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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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CUTTING-EDGE STRATEGIES IN CONTEMPORARY LAPAROTOMIC SURGERY: EMERGING TECHNOLOGIES, TECHNIQUES, AND FUTURE ADVANCEMENTS

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Abstract.

Introduction: Laparotomy is one of the most common surgical interventions, but postoperative wound healing is associated with a significant risk of complications such as infection, entrapment and postoperative hernia. Current laparotomy wound management practices using standard sutures and antiseptic treatments frequently fail to achieve optimal healing results.

Methods: The medical field shows increased enthusiasm for advanced wound management techniques like VAC therapy and bioengineered materials, which present fresh opportunities for enhanced patient recovery. Gene and molecular therapy is an up-and-coming field because it speeds up wound healing by stimulating the formation of new blood vessels and tissue regeneration. In this process, vectors help produce key growth factors like VEGF, PDGF, and FGF. RNA interference technology helps wound healing by reducing the activity of inflammatory cytokines TNF-α and IL-1β to control inflammation. New surgical treatments include laser therapy, photodynamic therapy, and advanced biomaterials.

Results: This paper examines different treatments for laparotomy wounds and checks their effectiveness using clinical research. It also shows how modern biotechnologies, like nanomaterials and gene therapy, can help reduce problems after surgery.

Conclusions: More studies in this field can improve surgical methods, speed healing, and help patients recover better.

Key words. Laparotomy, wound healing, gene therapy, VAC therapy, biomaterials.

Introduction.

Laparotomy is a standard procedure used to treat various abdominal conditions, including tumours, bowel obstruction, and organ perforations [1]. Infections, wound openings, and hernias can slow down healing after surgery. These problems can make recovery longer, increase hospital stays, and sometimes require more surgeries [2]. Laparotomy wounds have a high risk of infection because the skin barrier is weak. Infections happen in 5-20% of cases, depending on how sterile the surgery is and the patient's health [3]. Wound opening, when the wound edges separate and organs may come out, happens in 1-3% of cases. This can cause peritonitis and sepsis, increasing the risk of death [4]. Hernias after surgery are also common, affecting 10-30% of laparotomy patients. They happen when the wound does not heal well, or the sutures are weak [5]. Patients with obesity or diabetes have a higher risk, sometimes over 40% [6,7].

New surgical methods, sutures, and wound care have helped improve patient recovery [8]. Modern treatments like vacuum therapy, biodegradable sutures, and advanced dressings help wounds heal faster and lower infection risks [9]. Research on better laparotomy wound treatments is fundamental. Good treatment can prevent problems, shorten hospital stays, and help patients recover faster [10]. New technologies like laser therapy, stem cell treatments, and molecular therapies can accelerate healing and improve surgery results [11]. However, more studies are needed to apply these methods in real patient care. Ongoing research and clinical trials will be crucial in validating the efficacy of these advanced treatments and ensuring their safety for widespread use. As technology continues to evolve, the integration of these innovative approaches into standard practice holds the potential to revolutionize postoperative care. Ultimately, the goal is to provide patients with more effective, personalized treatments that reduce complications and enhance overall recovery outcomes.

Research Methods.

This review analyses scientific literature, including clinical trials and experimental studies on laparotomy wound treatment. It compares traditional and modern methods, focusing on healing speed, complication rates, and infection risks. The review also explores the potential use of biotechnology in surgery. It highlights advancements like gene therapy, nanomaterials, and tissue regeneration techniques to improve healing and reduce complications.

Results and Discussion.

Etiology and pathogenesis of laparotomy wound healing disorders:

Laparotomy wound healing involves clotting, inflammation, tissue growth, and remodelling. Any disruption can slow recovery, cause infections, or lead to hernias [12,13]. The effectiveness of healing largely depends on the patient's general condition, comorbidities, the quality of the surgical intervention, and the adequacy of postoperative care [14]. These factors highlight the need for comprehensive and individualized wound management strategies to ensure optimal healing and minimize postoperative complications.

Key risk factors:

Diabetes mellitus is a key factor that negatively affects reparative processes [15]. Hyperglycaemia promotes protein glycosylation and impaired angiogenesis, which decreases the supply of oxygen and nutrients to the wound area [16]. Dysfunction of the immune system in diabetes reduces the body's ability to fight infections, and impaired microcirculation and tissue hypoxia slow healing [17]. In addition, patients with diabetes have decreased collagen synthesis and changes in the

structure of the extracellular matrix, which affects the strength of the postoperative scar [18].

