

Modern Approaches to Treating Purulent Wounds: Treatment Tactics and Innovative Solutions

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Abstract

In surgical hospitals, the frequency of purulent wound diseases of the skin and soft tissues reaches up to 30-35%. Additionally, wound suppuration following planned surgeries is observed in 2-5% of cases. In the outpatient system, the number of patients seeking treatment for wound defects comprises 35-60% (Morozov A.M. 2021; Katorkin S.E. 2019; Gidirim G.P. 2018).

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In the composition of nosocomial infections, the prevalence of surgical infections of the skin and soft tissues (post-manipulation, postoperative, and post-injection complications) reaches up to 36%. Nearly 2 million patients with purulent wound diseases of the skin and soft tissues are treated annually in polyclinics, the majority of whom (over 75%) are people of working age. The duration of work capacity loss for patients undergoing treatment in outpatient settings is 13.6-17.6 days, while for inpatient treatment, it is 18.5-23.8 days. Furthermore, it has been determined that the rate of postoperative purulent-septic complications in trauma hospitals ranges from 12% to 31% (Shastina V.R. 2021; Shibaev E.Y. 2018).

Analysis of literature has shown that national research results from over 195 countries worldwide indicate the frequency of skin and subcutaneous tissue damage of various etiologies is 8.24%. At the same time, the incidence of inflammation in purulent wounds reaches 45% of the total number of surgical skin lesions, leading to disability and mortality rates ranging from 25% to 50% (Glukhov A.A. 2019; Martinengo L. 2019).

According to numerous authors, despite the availability of modern methods for local physical and mechanical treatment of purulent wounds in a physician's arsenal, wound dressing treatment remains a crucial task, especially at the pre-hospital stage (Nuzova O.B. 2022; Arkhipov D.V. 2020).

The spread of resistant strains of microorganisms in hospitals leads to nosocomial infections and the development of severe complications. Currently, microorganisms such as *K. pneumoniae*, *S. aureus*, *Acinetobacter* spp., and *P. aeruginosa* are distinguished by their multi-drug resistance to antibiotics, including drugs from the reserve group (Shastina V.R. 2021; Morozov A.M. 2021; Okulich V.K. 2020).

It has been established that at the stage of timely surgical and drug treatment with correctly selected drugs for local wound treatment, it is possible to limit the purulent process and prevent the spread of infection (Blatun L.A. 2020; Sarheed O. 2016). Modern multicomponent drugs, along with the ability to destroy bacteria, should also have absorption and analgesic properties, as well as stimulate tissue regeneration (Legonkova O.A. 2022; Morozov A.M. 2020; Goossens A. 2020).

An important aspect of wound treatment is monitoring, for which biosensors and nanosensors are being developed to enable continuous observation of physicochemical and biological processes occurring in the wound (Jiang L., Zhou Q. 2020; Chen J., Saha K. 2015). Often, to assess the condition of a wound, it is necessary to remove the bandage, which leads to additional damage to the wound surface. In this regard, non-invasive wound monitoring methods are of great interest, which are based on the use of modern dressing materials capable of responding to changes occurring in the wound with a change in color. This, in turn, helps to justify the frequency of dressing changes in purulent wound processes of the skin and soft tissues.

Our research is dedicated to the concept of local treatment of purulent wounds in the skin and soft tissues using new multicomponent medications. This concept aims to implement an individualized approach in treating patients suffering from purulent wound processes in the skin and soft tissues.

In the composition of surgical diseases, purulent wound processes account for one-third of all pathologies (Gelfand B.R. 2015; Visaitovich E.A. 2021). Despite the diversity of modern medical care methods, it is often impossible to achieve positive results in treating this category of patients. This is due to numerous aggravating factors, including socio-ecological factors affecting humans (urbanization, natural and man-made disasters). These factors lead to a decrease in immune defense. Additionally, the unjustified widespread use of medications, particularly antibiotics, has altered the biological characteristics of wound infections. This significantly complicates the course of the purulent wound process (Grigoriev E.G. 2020).

Among purulent wound diseases, sepsis is the most common complication and the primary cause of death (Hasko V.V. 2017; Nandhabalan P. 2018). Moreover, the disruption of microcirculation in affected parenchymal organs at the site of inflammation significantly aggravates the progression of septic processes (Valiahmedova K.V. 2019; Litviskiy P.F. 2020). In patients with widespread soft tissue phlegmon, septic coagulopathy and developing disseminated intravascular coagulation syndrome (DIC syndrome) play a crucial role in the pathogenesis of microcirculatory disorders (Dutkevich I.G. 2018).

Diagnosis of purulent ulcer diseases remains one of the most complex problems of surgery to this day. Among purulent-ulcerative diseases of soft tissues, artificial diseases occupy a special place, since patients who have artificially created purulent wounds in themselves also carefully hide the cause of their occurrence, which can lead to the spread of infection and death (Burlova T.V. 2017).

