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Laboratory tests in geriatric patients - an overview of the latest reports

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Abstract

Laboratory tests are extremely important in patient's monitoring and/or diagnosing. We described those that are particularly significant for elderly patients, namely: peripheral blood morphology, arterial blood gasometry, cancer markers. The aim of this article is to summarize current knowledge about laboratory tests important in geriatrics, as well as draw attention to the diverse use of laboratory tests in clinical practise.

Keywords: laboratory tests; geriatrics; blood morphology

Introduction

Laboratory tests are used to find patients with diseases or people with some risk factors. Moreover they are used to make decisions about treatment and to estimate remission of disease [1]. What is important laboratory tests can be used to estimate advance routine frailty assessment, especially in combination with other appropriate parameters from medical records [2].

For example, one of the most used laboratory tests to health evaluation is Complete Blood Count (CBC) [3]. Many laboratory indicators including apoA1, apoB, homocystein, hsCRP or albumin in urine play a role in risk assesment of cardiovascular diseases or diabetes mellitus. There is some clinical tests that ApoA1 concentration increase with age. Moreover, homocysteine concentration is observed to be lower in adult women than adult men, which have a cardioprotective effect in this group. What is more there are some recent guidelines from the Canadian and American Diabetes Associations that concentration of HbA1c should be used for diagnosing type 2 diabetes and assesing the increased risk and pre-diabetic conditions. There some clinical reports that there are two partitions for HbA1c , one containing patients at age 6-39 years old and 40-79 years old. In the second age group observed slightly higher values of HbA1c concentration which are higher than the reference interval [4].

Reference values are necessary to interpret results of laboratory tests and to management of patients in clinical conditions and research. Laboratory ranges are determined based on many factors : age, gender, dietary habits, ethnicity, and the environment. They must be appropriate for the proper population to correct interpretation [5].

There are some doubts whether haemoglobin and other haematology results, which are used for young adults, are legitimate for geriatric patients. Haemoglobin decrease with age especially comparing men to women. It is probably caused by some age- related conditions which can lead to reduce of haemoglobin, such as: decrease in the number of haematopoietic progenitors, smaller sensivity of these progenitors to growth factors and decrease in intensity of secretion of erythropoietin, which may cause to lower reference values for haemoglobin in laboratory results of older people compared to results of younger people [6].

Results

1. Blood morphology – the importance in clinical practice

Blood morphology tests are basic ones of laboratory tests. The following is a description of the most important parameters:

-WBC (white blood cells), among them NE (neutrophils), LY (lymphocytes), MO (monocytes) and MID (includes monocytes, eosinophils, basophils and abnormal cells, eg blastoma). If WBC are increased that means there is leukocytosis, if they are reduced that means there is leukopenia. The increase of NE can suggest infection, the reduce might suggest lowering immunity for bacterial and fungal infections. LY increase may suggest chronic lymphatic leukemia. An anomaly LY decrease may suggest AIDS or granulomatous lymphoma. The increase of MID is the most dangerous all among leucoties, because they indicate serious types of leukemia. Furthermore BASO (basophils) requires necessary hematological consultation; increase of EO (eosinophils) declaring that we are dealing with an allergy, a parasitic disease.

-RBC (red blood cells), HGB (hemoglobin), HCT (hematocrite - the ratio of erythrocyte volume to whole blood volume). The disturbance of these parameters is closely related. The decrease may suggest anemia, while the increase of these parameters above the norm can suggest polycythemia.

-MCV (mean corpuscular volume) the increase of this parameter above the norm suggests about the increase of erythrocytes (macrocytes), while the decrease of this parameter below the standard tells us about the reduction of the size of erythrocytes (microcytes).

-MCH (mean content of hemoglobin), MCHC (mean cell hemoglobin concentration) - if these parameters are below the norm it suggests that the erythrocytes are hypochromic, while if they are above the norm it suggests hyperchromic red blood cells.

-Retics (immature forms of red blood cells) their number is an indicator of the production of red blood cells.

-RDW (relative dimension width) is an index of anisocytosis that defines a variety of blood cell sizes.

-PLT (platelets).

