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DIAGNOSTICS AND TREATMENT OF PURULOUS-SEPTICCOMPLICATIONS OF SUBCLUSIVE VIN CATHETERIZATION (LITERATURE REVIEW)

Abstract: The problem of diagnosis and treatment of purulent-septic complications of subclavian vein catheterization has long attracted the attention of surgeons, anesthesiologists-resuscitators and specialists in surgical infections. The incidence of these complications, according to various authors, is very variable and ranges from 0.07% to 17.5%. According to the National Nosocomial Infection Surveillance, there are about 200,000 subclavian catheter infections reported annually in the United States (NNIS System Report, 1998). In Russia and, in particular, in St. Petersburg, bacteremia is detected in 9.3% of patients with subclavian catheters.

key words:purulent-septic complications, diagnostics, catheterization of the subclavian vein.

Clinical picture, diagnosis and prevention of purulent-septic complications that developed after the introduction of a subclavian catheter.

Microorganisms that cause catheter-associated infections most often enter the bloodstream from the skin at the site of catheter insertion. They migrate from the skin surface of the catheter insertion site along its outer surface, colonizing the distal end and thrombi located in the lumen of the vessel. Thus, a septic focus is formed. Its localization directly in the bloodstream determines the pathogenetic essence, clinical picture and prognosis of the disease.

The first sign of a local manifestation of the inflammatory process in the catheterized vein, which later leads to generalization of infection, is the appearance of pain along the vein during infusion. Then there are complaints of pain in the neck on the side of catheterization, swelling and cyanosis of the upper limb, dilatation of the saphenous veins of this area. Edema of the upper limb and neck develops on the side of catheterization [2]. Perhaps the occurrence of inflammatory edema in the area of the catheter, the appearance of hyperemia and purulent discharge through catheter wound with pressure on the area of introduction of the catheter [2].

With the development of thrombosis of the internal jugular vein, in addition to swelling and pain in the neck, patients report pain when swallowing. The jugular vein is palpable in the form of a dense painful cord, often visible to the eye [4].

At the same time, colonization of the catheter (especially by representatives of the skin microflora) can often proceed without clinical symptoms, which is associated with the low virulence of such pathogens [5].

With the development of a primary focus in the internal jugular vein due to the migration of the subclavian catheter there, together with the clinic thrombosis of the subclavian vein, a picture of infiltration develops, and then a deep phlegmon of the neck, which is described by V.F. Voyno-Yasenetsky in 1956 as the so-called "woody" phlegmon.

General clinical symptoms consist of signs of a systemic inflammatory response (SIRS): tachycardia (>90/min.), hyperventilation (respiratory rate>20/min.), blood leukocytosis (>12x109/l), fever (t>38°C) with further signs of sepsis with the progression of the complication [6].

Clinically, angiogenic sepsis (catheter-associated sepsis) is manifested by symptoms of sepsis of any other origin, but at the same time has some features. Characteristic is the coincidence in time of periods of temperature rise with intravenous administration of drugs [5].

M.I. Lytkin, NH Shikhverdiev (2017), based on their own observations (142 cases), distinguish the following criteria for a reasonable diagnosis of angiogenic sepsis:

1. localization of the source of infection in the vascular bed

2. the presence of clinical and laboratory signs of sepsis: fever with chills and increased sweating, especially after intravenous and intra-arterial infusions, signs of intoxication, the presence of metastatic purulent foci, progressive worsening of the condition, leukocytosis with a shift in the formula to the left, lymphopenia, anemia, hypoproteinemia, manifestation of insufficiency of those or other organs or systems; inconsistency of local signs of infection with the general reaction of the body, the disappearance of clinical manifestations and the normalization of laboratory parameters after removal of the catheter;

3. The presence of bacteremia.

With negative blood culture data, it should be borne in mind that bacteremia cannot be permanent due to the bactericidal properties of blood and the partially preserved ability of the body to delimit focus of infection. The breakthrough of the infection into the bloodstream is usually accompanied by hyperthermia, and blood sampling for culture must be done precisely at the height of the fever (Lytkin M.I., Shpkhverdiev N.N., 2017; Schwartz N.S., Nguyen DC, 2009). V.A. Gologorsky and co-authors (2018) consider the identity of the microflora inoculated from the catheter and blood in the presence of clinical signs of a generalized infectious process to be a prerequisite for the diagnosis of angiogenic sepsis.