The main focus in treating purulent wounds is to seek highly effective, minimally traumatic treatment methods that have the least impact on immunological and physiological processes, even without intervention, in pathologically unstable conditions. These methods also aid in restoring regeneration and trophism of damaged tissues (Vlasov and Korovin 2015). In purulent-ulcerative diseases of the skin and subcutaneous adipose tissue, topical medications with antibacterial activity are most commonly used (Blatun L.A. 2018). However, even the correct application of antiseptic agents does not always sufficiently affect the purulent focus, which leads to the development of prolonged and complicated forms of purulent infection in the skin and subcutaneous adipose tissue. There is evidence about the significant therapeutic effect of low temperature on purulent lesions of the skin and subcutaneous adipose

tissue. However, this method has not been adequately studied and is rarely used in clinical practice (Burenina I.A. 2018). Our hypothesis regarding the application of local cryotherapy in purulent wound diseases of the skin and subcutaneous adipose tissue is based on the following objectives: determining the potential of cryotherapy for treating affected areas in purulent wound diseases of the skin and subcutaneous adipose tissue, developing specific indications for this type of treatment, analyzing the results achieved when comparing this method with local antibacterial agents as a sole treatment, and developing a specific technique and temperature regimen for the use of local cryotherapy in clinical practice. All these factors establish the relevance of this research.

In the Russian Federation, over 12 million injury cases are recorded annually, with 18% of the population experiencing accidental or surgical injuries each year (Shetin S.A. 2015). Analysis of statistical data reveals a significant increase in childhood injuries. In Russia, open wounds account for 16.7% of injuries, while global statistics indicate 12.3% (Lavrova D.I. 2017). Open injuries of the extremities are considered one of the most severe types of injuries, comprising 21% to 30% of all injuries, both in terms of treatment selection and prognosis (Dubrov V.E. 2017).

The most common complications of open injuries to soft tissues and bones during childhood (ranging from 12.5% to 33.4%) continue to be wound infection, intoxication, slow bone healing, and scar deformities of soft tissues (Agadjanyan V.V. 2014). A direct correlation is observed between the severity of an open fracture and the degree of purulent complications. According to literature data (based on the Gustilo-Anderson classification), purulent complications occur in 0-2% of cases for type I fractures, 2-7% for type II fractures, up to 7% for type III-A fractures, 10-50% for type III-B fractures, and 25-50% for type III-C fractures (Samarsev V.A. 2015).

In severely ill bedridden patients, deep pressure ulcers develop when lying in low-mobility positions (in beds or armchairs) for extended periods without proper care. In childhood, pressure ulcers are most commonly found in patients with neurological diseases. The incidence rate in childhood is 0.47% (Batisheva T.T. 2015).

The treatment of purulent wounds requires addressing a number of organizational, tactical, and therapeutic challenges. These include: surgical debridement and preparation of wounds for plastic closure. It is well-known that "surgical wound debridement" is considered the first and most crucial stage of treatment. The primary step of this procedure involves meticulously excising and removing all non-viable tissues. In many cases, it is impossible to achieve a completely aseptic state in a purulent wound, which necessitates repeated surgical procedures and increases the number of surgical interventions. Enhancing the effectiveness of surgical debridement can potentially accelerate the healing process and improve outcomes in the treatment of purulent wounds, which remains an urgent task in surgery (Kostyuchenok B.M. 2018). Despite the introduction of new wound treatment methods in recent decades, the post-traumatic period of severe injuries is often (in up to 74% of cases) accompanied by the development of complications. This necessitates the development and implementation of new approaches to treating open injuries of soft tissues and bones (Mitish V.A. 2019).

The problem of treating complications of purulent wounds has remained relevant for many years. Despite the introduction of new treatment methods and the improvement of existing ones in recent years, purulent-ulcerative diseases of soft tissues continue to persist at a high level. According to various sources, they account for 25% to 54% of all surgical pathologies (Timofeev S.V. 2018; Semenov B.S. 2019). As a result, significant economic damage is being caused due to a decrease in the effectiveness of patient treatment and an increase in treatment costs. This underscores the ongoing relevance of this problem in surgery.

More than half of the deaths occurring after surgical interventions are associated with complications from purulent wounds. The increase in military conflicts, fires, and injuries further heightens the relevance of this problem, as it leads to a rise in the number of patients with damaged skin tissues (Prokopev A.S. 2016). The use of wound dressings in the local treatment of patients with skin defects is considered a

promising approach. Recently, numerous types of wound dressings have emerged, differing in the chemical composition of their base and the medicinal substances added to them.

Despite improvements in treatment methods, patients continue to experience a high percentage of infectious complications and persistent wounds. The development of microbial resistance to commonly used medications, as well as a decrease in general and local immunological reactivity, necessitates further study, development, and refinement of local treatment approaches for skin and soft tissue wound defects in the body. The selection of medications or their effective combinations for the local treatment of wounds and wound infections remains an unresolved problem.

