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Prophylaxis of surgical site infection

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Abstract

The article provides a literature review of the methods for the prevention of local infectious complications — preoperative, intraoperative and postoperative. The analysis of the literature is devoted to the methods of prevention of postoperative purulent inflammatory wound complications. The review of scientific medical literature is based on the analysis of this problem. The article presents risk factors that contribute to the development of postoperative wound complications. Classification of surgical wounds was adopted to determine the risk of developing a surgical site infection (SSI), which distinguishes 4 classes: clean, conditionally clean, contaminated and dirty. The presented classification is based on the postoperative assessment of the wound bacterial contamination rate. The Clavien–Dindo classification of postoperative complications is the most relevant. This classification presents the tactics of the surgeon, depending on the class. The results of various studies indicate that antibiotic prophylaxis in the preoperative period reduces the development of local complications. The description of prevention methods focuses on intraoperative methods (devices for bringing together the edges of the wound, devices for treating wounds, surgical needles, suture material) and various types of antiseptics, which can reduce tissue damage during surgical interventions, reduce microbial contamination and the number of wound postoperative complications. Intraoperative instrumental methods allow less pronounced trauma to the wound during its processing and suturing. The postoperative method for diagnosing wound complications is an ultrasound method, which determines various formations in a postoperative wound.

Keywords: wound complications, prevention methods, antibiotic prophylaxis, device, surgical needle.

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In the Russian national guidelines of "Surgical infections of the skin and soft tissues" (2015), the term "surgical site infection" (SSI) is particularly highlighted. The incidence of SSI depends on the type of surgical intervention, and amounts to 1.5%–6.9% of clean wounds, 7.8%–11.7% conditionally clean wounds, 12.9%–17% contaminated wounds, and 10%–40% dirty wounds [1–5].

Currently, SSI is considered as an infection that occurs within 30 days after surgery [6]. It is divided into superficial, deep, and infection in the site of the operated organ (organ-spatial infection) [7].

The degree of microbial contamination of the postoperative wound is one of the key factors influencing the development of SSI, which depends on the nature and volume of the surgical intervention [8]. Microbiological diagnostics of infections consisting studies of biological material obtained from the focus of infection. The study of biopsy intraoperative material provides reliable data. Results of aspiration biopsy have a high degree of accuracy. With all advantages of reliability, the classical culture-based method for isolating pathogens has undeniable disadvantages, which are due to temporal aspects of the study. Microscopy of Gram-stained prints takes into account not only the morphology and quantitative ratio of individual microorganisms, but also the presence of leukocytes [8].

To determine the probability of risk of SSI, a classification of surgical wounds has been adopted, which was distinguished into four classes as follows: clean, conditionally clean, contaminated, and dirty wounds. This classification is based on the postoperative assessment of the microbial contamination level of the wound; however, the decision to prescribe antibiotic prophylaxis is still made by the surgeon prior to intervention [9]. Operational factors remain one of the risk factors for SSI. The duration of the surgery depends on many components, including the experience and practical skills

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of the surgeon, complexity of the surgery, adequacy of hemostasis, and degree of tissue trauma [8].

The most relevant version of the classification of complications is the Clavien–Dindo classification [10–14]. According to which, complications are divided into five classes:

– I: deviations from the normal course of the postoperative period, which do not require special treatment or intervention, including the treatment of wound infection;

– II: problems requiring infusion/transfusion therapy and enteral and/or parenteral nutrition;

– III: situations requiring surgical intervention for their resolution (IIIa: under local anesthesia and IIIb: under general anesthesia);

– IVa: organ dysfunction;

– IVb: multiple organ failure; and

– V: lethal outcome.

Preoperative methods of prevention. Antibiotic prophylaxis is understood to be prescribing antibacterial drugs to a patient before microbial contamination of the surgical wound, as well as in the presence of contamination signs, when the primary method of treatment is surgical intervention; antibiotic prescription is aimed to minimize the risk of infection in the field of surgical interventions [15–18]. In a 1961 experiment on rats by J.F. Burke (Harvard University), it was revealed that the timing of the initiation of antibiotic prophylaxis is of fundamental importance, and the drug must be applied before surgery [19].

Choosing the correct time for intravenous administration of the first dose of the antibacterial drug enables the achievement of the therapeutic concentration of the drug in the tissues during incision [20–22]. From the point of view of efficacy and safety, I–II generation cephalosporins (cefazolin and cefuroxime) are the most acceptable as antibiotic prophylaxis in surgery [23,24].