At present, a scoring of the severity of violations of those or other organs and systems in sepsis has been adopted. Among the most simple and common are the SOFA (Sepsis Oriented Failure Assessment) scale and the MODS (Multiple Organs Disfunction Score) scale. The SOFA scale was developed JLVincent in 2006, adopted by the European Society for Intensive Care Medicine (ESIM). The scale is very easy to use and is available for almost any hospital that has a biochemical laboratory (Kostyuchenko A.L. et al., 2016). It is used to assess the severity of organ disorders, which makes it possible to objectively identify a group of patients with severe sepsis and describe the developing violations. To assess the severity of a condition at a particular point in time, the APACHE II (Acute Physiological and Chronic Health Estimation II) (Kostyuchenko A.L. et al., 2016; Beloborodov V.B., 2012; Gelfand B.R. et al., 2013).

Methods for diagnosing purulent-septic complications of catheterization of the subclavian vein, first of all, consist in assessing clinical manifestations, a thorough examination of the catheterization site, upper limb and neck on the side of catheterization. Measurement of central venous pressure is of great diagnostic importance for diagnosing vein thrombosis (Portnoy M.V., 2018; Stoyko Yu.M. et al., 2012; Sanders RJ, Haug C, 2018; Ena J. et al., 2018).

Ultrasound is a modern method for diagnosing obstruction of the subclavian vein. The advantage of ultrasound diagnostics is ease of use, non-invasiveness, and the possibility of repeated use to assess the dynamics of the process [7,8,9].

The leading method for diagnosing vein thrombosis today can be considered duplex angioscanning [10,11], which allows you to combine the ability to view (information about morphology) with the definition of Doppler analysis (hemodynamic information). In studies by GM Baxter et al. (2015) color Doppler ultrasound in the diagnosis of subclavian axillary vein thrombosis had a sensitivity and specificity of 100% in comparison with the results of phlebography. Other authors note that ultrasound research methods can often give false results in the diagnosis of obstruction of the subclavian vein [12,6]. MB Grinev et al. (2010) indicate the great diagnostic value of ultrasound research methods in the diagnosis of infiltrates, abscesses and phlegmon in the area of the subclavian catheter.

When conducting an ultrasound examination of catheterized veins with developed thrombosis, the acute stage of the process is characterized by a homogeneous, hypo- or anechoic structure of a thrombus, for the subacute stage and the stage of post-thrombotic disease - heterogeneous with the presence in the structure of areas of both low and high echogenicity [7,13].

Contrast phlebography, according to Yu.M. Stoyko et al. (2012), is the "gold standard" for diagnosing venous pathology. Phlebography allows you to determine the localization and extent of thrombosis, the degree of development of collateral outflow tracts of blood, the degree of recanalization of the thrombus, as well as the severity of post-thrombotic changes in the veins. However, according to R.Z. Losev (2010), the accuracy of the ultrasound method is 95% compared to phlebographic data, and its speed, non-invasiveness, absence of complications and contraindications for implementation, the possibility of monitoring control make ultrasound one of the leading methods for diagnosing venous thrombosis.

For successful diagnosis of purulent-septic complications of subclavian vein catheterization, scintigraphy, rheovasography, and nuclear magnetic resonance can be used [6,9,14,15,16].

Microbiological examination of the removed catheter and blood is extremely important for establishing the etiology of the developed complications and their adequate treatment.

Subject to strict requirements for the correct sampling of material and the use of modern microbiological techniques, a positive blood culture in sepsis is observed in 80-90% of cases [17].

Described by DG Maki et al., in 2017, the method of seeding the tip of the catheter (rolling it over a dense nutrient medium) is used by many authors to determine the contamination of the outer surface of the catheter [17].

