothelioma, metastases of malignant tumors in pleura).

Extrapleural seal.

Extrapleural oleothorax.

III. Formations located in a diaphragm and subdiaphragmatic organs (5 diseases).

1. Diaphragmatic hernia (esophageal aperture, a sternum-costal triangle, a lumbar-costal triangle, other localization).

2. Hyperplasia or atrophy of one-half of diaphragm or its part (a relaxation of a diaphragm). 3. Rise and deformation of a diaphragm at pathology subphrenic organs (a subdiaphragmatic abscess, an abscess of the top part of the liver, a tumor or cyst of the liver, etc.).

Formations located in mediastinal organs (9 diseases).

1. Benign or malignant primary and metastatic tumors.

2. Congenital malformations (dysembryomas) - dermoid cyst, teratoma.


4. Tumors and cysts of a thymus.

5. Hyperplasia and tumoral increase of mediastinal lymph nodes.

6. Esophageal achalasia with its expansion and bulging in a lung field.

Total 47 diseases

The note. Combinations of extra- and intrapulmonary pathology, causing of a local opacity syndrome have been observed quite often. The most often are the following combinations: a staphylococcal pneumonia with pleural empyema, a pulmonary cancer with pleurisy, pulmonary cancer with metastases in mediastinal lymph nodes, tuberculosis or a chronic pneumonia with pleural adhesions, a wound of lung with hemothorax.

It is difficult to differentiate very small congestion of a liquid in a pleural cavity from pleural stratifications or condensation in a cortical layer of lung. In these cases, decisive data provides an examination in lateroposition of the patient.

If a form and the sizes of the opacity has been change at examination in lateroposition, then it is the sign of a free pleural effusion. If the form and the sizes is not change in lateroposition, then it is a pleural condensation.
RESULTS

In the Tables 4-9 total of 21,573 written diagnoses have been analyzed (21,173 in the USSR, and 400 ones in Israel. Number of diagnoses by radiograms with local opacity syndrome – 6,076, total opacity – 3,350, round shadow 11,399, ring-shaped shadow - 748).

The number of examinees was from 10-12 in one student's group up to 412 students in the big lecture hall. Here diagnostics was carried out under the image of roentgenograms slides and algorithm on two big screens. In this, mass comparative experiment 6,689 written diagnostic conclusions have been received at once.

Many of criteria have been compared. The most demonstrative is a comparison the number of errors in both methods of diagnosis.

+, ±, - Conventional symbols for all Tables in this article: + correct complete diagnosis;

± correct, but incomplete diagnosis; - erroneous diagnosis; 0 absence of diagnosis.

Tables 4-7 Comparative evaluation of traditional and algorithmic diagnostics

at 4 X-ray syndromes (21,573 written diagnostic conclusions in percentage)

1. Independent diagnostics; 2. Diagnostics with DDA; 3. Repeated independent diagnostics after work with the DDA.
Problems Of Diseases Manifested By X-ray Local Opacity Syndrome, And Differential Diagnostic Algorithm For Its Solution

Very often mistakes appear as the result of standard traditional training. True optimal methods effectively eliminate shortcomings of traditional training.

Figure 5
Table 6

<table>
<thead>
<tr>
<th>Examinees</th>
<th>Nr</th>
<th>+</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV year</td>
<td>1</td>
<td>49</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>95</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>83</td>
<td>17</td>
</tr>
<tr>
<td>Students</td>
<td>1</td>
<td>48</td>
<td>52</td>
</tr>
<tr>
<td>VI year</td>
<td>2</td>
<td>96</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>Doctors</td>
<td>1</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>99</td>
<td>1</td>
</tr>
<tr>
<td>Doctors radiologists</td>
<td>1</td>
<td>69</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 7 Comparative evaluation of traditional and algorithmic diagnostics of pulmonary diseases (%) (20 Israeli family doctors, 10 chests X-rays, 400 written diagnostic conclusions, 200 usual + 200 algorithmic ones).