Intraoperative methods of prophylaxis. Unreasonable choice of instrumentation, frequent suturing, poor alignment of wound edges, and adaptation of sutured tissues with tension lead to compression of wound edges and development of local ischemia, which further contributes to the development of SSI [25]. Inflammatory complications that occur in the postoperative period are most often caused by microorganisms that contaminate the wound intraoperatively, and their risk of occurrence mainly depends on the degree of contamination.

At present, synthetic nonabsorbable surgical suture materials are widely used for suturing postoperative wounds, which are highly inert to biological tissues and are strong. The best known are polypropylene, fluoropolymer, and polycaproamide threads. Skin sutures passing through the wound cavity does not only become a conductor of infection and maintain a purulent-inflammatory process, but can also lead to the development of "ligature ischemia" if used under tissue tension conditions, which will complicate the course of the postoperative period.

A suture sinus is one of the late purulent-inflammatory complications after various surgical interventions associated with the rejection of a foreign body (thread), accompanied by the formation of an inflammatory infiltrate. Suture sinus is registered in 1.4%–8.2% of cases and in up to 14.3% of cases with widespread peritonitis of various origins [26,27], and these indices do not tend to decrease. A sawing effect of the thread occurs when edges of the wound are pulled together under conditions of elastic forces of the tissues, which can also be noted when sutures are removed, that is, with any movement of the thread in the wound channel, additional tissue trauma occurs, which contributes to the development of purulent-inflammatory wound complications [28–31].

Favorable conditions for regeneration processes are provided by optimal resting of the wound area, minimal tissue trauma during suturing, proper blood and lymph circulation, and sufficiently good microcirculation [32,33]. Well-known scientists are actively studying various materials used for wound closure, as well as methods of tissue connection [5,25, and 28]. Devices for approximation of wound edges with various options for the wire location provide reliable immobilization of wound defect edges, even distribution of the load on the tissues and reduction of tension in them, which reduces significantly the trauma before suturing and after wound closure, thereby creating favorable conditions for the course of the wound process.

The hardware method of wound closure enables to achieve significant optimization in the process of wound closure by avoiding wound defect, preventing intraoperative eruption of sutured tissues, reducing the number of postoperative purulent-inflammatory wound complications, and shortening the duration of patients' hospital stay. A classification of devices for approximation of wound edges is present. According to the method of fixation to the skin, devices can be divided into the following main groups: I: glue, II: needle, III: thread, and IV: wire. Another characteristic is a mechanism for approximation of wound edges. The ratchet mechanism and guide rods are most widely used [34,35].

Clinical studies have shown that when using surgical needles with cutting edges, a triangular point for example, the degree of their deformation (stretching and crushing) decreases due to the cutting of tissues of hole edges formed when the cut-

ting edges intersect edges, which leads to a less degree of trauma. The emergence of new various surgical needles in clinical practice has led to a detailed field study for their improvement in terms of diameter reduction of the puncture channel, wear resistance, quality of thread fixation in the eye of the needle, etc. Standardized research methods for surgical needles are present [GOST 25981-83, GOST 26641-85], which determine their main technical characteristics [35,36].

The treatment of the surgical site before the surgical incision is obligatory since most infectious complications developed after surgery are caused by the patient's own microflora [37]. The efficacy of povidone-iodine as an antiseptic for treating the surgical site before surgery was confirmed in a major study conducted on 7,669 patients, as well as the Cochrane Review [38–40]. It has been revealed that washing surgical wounds with an aqueous solution of povidone-iodine during surgery reduces the incidence of SSIs [41,42].

A.N. Aidemirov (2012) reported a decrease in the number of wound complications after the application of tissue latex glue to eliminate the dead space between the endoprosthesis and walls of hernial sac during surgery [43]. Authors found that the combination of an endoprosthesis with TachoComb device reduces the number of wound complications [44]. V.F. Chikaev et al. (2015), after plastic surgery of the hernial orifice, covered the wound surface with gauze napkins treated with the Hemoblock agent. The exposure time with the Hemoblock agent was 3 min. This drug is effective as a prophylactic agent for seromas, hematomas, and wound discharge volume reduction [45].