The frequency of flora seeding from the catheter tip ranges from 26% to 43%. X. Lode (2018), G. Ferretti et al. (2013) suggest carrying out quantitative microbiological studies - the number of colonies isolated from a blood sample taken through a catheter should be five times higher than that isolated from a simultaneously taken peripheral blood sample. For a more complete seeding of the internal contents of the catheter, it is proposed to use special brushes, followed by centrifugation and staining of the leukocyte sediment with acridine orange. According to X. Lode (2018), in patients receiving total parenteral nutrition, this method had a sensitivity of 95% and a specificity of 84%. Bacteriological diagnosis of catheter septicemia requires multiple peripheral blood cultures, both venous and arterial. If a catheter infection is suspected, blood cultures should be performed from the catheter and an intact peripheral vein. A positive result is the isolation of identical pathogens [17,18,19,20].

Yakovlev SV. (2010) proposes the following rules for making an adequate microbiological diagnosis of catheter infection and sepsis:

1. Blood for research must be taken before the appointment of antibiotics. If the patient is already receiving antibiotic therapy, then, if possible, antibiotics should be discontinued for at least 24 hours, after which blood sampling should be carried out. In cases where it is impossible to cancel antibiotics, blood should be taken immediately before the next administration of the drug.

2. The required minimum sampling is two samples taken from different hands with an interval of 30 minutes. It is optimal to take three blood samples, which significantly increases the detection of the pathogen. Studies have shown that more samples have no advantage over sampling three times in terms of the frequency of detection of pathogens.

3. Blood for research must be taken from a peripheral vein.

No benefit of arterial blood sampling has been shown. If catheter-associated sepsis is suspected, a intact peripheral vein and through a suspicious catheter. If the same microorganism is isolated from both samples, and the quantitative ratio of

contamination of samples from the catheter and vein is equal to or more than 5, then the catheter is most likely a source of sepsis. The sensitivity of this diagnostic method is more than 80%, and the specificity reaches 100%.

4. It is more optimal to use standard special vials with ready-made culture media, rather than vials with culture media closed with cotton-gauze stoppers prepared in the laboratory. Firstly, laboratory-prepared media are not sufficiently standardized and the frequency of isolation of microorganisms from the blood during their use is significantly lower. Secondly, when opening the vial and introducing a blood sample from the syringe, there is a risk of contamination of the nutrient medium with air microflora. In addition, negative pressure is created in commercial vials, which ensures the supply of a strictly defined amount of blood without contact with the environment when using an adapter system with needles at opposite ends of the catheter.

5. Blood sampling from a peripheral vein should be carried out with careful observance of asepsis. The skin at the venipuncture site is treated with a solution of iodine or povidone-iodine with concentric movements from the center to the periphery for at least 1 minute. Immediately before the fence, the skin is treated with 70% alcohol. Sterile gloves are used during venipuncture. The lid of the vial with the medium is treated with alcohol. For each sample, 10 ml of blood is taken.

Careful processing of the skin, vial caps and the use of special systems for blood sampling with an adapter can reduce the degree of sample contamination to 3% or less [21,22].

An important stage in the development of measures to prevent catheter-associated infections was the generalization of world experience in prevention methods in the form of Recommendations published in 2016 in the United States [23].

In 2017, revised and supplemented Recommendations for the Prevention of Infections Associated with Vascular Catheterization were published [1]. The recommendations contain new and systematize already known data of prevention methods. They can be divided into the following groups:

1. Hand cleaning and aseptic technique. Effective hand cleaning is achieved by using waterless alcohol-based products or antibacterial soaps and then rinsing the soap with water. It is necessary to use the maximum amount of asepsis: a cap, a mask, a sterile gown, sterile gloves and a wide treatment of the surgical field.

2. Skin treatment. Povidone-iodine is the most common antiseptic for treating the skin in the area of central venous catheterization.

3. Dressings on the area of catheterization. Transparent, semi-permeable dressings are becoming popular for covering the cath site. They are safe for catheters and allow visual control of the catheterization area. Colonization of catheters with the use of transparent dressings (5.7%) is comparable with gauze dressings (4.6%), did not reveal clinically significant differences for the development of thrombophlebitis.