<table>
<thead>
<tr>
<th>Diagnostics</th>
<th>Traditional</th>
<th>With DDA</th>
<th>Reduction with DDA in times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct completely</td>
<td>+</td>
<td>23</td>
<td>67</td>
</tr>
<tr>
<td>Correct partially</td>
<td>±</td>
<td>24</td>
<td>16</td>
</tr>
<tr>
<td>Wrong</td>
<td>-</td>
<td>43</td>
<td>14</td>
</tr>
<tr>
<td>Diagnosis is absent</td>
<td>0</td>
<td>10</td>
<td>3</td>
</tr>
</tbody>
</table>

Footnotes:
Physicians used diagnostics by means of algorithm for the first time in their life.
Short clinical data for each patient were presents to the participants with each chest X-ray.

Figure 8
Table 9. Additional examinations required during diagnostics (20 participants, 400 written diagnostic conclusions)

<table>
<thead>
<tr>
<th>Required exams</th>
<th>Diagnostics</th>
<th>Reduction with DDA in times</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Traditional</td>
<td>Algorithmic</td>
</tr>
<tr>
<td>Clinical</td>
<td>536</td>
<td>63</td>
</tr>
<tr>
<td>Laboratory</td>
<td>167</td>
<td>18</td>
</tr>
<tr>
<td>Special invasive</td>
<td>88</td>
<td>28</td>
</tr>
<tr>
<td>Total additional exams</td>
<td>791</td>
<td>109</td>
</tr>
</tbody>
</table>

Footnotes:
1. The same two participants require almost all superfluous additional examinations to algorithmic diagnostics. All other physicians diagnosed all diseases based on the algorithm only.
2. Clinical data contains 30 various methods/tests/procedures. According to instruction, if a participant of experiment has not write the accurate needed test, then all contents of this method is counting (e.g. history 12 symptoms/signs, physical examinations 14 ones, etc.). However, only method without details was really calculated, i.e. required tests/symptoms/signs were artificially decreased many times.
Comparative estimations data of intellectual activity of students and doctors have accumulated gradually. Part of these data presented in Tables 4-9 with the results of a comparative appraisal of 21,573 written diagnoses, which have received at strict observance of a principle of other equal conditions. Tables 4-9 show unsatisfactory qualification in diagnostic interpretation of a pulmonary radiological picture at the basic X-ray syndromes.

At work with algorithms, the numbers of mistakes decreased sharply, at students from 7 to 45 times at students (from 8.5 to 16.3 at local opacity), from 7.4 to 50 times at doctors, and in 3.7-14.5 times at doctors radiologists. Sometimes numerous mistakes were disappeared at all, even from 31%-36% up to 0%

Tables 4-9 represent strategic importance not only as a demonstration of high efficiency algorithmization thinking in the process of diagnostics. It refutes of the standard axiom that in process of students’ promotion from year to year, and clinical self-training of doctors seniority rising necessarily. This axiom is common to all professional educational institutions, and the whole doctrine of professional education, including of higher medical education.

The reality has appeared unexpected. In independent diagnostics of pulmonary X-ray pictures students of VI year were mistaken more often, than students of IV year, and doctors sometimes were mistaken even more often, than students IV and VI years.

Paradoxical there was a vocational training of doctors-radiologists. It would seem, special professional training and daily practice should provide this category of examinees conclusive advantage before the others. Nevertheless, doctors-radiologists were mistaken as frequently, as students of IV year, diagnosing ring-shaped shadow, and even more often than students of VI year at interpretation of the most rough and expressed changes at a syndrome of total opacity.

The recognition of pulmonary X-ray represents only intellectual task. All signs, which are necessary and sufficient for effective differential diagnostics and reliable diagnosis have directly present on roentgenogram. The examinee should transform available signs into the diagnosis. Nevertheless, often mistakes in this category of experiment convince of an inefficiency of cogitative operations not only at students, but also at doctors, and even at professional radiologists.

Such negative result produces both former Soviet, and the western higher medical education. Hence, as the reason of insufficient qualification geographical, political, social, and so on features cannot serve. Apparently, a general intellectual defect of the higher medical education takes place. We shall try to understand the main reasons of often diagnostic mistakes.

Why arise multitude of diagnostic mistakes? What these reasons can be? What axioms have become obsolete?

What axioms have become obsolete?