Authors proposed injecting intraoperatively a 10% solution of colloidal silver into the surgical wound, after eliminating signs of strangulation of hernia. At the same time, edges of hernial orifice were first pricked along the perimeter at a rate of 0.1 ml of solution per 1 cm^2 of the aponeurosis, and then the synthetic implant was fixed by pricking along the suture line along the periphery at a rate of 0.1 ml per 1 cm of the suture. After that, the subcutaneous fatty tissue was infiltrated with a solution of colloidal silver at a rate of 0.1 ml of solution per 1 cm^2 of wound. The method provided a significant reduction in the risk of pyoinflammatory complications development in patients with a strangulated hernia, and accelerated the processes of reparative tissue regeneration [46].

In order to prevent SSI on the incision in the process of a layer-by-layer wound closure, surgeons resort to a staged irrigation of the wound cavity with solutions of antibiotics (gentamicin) or antiseptics (0.5% aqueous-alcoholic solution of chlorhexidine) [47]. A.S. Kasenov (2018), in his studies, proved that the prevention of pyoinflammatory complications when using a solution of decamethoxin and octenidine dihydrochloride plus phenoxyethanol helps to reduce the frequency of pyoinflammatory complications by almost five times, and the presence of these drugs in the wound accelerates the wound process. These solutions were used to treat the abdominal cavity during surgery and in the postoperative period by washing the drainage tube with 0.02% decamethoxin solutions [48].

Postoperative prevention methods. Ultrasound examination of the anterior abdominal wall after laparotomy, as well as postoperative wounds of soft tissues of various localizations, is used in surgical practice to assess the course of wound process in the site of postoperative intervention and diagnose developing complications. Superficially localized (subcutaneous tissue) foci of purulent inflammation have rather distinct clinical manifestations (hyperemia, edema, and pain), which enable early stages diagnosis of pathological process. Disruption of wound healing process in deeper layers (muscular-aponeurotic layer) is clinically manifested much later, and is therefore diagnosed late.

According to a number of authors, the study of the dynamics of postoperative changes in the site of surgery using ultrasound enables to determine postoperative local complications (infiltrates and fluid accumulations) in early stages before the development of a purulent process, as well as predict complications of the course of wound process [49, 50]. When prescribing an ultrasound scan, tasks are always posed to assess the pathological formation in the anterior abdominal wall (in the area of the postoperative scar), as well as its location and dimensions. Ultrasound can supplement the clinical presentation and reveal the formation of serous accumulations at a significant distance from the incision line [50–53].

A.I. Kilin et al. (2013) conducted a study of the postoperative wound from the proximal angle of the wound to the distal one in transverse and longitudinal scanning in B-mode to determine pathological formations in the thickness of soft tissues. In addition, the local arterial blood flow was analyzed by color duplex scanning. Indices of the postoperative wound site were compared with the intact area. In the presence of one or more indirect signs of inflammation, such as increase in diameter and number of vessels by 50% or more, increase in average peak systolic velocity by 50%, and resistance index in the arteries of the abdominal wall superficial layer by 30% or more, the SSI can be diagnosed [54].

Thus, despite the variety of existing methods for the prevention of pyoinflammatory complications

of postoperative wounds, this problem currently remains unresolved and requires further research to find more efficient and clinically available methods.

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REFERENCES

1. Malkov I.S., Filippov V.A., Shaymardanov R.Sh. et al. Experience in performing posterior separation plasty in giant postoperative ventral hernias. *Kazan Medical Journal*. 2017; (4): 636–640. (In Russ.) DOI: 10.17750/KMJ2017-636.

2. Kukosh M.V., Razumovskij N.I., Kolesnikov D.L. et al. Antibiotic prophylaxis of infectious complications of postoperative wounds in case of acute appendicitis. *Meditsinskiy almanakh*. 2012; (2): 161–164. (In Russ.)

3. Gostishchev V.K., Omelyanovskiy V.V. Ways and possibilities of prevention of infectious complications in surgery. *Khirurgiya.* 1997; (8): 5–11. (In Russ.)

4. Larichev A.B., Babadzhanyan A.R., Fomin A.N. et al. The clinical pharmacokinetic parallels of peri-operational antibiotics prevention in abdominal surgery. *Rossiyskiy meditsinskiy zhurnal.* 2018; 24 (2): 73–77. (In Russ.) DOI: 10.18821/0869-2106-2018-24-2-73-77.

5. Parshikov V.V., Loginov V.I., Baburin A.B., Kasimov R.R. 50-year's path of development of postoperative wound infectious complications prophylaxis. *Meditsinskiy vestnik Bashkortostana.* 2017; 12 (1): 82–93. (In Russ.)