4. Fixation of the catheter. Sutureless catheterization has its advantages over catheter suturing in terms of preventing catheter infection.

5. Bacterial filters. Bacterial filters have been shown to be effective in reducing the incidence of phlebitis during peripheral venous catheterization, but there is no evidence of an increase in the effectiveness of the prevention of catheter infection. Therefore, their use is not recommended.

6. Catheters and cuffs impregnated with antibiotics and antiseptics.

All studies on impregnated catheters have been performed on uncuffed triple lumen catheters in adults with a catheterization duration of less than 30 days. With impregnation minocycline/rifampicin on the outer and inner surface of the catheter, a decrease in the number of catheter-associated infections was found compared to catheters coated on the outside chlorhexidine/silver sulfadiazine. Benefits were seen after day 6 of catheterization, but were not present after day 30. The use of catheters with cuffs coated with platinum/silver ions is described. However, the use of catheters impregnated with antibiotics and antiseptics should be accompanied by all preventive measures.

7. Prophylactic use of antibiotics. To date, there are no studies demonstrating a reduction in the incidence of catheter-associated infection with oral or parenteral antibiotics.

8. Ointments containing antibiotics and antiseptics. The use of ointments containing antibiotics and antiseptics on the site of catheterization to reduce the incidence of catheter-associated infection has the most conflicting data. A clear decrease in catheter colonization was not obtained. S. Danchaivijitr, R. Theeralharathom (2012) conducted a study aimed at studying the colonization of catheters when using chlorhexidine ointment, ointment containing iodophor, and alcohol dressings in 150 patients with central catheters. The study showed that the frequency of catheter colonization in patients who used alcohol dressings was 22.7% less than in patients who used ointments with chlorhexidine and iodophor.

9. Prophylactic filling of the catheter with an antibiotic solution. For the prevention of catheter-associated infection during periods of time when the

catheter was not used, its lumen was filled with solutions of antibiotics and anticoagulants, but their effectiveness has not been proven.

10. Anticoagulants. Anticoagulant solutions are widely used to prevent catheter thrombosis. With the use of heparin (3 U / ml in solution, 5000 IU every 6 or 12 hours or 2500 IU of low molecular weight heparins subcutaneously) in patients with short-term central venous catheterization, the risk of catheter thrombosis was reduced, but there were no significant differences in the incidence of catheter-associated infection.

11. Rearrangement of catheters. Scheduled catheter replacement (after 3-7 days) to reduce the incidence of catheter-associated infection was ineffective.

12. Replacement of systems for transfusion. The optimal interval for changing intravenous transfusion systems is 96 hours. In the case of infusions of fluids with an increased likelihood of contamination by microorganisms (fatty emulsions, blood), more frequent replacement of systems is indicated. Additional ports with taps (for drug administration, blood sampling) represent a potential danger of introducing microorganisms into the catheter, vessels, infusion fluids (faucet contamination is 45-50% of cases). However, whether such contamination is the source of catheter-associated infection has not yet been proven.

F. Parras et al. (2014) report data from a study conducted among 500 patients who had a subclavian catheter and were exposed to a "mandatory program" that included methods for careful prevention of catheter infection. The incidence of phlebitis decreased by 1% (from 15 to 14%), colonization of the inner and outer surface of the catheter by 1% from 12 to 11% and from 2 to 1%). According to AF Widmer (2014), the use of a mandatory prevention protocol can reduce the incidence of catheter infection by 40% - 50%. A.M. Cazalla Foncueva et al. (2013) also describe a reduction in the number of catheter infections with strict adherence to the prevention protocol.

According to the US Centers for Disease Control, through special prevention measures for 4 years, the number of catheter infections in hospitals in Pennsylvania was reduced by 67% [24].

There are other studies devoted to the prevention of purulent-septic complications of cavacatheterization [25,26,27,28,29]. Modern principles of treatment of patients with purulent-septic complications of cavacatheterization.