The results of blood morphology are always given correct values and if any parameter deviates from the norm it is marked with the letters H (high) or L (low). The more the given parameter deviates from the norm, the more serious the illness affects, and small deviations from the norm may suggest the beginning of some diseases or may be completely accidental. Large deviations from the norm inform us about the disease but it does not have to affect blood diseases. Only further diagnostics will help to make the right diagnosis. If we interpret the result of the blood morphology and there are deviations from the norm, the earlier results of the patient's examinations are very helpful. They show whether such abnormalities occurred before [1].

In acute leukemia, a neoplastic disease of the hematopoietic system characterized by clonal proliferation, abnormal maturation and release of white blood cells into the peripheral blood, all parameters except the MCV change [2]. WBC is significantly elevated. NE, LY, MO and MID are significantly increased depending on the type of leukemia, only one or several parameters may increase at the same time. RBC and PLT are usually lowered because they are replaced by white blood cell cells, which can lead to anemia and thrombocytopenia. Based on the blood morphology, we can not determine a specific type of leukemia, whether it is myeloid or lymphoblastic. Immunophenotyping and genetic testing should be used for further diagnosis. In Chronic Lymphocytic Leukemia, that is B-cell monoclonal lymphocytosis, which lasts at least 3 months, will increase, but not as much as in the case of acute leukemia WBC and LY while maintaining other parameters in the norm or deviating from the norm [3]. Genetic research will be needed here, because it may also be suggested by leukemic reaction.

Significantly elevated RBC, while maintaining the norm of other parameters, may indicate a myeloproliferative syndrome, whose complication may be transformation to acute leukemia [4]. It may be secondary to eg lung disease. However, a significant reduction in RBC may indicate anemia. Depending on the parameters described above, MCV, MCH and MCHC may be microcytic or macrocytic, as well as hypochromic, hyperchromic or normochromic.

If PLT are significantly lowered, it may occur thrombocytopenia, which may lead to impaired wound healing and may even cause fatal haemorrhages, but if PLT are significantly elevated, it may cause excessive clotting, which may result in stroke or infarction or suggest a rare type of cancer blood called essential thrombocythemia [5].

2. Arterial blood gasometry (ABG) test - the importance in medical practise.

The evaluation of arterial blood gases was used, among others, in predicting further prognoses for patients with COPD. According to the collected data, blood gasometry, which is a simple procedure collected at the patient's bed, allows for quick analysis and change of treatment for patients. This is due to the main cause of COPD, which is smoking cigarettes. Hypercapnia and acidosis were shown for patients with severe COPD in gasometry. It turned

out that this is associated with a worse prognosis and a longer time of hospitalization of such patients. Regarding patients with a stable condition - such patients had normal blood gas values, which allowed for a shorter hospitalization and better prognosis [1].

Patients from the intensive care unit and hospitalized patients were tested for the parallel between venous and arterial blood gasometry. The aim was to find out whether venous blood is a good alternative to arterial blood in acid-base balance studies. Studies have shown that venous blood may allow us to initially assess the acid-base balance in critically ill patients. In addition, arterial blood gases can only be performed for confirmation. However, venous blood gasometry could be sufficient to check the patient's response to treatment [2].

Blood arterial gasometry was also studied in patients with severe head trauma. This factor was examined (along with others) to see how they relate to the prognosis of patients with traumatic brain injury. In this study, the obtained values were compared to the parameters of healthy people. Many laboratory parameters were tested, including PT, INR, Na. However, in the case of the ABG test, the pCO₂ values, HCO₃⁻ and SO₂ have changed significantly. As it turned out, it did not affect the prognostic value of patients with severe head trauma, as opposed to Cr, Na⁺, INR, PT, or GCS [3].

Other studies inform that different marker can be also used in obese patients with acute dyspnea. Regarding to obese patients, arterial pH may selectively predicts critical care needs in ED. The authors of the study realised that pH <7,36 should be consider as a marker of severity when assessing acute dyspnea in obese ED patients. Arterial pH is independent predictor in obese patients, but it isn't relevant in non-obese patients [4].