6. Sergeev A.N., Morozov A.M., Askerov E.M. et al. Methods of local antimicrobic prophylaxis of surgical site infection. *Kazan Medical Journal*. 2020; 101 (2): 243–248. (In Russ.) DOI: 10.17816/KMJ2020-243.

7. Podzolkova L.N. Value of clean facilities in the fight against nosocomial infection. *Khirurg*. 2019; (8): 57–66. (In Russ.)

8. *Hirurgicheskie infekcii kozhi i myagkih tkanej*. Rossijskie nacional'nye rekomendacii. (Surgical infections of the skin and soft tissues. Russian national recommendations.) Ed. by B.R. Gelfanda et al. M.: Izdatelstvo MAI. 2015; 109 p. (In Russ.)

9. Garner J.S. Guideline For prevention of surgical wound infections. *Infect. Control*. 1986; 7 (03): 193−200. DOI: 10.1017/S0195941700064080.

10. Timerbulatov V.M., Timerbulatov Sh.V., Timerbulatov M.V. Classification of surgical complications. *Khirurgiya*. 2018; (9): 62–66. (In Russ.) DOI: 10.17116/hirurgia 2018090162.

11. Akhi M.T. Antibiotic susceptibility pattern of aerobic and anaerobic bacteria isolated from surgical siteinfection of hospitalized patients. *Jundis-hapur J. Micribiol*. 2015; 8 (7): 203–209. DOI: 10.5812/jjm.20309v2.

12. Dindo D., Demartines N., Clavien P.A. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann. Surg*. 2004; 240 (2): 205–213. DOI: 10.1097/01.sla.0000133083.54934.ae.

13. Parshikov V.V. Inflammatory Complications of the Abdominal Wall Prosthetic Repair: Diagnostics, Treatment, and Prevention (Review). *Sovremennye tehnologii v medicine.* 2019; 11 (3): 158–178. (In Russ.) DOI: 10.17691/stm2019.11.3.19.

14. Sahoo S., Haskins I.N., Huang L.C. et al. Early wound morbidity after open ventral hernia repair with biosynthetic or polypropylene mesh. *J. Am. Coll. Surg*. 2017; 225 (4): 472–480. DOI: 10.1016/j.jamcollsurg.2017.07.1067.

15. DeBord J., Novitsky Y., Fizgibbons R., Montgomery M. SSI, SSO, SSE, SSOPI: the elusive language of complications in hernia surgery. *Hernia*. 2018; 22 (5): 737–738. DOI: 10.1007 s10029-018-1813-1.

16. Rodin A.V., Agafonov O.I. Tedizolid — a new antibiotic to solve old problems: prospects for the treatment of complicated skin and soft tissue infections. *Hospital-replacing technologies: Ambulatory surgery.* 2019; (1–2): 80–86. (In Russ.)

17. Golub A.V., Kozlov R.S., Pleshkov V.G. et al. Surgical site infections after open appendectomy and effectiveness of complex approach to their prevention. *Khirurgiya*. 2016; (6): 68–76. (In Russ.) DOI: 10.17116/hirurgia 2016668-76.

18. Zubkov D.S. Instructions for perioperative antimicrobial prophylaxis. Warning for those who want to prevent infection. *Hospital-replacing technologies: Ambulatory surgery.* 2019; (1–2): 6–12. (In Russ.)

19. Burce J.F. Yhe effective period of preventive antibiotie action in experimental incisions and dermal lesions. *Surgery.* 1961; 50: 161–168. PMID: 16722001.

20. Strachunskiy L.S., Kozlov S.N. *Sovremennaya antimikrobnaya himioterapiya*. Rukovodstvo dlya vrachey. (Modern antimicrobial chemotherapy. A guidance for doctors.) M.: Borges. 2002; 436 p. (In Russ.)

21. Zhuchkov M.V., Zhuchkova U.V., Tarasenko S.V. The possibility of using a topical combined antibacterial agent in the prevention of infection during surgical intervention. *Hospital-replacing technologies:Ambulatory surgery.* 2019; (1–2): 87–92. (In Russ.) DOI: 10.21518/1995-1477-2019-1-2-87-92.

22. Musaev A.I., Kasenov A.S. Integrating the postoperative purulent complications preventive methods in abdominal surgery. *Annaly hirurgii*. 2018; (4): 227–232. (In Russ.) DOI: 10.18821/1560-9502-2018-23-4-227-232.