Treatment of purulent-septic complications of subclavian vein catheterization is not unambiguous. Depending on the form of the complication and the severity of the patient's condition, it can be both conservative and operative.

According to most researchers, the basic scheme of treatment of patients with purulent-septic complications of subclavian vein catheterization should include the following set of therapeutic measures: 1) sanitation of the septic focus; 2) antibiotic therapy; 3) improvement of the rheological properties of blood; 4) correction of immune response disorders; 5) normalization of the functioning of the main life support systems of the body [1,14,30].

The need to eliminate the primary septic focus is recognized by all authors. Since the focus of infection is the subclavian catheter, it is removed and, if necessary, catheterization of a vein of another location is performed [1]. With phlegmon of the subclavian region, an abscess is opened and drained.

There is no single tactic for the treatment of patients with thrombophlebitis of the central veins in the literature. Some authors believe that blood clots should be removed from a vein [9,22]; others believe that with this complication it is enough to ligate a vein, others recommend conservative therapy and resort to surgery only if the treatment fails, BA Pruitt et al. catheter and the start of conservative therapy, it is necessary to perform surgical removal of the affected peripheral vein, while the issue of operations on the central veins is not considered. E.S. Baimyshev et al. (2018) describe the only case of subclavian vein surgery with a favorable outcome. RN Garrison et al. (2012) report the experience of surgical treatment of 35 patients for 6 years with purulent thrombophlebitis, which was the cause of sepsis, as a result of peripheral vein catheterization. The veins were excised, which led to a rapid regression of the symptoms of sepsis. RE Winn et al. (2018), demonstrate a case of surgical treatment of purulent thrombophlebitis of the subclavian vein - it was ligated with excision of the area filled with blood clots.

For the first time, thrombectomy from the internal jugular vein with otogenic
sinus thrombosis and thrombosis of the internal jugular vein was performed by M. Chiray and G. Semelaigne in 1922. After opening the lumen of the vein, the authors used a syringe with a thick needle to remove blood clots. In Russia, the technique of surgery with the removal of thrombotic masses in case of thrombosis of the internal jugular vein was described and applied by A.N. Bakulev et al. in 2018. The vein was accessed from a longitudinal incision along the anterior edge of the sternocleidomastoid muscle. Since the 70s of the XX century, with the development of thrombosis or thrombophlebitis of the internal jugular vein with phlegmon of the vascular bundle of the neck, many authors recommend wide opening of the phlegmon and bandaging the vein without opening its lumen and removing blood clots.

The most important component of the complex therapy of purulent-septic complications of subclavian vein catheterization are antimicrobial agents. At the same time, purposeful and adequate antibacterial therapy is carried out with broad-spectrum antibiotics that have a bactericidal effect on the maximum number of potential pathogens [1,30].

Early use of antibiotic therapy reduces the risk of death. In the case of inadequate antibiotic therapy, mortality increases significantly. So, according to N.V. Zawada et al. (2013), survival in septic shock in patients receiving inadequate antibiotic therapy did not exceed 20%.

M. Antonelli et al. (2010) suggest the use of a de-escalation therapy regimen. The principle of the method is the use of drugs or combinations characterized by an ultra-wide spectrum of action, resistance to which in probable pathogens is minimal. De-escalation therapy involves an active search for the causative agent of infection. After its isolation and sensitivity assessment, a transition to targeted therapy is carried out.

According to the Kaluga Conference of the Russian Academy of Agricultural Sciences (2014), when allocating oxacillin-sensitive strains of Staphylococcus aureus and epidermal Staphylococcus aureus in patients with sepsis on the background of a catheter-associated infection, it is recommended to use oxacillin and cefazolin as first-line antibiotics. If these pathogens are not sensitive to oxacillin, then vancomycin with linezolid should be used. According to WF Ehni et al. (2012); A.L. Kostyuchenko et al. (2016); V.A., Rudnova (2012); S.V. Yakovleva (2015) in cases of clinically distinct or visualized by ultrasound phlebothrombosis, an antistaphylococcal drug (protected amoxicillin, rifampicin, glycopeptide antibiotic) should be an obligatory component of treatment.