When taking arterial blood, it should be taken into account that arterial puncture is a painful procedure. For this reason, efforts are being made to introduce new blood collection techniques to clinical practice. Particular hopes are associated with collecting blood from capillaries, an example of which is the technique of puncturing capillaries from the earlobe, which has been promoted for decades as a substitute for puncturing arteries. In the following years, the issue of higher efficiency of blood collection from capillaries was raised in a study by Dar et al., in which participated 55 patients. Attention was drawn not only to the slight difference in the biochemical composition between blood taken from the artery and blood taken from the capillaries, but also to the benefits of much less pain when puncturing the earlobe [5]. This is particularly important in patients with low mental resistance to pain, so further efforts should be made to examine and promote capillary punctures for arterial blood testing.

3. Geriatric cancer markers

The most common types of male cancer are prostate, lungs & bronchus, colon&rectum and pancreas cancer. Female most frequently occurring cancer types are breast, lung&bronchus, colon&rectum and pancreas. There are some biochemical indicators of presence of a tumor named cancer markers that help to detect, differentiate and determine the risk of cancer. Although they are not perfect to detect tumor, they can be used to monitor treatment and to determine the prognosis.

Carcinoembryonic antigen (CEA) is a high molecular weight glycoprotein belonging to the immunoglobulin superfamily of molecules [1]. CEA is being detected in serum and it is being used to detect colorectal carcinoma, pancreatic carcinoma, gastric and breast carcinoma. The tests are positive for colorectal cancer in 60-80%, less for pancreatic cancer- 50-80%, and for gastric and breast carcinoma at 25-50%. The level of CEA in serum also rise in many benign disorders as alcoholic cirrhosis, hepatitis, ulcerative colitis [2]. It is not recommended to use CEA as a screen for early stages of colorectal cancer, because of inadequate sensitivity in screening, but trends in CEA measurements apart form single test result are being used to monitor treatment of colorectal cancer and improve diagnostic accuracy for recurrence [1, 3].

Estrogen receptor (ER) and progesterone receptor (PR) are very important indicators determining the validity of hormone therapy for patients with breast cancer. ER and PR can be detected by enzyme-linked immunosorbent assay (ELISA) or immunohistochemistry (IHC) from patient's blood.

Human epidermal growth factor-2 (HER2) – overexpression of this marker announces more aggressive disease with a poor prognosis. This marker should be quantified to select patients with breast cancer that may be treated with trastuzumab [4].

Prostate-specific antigen (PSA) is being produced either by healthy and malignant prostatic glands, that is why 67% of men with a high PSA do not have a cancer and 20% of men with cancer have PSA within the normal range. Furthermore this cancer marker's level increases with age or in benign prostatic hyperplasia, urinary tract infection and digital rectal examination. Notwithstanding PSA is the basic marker used to detect early stage of yet curable prostate cancer, to monitor tumor recurrence or progression following definitive treatment [5]. There were some steps taken to improve specificity as measurements of free PSA, complexed PSA, PSA velocity, PSA density and age specific reference values [6].

CA-125 is the tumor marker for ovarian cancer and it is the most common marker used to detect this type of tumor because about 80% of patients with advanced ovarian cancer have increased level of CA-125. Unfortunately this marker is not perfect for the reason that only 50-60% of patients with early-stage ovarian cancer have CA-125 above the normal level, and it also rises in such diseases like pancreatic cancer, breast cancer, bladder cancer, liver cancer, lung cancer, diverticulitis, cirrhotic, endometriosis, or in some physiological conditions like menstruation or pregnancy. That is why CA-125 should not be used for screening ovarian cancer [7].

4. The importance of laboratory tests in geriatric emergencies

Laboratory diagnostics is a dynamically developing discipline of medicine. Research aimed at determining the biological and physicochemical parameters of blood essential for patients in emergency situations, eg in patients with stroke, are becoming more and more numerous in different parts of the world [1].