23. Ignateva T. Algorithm of antimicrobial prevention in aesthetic medicine. *Aesthetic Medicine*. 2018; (3): 345–349. (In Russ.)

24. Shaikhrazieva N.D., Sabaeva F.N. A new look at the epidemiological situation in a multi-field hospital. *Medical Almanac*. 2012; (3): 120–121. (In Russ.)

25. Mihailichenko V.Yu., Tatarchuk P.A., Shestopalov D.V. et al. Application of devices for the closing of wounds in surgery. *Vestnik neotlozhnoy i vosstanovitel'noy khirurgii.* 2019; 4 (1): 92–103. (In Russ.)

26. Akentieva T.N., Ovcharenko E.A., Kudryavtseva Yu.A. Influence of suture material on the development of postoperative complications in vascular surgery and their prevention. *Khirurgiya*. 2019; (10): 75–81. (In Russ.)

27. Mokhov E.M., Sergeev A.N. Implantation antimicrobial prevention of infection in the surgery intervention area. *Sibirskoe meditsinskoe obozrenie*. 2017; (3): 75–81. (In Russ.) DOI: 10.20333/2500136-2017-3-75-81.

28. Izmajlov S.G., Lukojanychev E.E., Spiridonov V.I. et al. Instrumental-pharmacological combination in the prevention of wound infection in emergency abdominal surgery (review). *Zabaykal'skiy meditsinskiy vestnik*. 2019; (1): 135–143. (In Russ.)

29. Izmaylov S.G., Beschastnov V.V., Ryabkov M.G. et al. The role of hypoxia-induced factor in the regulation of oxygen homeostasis during reparative regenera-

tion in compromised microcirculation. *Al'manakh klinicheskoy meditsiny.* 2017; 45 (8): 674–680. (In Russ.)] DOI: 10.18786/2072-0505-2017-45-8-674-680.

30. Samartsev V.A., Gavrilov V.A., Kuchumov A.G. Differentiated application of single-row suture for prevention of surgical infection in abdominal surgery. *Novosti khirurgii*. 2013; 21 (6): 38–46. (In Russ.) DOI: 10.18484/2305-0047.2013.6.38.

31. Fedoseev A.V., Rybachkov V.V., Inyutin A.S. et al. A new method of aponevrosis suturing after laparotomy in urgent abdominal surgery. *Khirurgiya*. 2020; (1): 40–45. (In Russ.) DOI: 10.17116/hirurgia202001140.

32. Izmaylov A.G., Dobrokvashin S.V., Volkov D.E. et al. Diagnostics and treatment of ligature fistulas of the anterior abdominal wall. *Kazan Medical Journal*. 2016; 97 (2): 204–207. (In Russ.) DOI: 10.17750/KMJ2016-204.

33. Dibirov M.D., Torshin S.A. Prevention of complications and the results interplastica in elderly and senile age. *Khirurg.* 2014; (7): 74–87. (In Russ.)

34. *Soedinenie tkaney v khirurgii.* Rukovodstvo. (Connecting tissues in surgery. A guidance.) Ed. by V.A. Ovchinnikova, A.I. Abelevich. Nizhniy Novgorod: Izd-vo NizhGMA. 2014; 152 p. (In Russ.)

35. Loginov V.I., Parshikov V.V., Nasimov R.R., Baburin A.B. Current mechanical methods of intraoperative prevention of surgical site infections. *Novosti khirurgii*. 2015; 23 (5): 559–565. (In Russ.) DOI: 10.18484/2305-0047.2015.4.559.

36. Sahoo S., Haskins I.N., Huang L.C. et al. Early wound morbidity after open ventral hernia repair with biosynthetic or polypropylene mesh. *J. Am. Coll. Surg.* 2017; 225 (4): 472–480. DOI: 10.1016/j.jamcollsurg.2017.07.1067.

37. Hakkarainen T.W., Dellinger E.P., Evans H.L. et al. Comparative effectiveness of skin antiseptic agents in reducing surgical site infections: a report from the Washington. State Surgical Careand Outcomes Assessment Program. *J. Am. Coll. Surg.* 2014; 218 (3): 336–344. DOI: 10.1016/j.jamcollsurg.2013.11.018.