The results presented in the Tables 4-9 allow reconsidering the following habitual axioms.

1) Official examinations do not reflect real quality of students and doctors qualification, in particular, in skill of X-ray diagnostics. An effective thinking has not generated; therefore, diagnostic errors occur often, even at the recognition of simple classical X-ray pictures.

2) A quality of pulmonary X-ray diagnostics professional training of medical students, physicians, and even professional radiologists is unsatisfactory, and has been accompanied by often mistakes.

3) This quality does not rise in process of increase of duration of traditional medical education in reality.

4) Daily practical activity with a constant pulmonary X-ray diagnostics is not a tool and a guarantee of effective self-training using traditional nosological literature.

5) The main reason of unsatisfactory X-ray diagnostics training is not optimal nosological thinking.

6) It is necessary to create new optimal forms and methods of self-training of syndromic algorithmic X-ray diagnostics.

7) Presented data remains actual and today, and induce to reconsider critically existing ideas and methods of traditional training of X-ray diagnostics during undergraduate and postgraduate professional medical education.

Preamble to Differential Diagnostic Algorithm for diseases, manifested with X-ray local opacity

Differential Diagnostic Algorithm for diseases, manifested by local opacity, has intended for medical students and
family doctors, general practitioners working in polyclinics. However, the DDA can also be useful for radiologists, helping to accelerate of diagnostics and reduce the price of X-ray examinations.

Such doctors have constant deficiency of a time during their work with patients. There are also financial and organizational restrictions in use of the advanced expensive diagnostic methods.

The algorithm presented below has created in view of these restrictions. Differential diagnostics at the first stages has carried out on the most accessible s/s and during the shortest time. More exact methods, mainly bacteriological, serological examinations appear at last stages of diagnostic decision-making process.

The work with diagnostic algorithm

Each stage of the algorithm has been printed by larger bold font, has the serial number, and represents one concrete sign. From each sign, there are two or more branches with the words “present” or “absent”, or appropriate concrete signs.

New branches go away from each sign. Here again three variants of the conclusions have been present.

1) The intermediate conclusions, which have no number, and has been written by the bold italic font.

2) The numbered list of diseases to which following differential diagnostics is necessary at the subsequent stages of the algorithm.

3) The final diagnosis, which have been written by the bold font and underlined.

Algorithmic thinking is very effective and economical. 36 diagnoses have established on the basis from 1 up to 6 signs. It allows to establish diagnoses very quickly, already at the first examination of the X-ray. Special additional methods of examination have used at the last stages of diagnostics.

In most cases, the algorithmic diagnosis can be considered as the final diagnosis. However, in special cases, e.g., if surgical intervention is required, then exact preoperative diagnosis is necessary. With this purpose under many diagnoses, the bold font specifies appropriate recommendations.

List of diseases, manifested by local opacity and included to DDA
Figure 14

If it is necessary to pass at the night on twisting path, not seeing the future bends, it is necessary to go, groping the path by a leg. In the daytime the man will run along on this path rapidly, since the forthcoming route is seen to him.

Ishikava Kunigiko

The Differential Diagnostic Algorithms developed by the author completely coincide with practical purposes of diagnostics.

1. The DDA has based on a syndromic principle of thinking. Each algorithm has designed for the certain large syndrome, and provides diagnostics of all diseases manifested by given syndrome.

2. Differential diagnostics of diseases inside of each syndrome provides by minimum of the most informative decisive s/s.

3. The algorithm does not contain anything superfluous, but only the most necessary for fast effective differential diagnostics and an establishment of reliable diagnosis by the most convincing s/s.

The idea of algorithmic diagnostics seems as a non-standard, but quite natural. The offered DDA allows solving the diagnostic problem on the highest intellectual level.

By means of a few decisive radiological and simplest clinical s/s of the DDA 36 diagnoses have been established. In special cases, when a surgical intervention or antibacterial therapy it is assumed, the following additional tests have been recommended.

Bacteriological and serological data – 8 times; ANCA – 1; pleural puncture with a liquid examination – 2; pleural puncture + biopsy – 1; CT – 2; bronchoscopy with biopsy – 2; open lung biopsy - 1

It is easy to see that, with usual nosological thinking expensive additional surveys would be assigned much more. True optimal methods of thinking effectively eliminate lacks of traditional training.