The most common laboratory tests performed in hospitals in both departments and emergency departments include peripheral blood counts, electrolytes, urea and creatinine, glucose and enzymes. It is also worth to assess the level of troponin I. In patients with stroke, such tests are primarily aimed at obtaining a general picture of the patient's condition. They also allow to determine the patient's condition, the degree of homeostasis of the organism and allow to explain the cause and pathogenesis of the disease. Other key parameters in the diagnosis of stroke include, but are not limited to, brain natriuretic peptide (BNP), von Willebrand factor (vWF), TNF-alpha, neurospecific enolase (NSE), leptin. An important and one of the most frequently studied biomarkers in the course of stroke is the brain natriuretic peptide (BNP). BNP is a peptide neurohormone produced by cardiac myocytes. The main task of BNP is to preserve homeostasis - namely the pressure and volume of circulating blood. It is secreted due to the increase in the extension of the heart muscle wall - as a consequence of volume or pressure overload. In the acute phase of the stroke, patients can be observed to increase the level of BNP in plasma and increase the concentration of its biologically inactive final fragments - NT-proBNP. The scientific study proves that the BNP concentration in plasma is elevated in people with cerebrovascular disease regardless of heart disease. Another parameter whose activity increases in the course of stroke is von Willebrand factor - vWF. It has been proven that there is a relationship between acute elevation of endothelial markers in the blood and platelet activation, and ischemic stroke. vWF is helpful in making decisions about the implementation of anticoagulant therapy, especially in patients who are in the group with moderate risk of stroke [2, 3, 4].

Another sudden condition, a possible life-threatening condition is a pain in the chest area. In the diagnosis of myocardial infarction, it is preferable to test the concentration of high-sensitivity cardiac troponins (hs-cTn) in the blood. This test is in line with the guidelines for the diagnosis of acute coronary syndromes. However, other tests, such as blood counts, coagulogram, lipidogram, determination of potassium, sodium and magnesium, creatinine, urea and glucose, must not be forgotten. All parameters studied have influence on making decisions regarding further treatment of the patient, they allow to assess the patient's current condition and homeostasis. Rapid diagnosis of patients with chest pain is important not only for proper behavior, but also for the hospital from the point of view of economics [1, 5, 6].

5. The latest trends and directions of research

Modern laboratory diagnostics can save lives. In many diseases, early diagnosis is crucial, which is why prevention and specialist examinations are so important. From year to year they can bring new diagnostic possibilities.

Prostate cancer is a very common disease among elderly men. PSA is a commonly used marker which can help in early detection of this cancer. Unfortunately, it appeared that PSA participates in overdiagnosis of less aggressive cancer [1]. Consequently, to reduce the overidentification of low risk cancers and improve the detection of those cancers which are clinically significant - new blood-based biomarkers have been taken into consideration. The 4K panel have been developed and it is recommended to avoid prostate biopsy. 4K is a statistical model based on four kallikrein markers which combines total PSA, free-PSA, intact PSA, and Hk2 in blood. Its accuracy in detecting the advanced prostate cancers is substantially high [2]. PHI, ExoDx, SelectMDx are also recommended as biomarkers that can increase the diagnosis of clinically significant tumors and to select patients for biopsy. PCA3 and ConfirmMDx are for patients with suspicion of prostate cancer but with negative biopsy, to check if rebiopsy is needed. Oncotype DX and Decipher are prognostic and can be helpful in choosing whether the treatment should be radical or conservative. Decipher and Prolaris can be used in decision if adjuvant radiation therapy is needed [3].

When it comes to Alzheimer's disease new studies have shown that cerebrospinal fluid biomarkers can have a great diagnostic accuracy. The potential in using platelet tau protein in indication of early stages of cognitive impairment is very promising [4]. Furthermore, for early idiopathic Parkinson disease there is a potentially useful and noninvasive biomarker such as salivary heme oxygenase-1 which has been implicated in the pathogenesis of this disease [5].

Osteoporosis is a common disorder, especially affecting postmenopausal women. It is often diagnosed too late when the damage has already appeared. The fracture has a dangerous health outcomes so new biomarkers are needed to diagnose this disease in its early stages. There is a huge focus on miRNA and small noncoding RNA. They can be also used in stratification of risk and fractures [6].

It is important to look for new solutions all the time. Many diseases leave certain trails and scientists find it significant to research it and make it a new standard in diagnosis.