A similar situation is observed in other regions of the near abroad. Up to 5 million patients with purulent wound diseases of soft tissues are registered annually in these areas. In the USA and Western European countries, 10% of hospitalized patients suffer from surgical soft tissue infections. The annual economic damage resulting from this is estimated at 9-10 billion US dollars (Pirasenko L.V. 2018; Malone D. 2019). It is well-known that the most effective method of treating patients with surgical soft tissue infections loses its efficacy if it is not combined with technologies that facilitate the cleansing of the purulent wound and create favorable conditions for healing processes (Lipatov K.V. 2016). The achievements of scientific and technological progress by the end of the last century allowed for a new approach to optimizing treatment measures. Nevertheless, surgical treatment of purulent wound sites remains the main method of treatment for this category of patients. Today, there is a wide range of physical and physicochemical methods for local application used in conjunction with traditional (mechanical) surgery (Emelyanov A.Y. 2016; Sergeev V.A. 2016).

The clinical diversity in the manifestation of soft tissue purulent infections necessitates the search for an algorithm to diagnose the severity of the purulent wound process, clarify indications for applying various treatment methods, and optimize components of complex treatment (Gostishev V.K. 2017). The modern methodology for local treatment of purulent wounds is based on the targeted application of biologically active dressing materials with specific properties, taking into account the nature and stage of the wound healing process (Briskin B.S. 2014). At the same time, despite a significant stockpile of various materials used in treating purulent wounds, means that allow for effective treatment of wound infections and purulent wound processes remain promising. In our opinion, materials containing various biologically active substances, selected taking into account the sensitivity of the microflora, as well as the nature and phase of the purulent wound process, meet this requirement.

In severe clinical forms of purulent wound diseases, as a result of purulent infectious aggression, profound disturbances occur in the body's regulatory and effector systems, manifesting as endogenous intoxication syndrome (Bekyakov S.A. 2017). Thus, all of the above demonstrates the necessity of conducting work to improve the comprehensive treatment of patients with purulent wounds of various origins that have a severe clinical course.

The prevention and treatment of purulent surgical infections remain one of the most urgent challenges in modern surgery. This is attributed to the high prevalence of purulent-ulcerative diseases of soft tissues and postoperative complications (Tolstix P.I. 2016). The average duration of purulent wound treatment, recurrence of adverse outcomes, general spread of infection, and incidence of various toxic-allergic reactions have remained unchanged for a long time (Chadaev A.P., Yarema I.V. 2017).

According to data from the Ministry of Health of the Russian Federation (2000), 52% of the bed capacity in surgical hospitals in Russia consisted of purulent departments, and more than 40% of surgical patients suffered from purulent wound diseases and their complications. This indicates significant economic losses in the treatment and medical-social rehabilitation of this category of patients. Annually in the CIS countries, approximately 5 million patients are registered with purulent-ulcerative diseases of soft tissues, which result in death in 7-11% of cases (Adamyan A.A. 2016). These compelling figures convincingly demonstrate the urgency of the problem of purulent infection in surgery and the fact that it remains unresolved (Amiraslonov Y.A. 2017). Therefore, it is no coincidence that in recent years, doctors'

attention has been drawn to combinations of medical products, including wound dressings containing antioxidants. Due to their synergistic effect on the pathophysiological processes in the wound, it becomes possible to both cleanse the purulent wound and promote the formation of granulation tissue (Dobish S.V. 2013).

Along with known and traditional methods of treating purulent wounds, there is a clear urgency to implement multifaceted and synergistically effective approaches that can be applied at both hospital and outpatient-polyclinic stages (Filatov V.N. 2017). One of the methods that significantly enhances the radicalness of surgical wound treatment is the use of low-frequency ultrasound (Stolyarov E.A. 2013). However, this treatment method is not always effective, particularly in cases of widespread bacterial invasion and ongoing purulent-destructive processes. At the same time, several authors have noted the biological activation of medicinal preparations under the influence of low-frequency ultrasound (Savin O.A. 2014).

In recent years, a new direction has emerged in improving the local treatment of purulent wounds - the development of drug delivery vehicles (Klimiashvili A.D. 2018). The arsenal of dressing materials is continuously being replenished with new atraumatic wound coverings. These coverings are prepared based on biologically active hydrogels with the addition of antiseptics, enzymes, and local anesthetics. They allow for a significant improvement in the outcomes of purulent wound treatment (Kodjoglyan A.A. 2017). Among these, a special place is occupied by the local interactive wound dressings "Voskopran" and the biodegradable collagen-chitosan complex "Collaxit-FA." These have been recommended by the Ministry of Health of the Russian Federation for mass production and use in medical practice. However, some publications on the use of these materials for treating purulent wounds are based on a limited number of clinical observations. Furthermore, data on their effects on microflora and morphological changes in tissues are lacking, especially regarding their application at various stages of purulent wound development.

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