The X-ray local opacity DDA advantages

1. Fast and reliable diagnosis of each disease that has been included in the DDA;
2. Comprehensive differential diagnosis of majority diseases manifested by common given X-ray syndrome;
3. Each step of the diagnostic reasoning process quickly diminishes a number of probable diseases;
4. The final 36 diagnoses can be achieved within maximum 6 steps;
5. A work with the DDA from the beginning to diagnosis takes minutes;
6. Conclusion for user with reliable final diagnosis and fixation of each revealed s/s;
7. The best combination of the most effective several original training systems and tools.
8. Available anytime, anywhere;
9. Guaranteed consistency;
10. Personalized and relevant;
11. Costs have been reduced;
12. Accessibility is increased;
13. Community-orientation is enhanced.

For practical mastering the DDA it is not necessary to remember all its structure, signs and diagnoses. The algorithm has been acquired very quickly at the decision of diagnostic tasks. Each diagnostic task should be focused on the diagnosis included in algorithm. In a task there should be the s/s available in the DDA. The formulation of symptoms in a task and in the DDA should be identical. If s/s in tasks and in algorithm will be formulated differently, the student
not always can identify various formulations. For this reason, identity of the formulation of s/s in the algorithm and the tasks is important. To train in mastering by algorithmic diagnostics it is useful also, establishing diagnoses on illustrations of roentgenograms in books and journals. Certainly, to such testing of the algorithm to be only the X-ray picture, which belong to the local opacity syndrome.

On algorithm will not be also established such diagnoses, which correspond to the given syndrome, but not available in the algorithm. After training the decision of diagnostic tasks and photocopies of roentgenograms, mastering of the DDA will be generated very quickly. After that, a student and a doctor with already generated syndromic algorithmic thinking will establish reliable diagnoses easily and quickly, not looking any more in the algorithm.

What else advantages give syndromic algorithmic approach to diagnostic decision-making?

General practitioners, family doctors, and even experts very often designated of CT for diagnosis at many pulmonary diseases. I have studied personally and sorted again into radiological syndromes (Table 1) huge radiological archive in Pulmonary Department of the largest hospital of Israel in Beer-Sheva. The roentgenograms in this archive have reflected all radiological syndromes. In each package there were a long-term series of roentgenograms, and a complex of computer tomograms of every patient. First, I looked through standard chest roentgenograms, and only then have studied s/s of each patient. Hundreds cases have been compared carefully, but only at several patients CT brought corrective amendments in a diagnostic estimation of the image on simple chest roentgenograms. Apparently, wide assignment of s/s for pulmonary pathologies diagnostics is superfluous. At the syndromic approach, effective algorithmic differential diagnostics in overwhelming majority of cases can be carried out under simple survey chest roentgenograms.

The strategic principle of the DDA is “To spend a minimum for receiving a maximum”

The most effective professional self-training ensuring the most reliable diagnosis for medical professionals in the most efficient way, using minimum medical examinations, minimum signs, the doctor’s least efforts, the shortest time for a patient and a physician, and efficient costs of diagnosis. The DDA is the most effective means for self-learning and quality of diagnosis optimization. Modern universal value of DDA is that algorithms can submit to user both in paper, and in computer variants. Today in the world is more than 1 billion of personal computers, including at physicians and medical students.

The DDA international significance has been defined by the following. 24 countries-members of OECD have a total population ~885,000,000, physicians ~2,000,000, hospital beds ~7,000,000, 1642 higher medical schools worldwide.

The biggest contemporary problem is a globalization of education. New unusual requirements have appeared - to learn effectively of EACH learner. Here and now a very old Pestalozzi’s idea still applies: “Just methodology is the main element of learning, which has been given and mastering during a process of a learning”.

CORRESPONDENCE TO

Prof. Leonid Naumov E-mail: leonaumov@zahav.net.il

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Author Information

Leonid B. Naumov, DScMed
Professor, Center for Medical Decision-Making, Faculty of Health Sciences, Ben-Gurion University of the Negev