The duration of antimicrobial therapy should be significant - 17-20 days, because. a short course creates a risk of developing angiogenic generalized infection, for example, in the form of endocarditis. In the absence of signs of thrombophlebitis, the pathogen is eradicated using antipseudomonas antibiotics (ceftazidime, cefopirazone, ceftriaxone).

The basis of drug therapy for acute phlebothrombosis is currently the use of anticoagulants (including low molecular weight fractionated heparins), inhibitors of the synthesis of vitamin K-dependent coagulation factors (coumarins), inhibitors of platelet function (aspirin, plavix, rheopolyglucin), as well as thrombolysis activators.

The main component of such therapy is heparins, which stop the growth of platelets and stimulate natural vein recanalization [15].

In most patients with the development of thrombosis and thrombophlebitis of the catheterized vein and its tributaries, non-fractional heparin is used [10]. After a single intravenous injection of 5 thousand units, heparin is administered subcutaneously to the patient after 6-12 hours at an average daily dose of 500 units / kg of body weight, but not more than 20-30 thousand units of heparin per day for 5-7 days. Subsequently, patients are transferred to indirect anticoagulants (warfarin).

The standard heparin treatment regimen has a number of disadvantages, since this drug is difficult to dose, requires frequent injections or long-term infusions, constant laboratory monitoring, and has side effects (leads to the development of hematomas, heparin thrombocytopenia, osteoporosis, etc.). In recent years, conventional heparin has been gradually replaced by low molecular weight heparins (fraxiparin, clexane, etc.), which are devoid of these disadvantages. Their dosage is calculated individually.

Some authors, regarding the treatment of thrombosis of the subclavian vein, talk about the need for more "aggressive" therapy, that is, the use of fibrinolytic drugs [9]. However, a large number of complications of thrombolytics and, as a result, a wide range of contraindications to their use (recent surgery or trauma - less than 1 month, hemorrhagic conditions, pregnancy, brain disease, a period of more than 7 days from the onset of thrombosis, etc.) significantly limit their use. The benefit/risk ratio of thrombolytics is not superior to heparin therapy.

The objectives of immunocorrective therapy for catheter-associated infection are: 1) neutralization of infectious agents and their toxins; 2) modulation of the activity of macrophages, granulocytes, lymphocytes and platelets; 3) modulation of the synthesis and excretion of pro- and anti-inflammatory cytokines; 4) correction of manifestations of a systemic inflammatory response to prevent the development of multiple organ failure.

Studies conducted in the treatment of patients with sepsis show that the use of pentoxifylline, immunoglobulins G and M helps to reduce mortality; and the use of small doses of corticosteroids leads to stabilization of hemodynamics. One of the mandatory elements of the treatment of patients with purulent-septic complications of cavacatheterization is the normalization of the functioning of the main life support systems against the background of well-imposed enteral and parenteral nutrition. This includes complex infusion-transfusion therapy, the fight against hypoxia, the normalization of all types of metabolism, tissue metabolism, the function of parenchymal organs, etc. [6,10,22,29].

The results of treatment of patients depend on many circumstances: the underlying and concomitant diseases, the nature of purulent-septic

complications of catheterization, the type of surgery, etc. There are few data on the successful treatment of patients. However, most authors consider the results of treatment of these patients unsatisfactory. Mortality in the development of purulent-septic complications of cavacatheterization, in particular, in severe sepsis, reaches high numbers - 50-80% [17]. In America, bloodstream infections are among the top ten leading causes of death (NNIS System Report, 2014).

Conclusion. The analysis of literature data shows that despite the great successes of surgery and anesthesiology, purulent-septic complications are among the difficult-to-diagnose complications of subclavian vein catheterization. Information about the results of treatment of these complications is ambiguous and contradictory. The existing generally accepted methods of prevention and methods of surgical treatment are not effective enough. The study of the features of diagnosis, prevention and treatment of purulent-septic complications of subclavian vein catheterization is an urgent scientific problem.

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