38. Rodin A.V., Privolnev V.V., Savkin V.A. Use of povidone-iodine to treat and prevent effects infections in the practice of a physician surgeon. *Hospital-replacing technologies:Ambulatory surgery.* 2017; (3–4): 43–51. (In Russ.)

39. Dumville J.C., McFarlane E., Edwards P. et al. Preoperative skin antiseptics for preventing surgical wound infections after clean surgery. *Cochrane Databaseof Syst. Rev.* 2015; 4: CD003949. DOI: 10.1002/14651858.CD003949.pub4.

40. Kim S.S., Yu S.B., Kim J.D., Ryu S.J. Comparison of disinfective power according to application order of 70% isopropyl alcohol and 10% povidone-iodine. *Korean J. Anesthesiol.* 2013; 65 (6): 519–524. DOI: 10.4097/kjae.2013.65.6.519.

41. Giordano S., Peltoniemi H., Lilius P., Salmi A. Povidone-iodine combined with antibiotic topical irrigation to reduce capsular contracture in cosmetic breast augmentation: a comparative study. *Aesthet. Surg. J.* 2013; 33 (5): 675–680. DOI: 10.1177/1090820X13491490.

42. *Global guidelines for the prevention of surgical site infection*. World Health Organization. 2016; 184 p.

43. Aydemirov A.N., Vafin A.Z., Chemyanov G.S. et al. New technologies in diagnosis and treatment of large and huge ventral hernias. *Meditsinskiy vestnik Severnogo Kavkaza.* 2012; (1): 38–42. (In Russ.)

44. Mishustin A.M., Dolzhikov A.A., Yarosh A.L. et al. Way of abdominal hernia repair. *Fundamental research*. 2012; (1): 68–72. (In Russ.)

45. Chikaev V.F., Galyautdinov F.Sh., Kuznetsov M.V., Bondarev Yu.V. Intraoperative prevention of grey patients opererating about hernias of the anterior abdominal wall of emergency. *The Bulletin of contemporary clinical medicine.* 2015; 8 (S1): 101–104. (In Russ.)

46. Raskatova E.V., Lebedev A.G., Yarcev P.A. et al. *A method for the prevention of purulent-inflammatory complications of wounds of the anterior abdominal wall with strangulated ventral hernias*. Patent for invention RF No. 2500359, issued at 10.12.2013. (In Russ.)

47. Savchenko Yu.P., Malishko V.V., Golikov I.V., Szczerba S.N. Causes of suppurative complications in the postoperative period and prevention. *Kubanskiy nauchnyy meditsinskiy vestnik*. 2013; (7): 112–114. (In Russ.)

48. Kasenov A.S. Prevention of purulent-inflammatory complications in immediate surgery of organs of abdominal cavity. *Vrach-aspirant*. 2018; (6): 30–37. (In Russ.)

49. Dobrokvashin S.V., Izmailov A.G., Volkov D.E. et al. Concept of prevention and treatment of postoperative wound complications in surgical patients. *Prakticheskaya meditsina.* 2017; (6): 50–54. (In Russ.)

50. Sharafislamov I.F., Klyushkin I.V., Klyushkina Yu.A. et al. Spontaneous hematoma of the anterior abdominal wall in emergency surgery clinic. Sonographic aspects. *The Bulletin of contemporary clinical medicine.* 2018; 11 (5): 149–153. (In Russ.) DOI: 10.20969/VSKM.2018.11(5).149-153.

51. Antonova N.A., Lazarev S.M. Prevention of postoperative complications and recurrence of hernias of the anterior abdominal wall in patients with metabolic syndrome. *Vestnik hirurgii imeni I.I. Grekova.* 2019; 178 (1): 49–54. (In Russ.)

52. Abbaszade T.N., Andreev A.I., Anisimov A.Yu. Prevention of early postoperative wound complications in hernioplasty of large ventral hernias. *The Bulletin of contemporary clinical medicine.* 2015; 8 (S1): 11–18. (In Russ.)

53. Minnullin M.M., Krasil'nikov D.M., Zaynullin I.M., Tolstikov A.P. Surgical tactics in strangulated postoperative ventral hernias complicated with intestinal obstruction. *Prakticheskaya meditsina*. 2016; (4-1): 130–133. (In Russ.)

54. Kilin A.I., Fastyhovskaya E.D., Baranov A.I. et al. *A method for early diagnosis of infection in the area of surgical intervention using ultrasound examination*. Patent for invention RF No. 2501524., Bulletin, issued at 20.12.2013. (In Russ.)