Discussion

The aim of our article is to draw attention to the diverse use of laboratory tests in clinical practice, as well as to show differences between their use in geriatric patients in relation to other patients. Laboratory diagnosis is helpful when determining the next stages of treatment, remission assessment and also when trying to select people with specific risk factors or diseases. An appropriate development of laboratory ranges takes into account gender, age, genetic and environmental determinants for a given population. This allows for a better interpretation of the research.

Indicators such as homocysteine, hsCRP or apoA1 are used to assess the risk in diabetes and cardiovascular diseases. It is worth noting that the reference ranges of parameters such as apoA1 or HbA1c may be higher in the elderly. However, for haemoglobin they may be lower than for the rest of the population.

A change in the concentration of individual laboratory parameters may suggest specific disease entities, for example MID increase may indicate serious types of leukemia, and a reduction in LY-AIDS anomalies or granulomatous lymphoma. A decrease in the PLT number leads to abnormal wound healing, and the increase to excessive clotting, which occurs in a rare condition that is essential thrombocythaemia.

Arterial blood gas assessment can be used as a prognostic factor in COPD patients as well as in obese patients. In the first group, hypercapnia and acidosis increase the risk of prolonged hospitalization and unfavorable prognosis. However, in the case of obese patients with ED pH <7.36, it is an indicator of the severity of acute dyspnoea.

Tumor markers are biochemical indicators used primarily to monitor treatment and determine prognosis. This function is performed by the estrogen and progesterone receptors in breast cancer or prostate specific antigen in prostate cancer. They are less frequently used in screening tests due to insufficient sensitivity.

In emergency states such as a stroke, it is worth determining the brain natriuretic peptide, von Willebrand factor or TNF-alpha. The level of BNP in plasma also increases in patients with cerebrovascular disease. Increasing troponin concentration with high sensitivity is the basis for diagnosing infarction. The above parameters should also be taken into account when assessing homeostasis and current patient status.

Recent research indicates the possibility of using unknown markers, for example salivary heme oxygenase 1 in the course of idiopathic Parkinson's disease or miRNA in the stratification of risk and fractures in the case of osteoporosis. We want to encourage the medical community to seek new solutions for laboratory research, as well as to gain current knowledge about them, so that the patient's diagnosis becomes even faster and more accurate.

Conclusions

Blood laboratory tests are necessary in the care of a geriatric patient. The primary practitioner's task is to guide your patient in order to detect the most common diseases characteristic of this age group. The levels of WBC, LY, MO and MID should be investigated to exclude leukocytosis, leukopenia and various infections. Cancer, allergies and anemia should be considered. Genetic testing may be necessary. In the interpretation of the result, attention should be paid to the level of deviation from the norm and to extend the diagnosis in case of any doubts. Arterial blood gas measurement is performed primarily in patients with COPD and intensive care units. It is used in simple diagnostics of acidosis and hypercapnia, which results in a poor prognosis of the patient. Venous blood is also suitable for blood gas testing. In order to broaden the diagnosis and make the right diagnosis, it is worth checking the cancer markers, especially those diseases that most often occur in geriatric patients. These include markers characterizing breast cancer, lung and bronchus, prostate, colon and rectum as well as pancreas. There are also markers that are detected not only in cancer but also in other benign conditions. It should be remembered that there are markers (CA-125) that also grow in the course of other neoplastic diseases than those characteristic of themselves. Markers play the role of monitoring the course of the disease. Blood tests in a geriatric patient are necessary in emergencies and life-threatening situations. Performing these tests and their quick interpretation allow you to take appropriate actions to save health and life. In addition, proper diagnosis reduces the cost of hospital treatment. The most common parameters that are tested for emergency diagnosis are glucose, morphology, troponin I, urea, enzymes, electrolytes, creatinine. Also, be sure to examine the brain natriuretic peptide

(BNP), von Willebrand factor (vWF), TNF-alpha, neurospecific enolase (NSE), leptin and high-sensitivity cardiac troponins (hs-cTn) in the blood. Laboratory diagnostics of blood is becoming more and more modern. Its purpose is not only to diagnose numerous diseases, but also to predict further treatment.

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