Obesity slows wound healing. Fat tissue has poor blood flow, limiting oxygen and nutrients [19]. Obesity causes inflammation, increasing harmful cytokines like IL-6 and TNF α [20,21]. This delays tissue repair and raises the risk of suture failure [22]. Infections are a significant issue, especially during surgery or with infected tissues [23]. Poor sterilisation and antibiotic-resistant bacteria worsen infections, while biofilms complicate treatment. Malnutrition also delays healing. A lack of proteins, vitamins, and minerals like zinc affects collagen and tissue repair. Low albumin increases the risk of complications, such as hernias and suture failure. A weak immune system also makes infections more likely [24]. Given the significant impact of these systemic factors, effective wound healing requires a multifaceted approach that addresses underlying conditions and optimises both surgical technique and postoperative care.

Influence of systemic and local factors on tissue regeneration:

Hypoxia slows healing by reducing oxygen, which affects fibroblasts and collagen production [25]. Low blood volume and anemia also reduce tissue oxygen, hindering recovery [26]. Chronic conditions like heart or kidney failure can worsen healing by affecting blood flow [27]. Glucocorticoid therapy can weaken inflammation and collagen production, leading to poor scars [28].

Factors like hematomas and serum in the wound create conditions for infection. High tension during suturing can cause suture rupture, and tissue damage leads to poor scarring. The type of suture used affects healing and inflammation [29]. Both systemic and local factors influence healing. Addressing risk factors and using modern techniques can improve outcomes.

Additionally, it is essential to identify biomarkers that can predict wound healing outcomes and guide personalized treatment strategies. Collaboration between clinical and research institutions will further accelerate the translation of innovative methods into practice [30].

Traditional Treatment Methods for Laparotomy Wounds:

Laparotomy wounds are treated with basic methods, such as stitching the wound immediately or after some time. Doctors also use creams to prevent infection In addition to primary and delayed suturing techniques, the use of topical agents—such as antiseptic creams and antimicrobial ointments—plays a critical role in reducing bacterial colonization, controlling local inflammation, and creating a microenvironment conducive to tissue regeneration and epithelialisation [31].

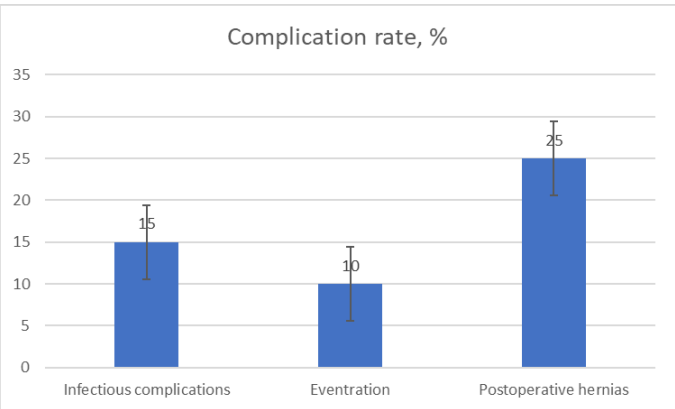

Figure 1. *Common Complications After Laparotomy. Source: developed based on [6,7].*

Primary and Delayed Closure Methods:

Primary suturing is done right after surgery to close the abdominal wall. It's used in clean surgeries with low infection risk, leading to faster healing, less pain, and less scarring [32]. Delayed suturing is used when the infection risk is high. The wound is left open for cleaning and drainage before being closed to reduce infection and improve healing [32].

Studies have shown that primary suturing reduces the average length of hospital stay by approximately 3–4 days compared to secondary healing. Furthermore, patients who undergo primary closure require 25–30% less analgesia, which positively influences overall comfort and accelerates rehabilitation [33].

Traditional suture materials:

The suture material is essential for wound healing and affects scarring, inflammation, and suture separation. Common materials for laparotomy wound closure include nylon, polypropylene, polyglactin, and polydioxanone [34]. Nonabsorbable materials like nylon, polypropylene, and polyester are strong and used to secure the aponeurosis, providing resistance to tension. However, they may increase the risk of chronic inflammation and fistula formation [35]. Resorbable materials (polyglactin, polydioxanone) are widely used for suturing muscle and subcutaneous structures, gradually degrading without needing removal. They reduce the risk of inflammatory reactions and promote the natural healing process. The optimal choice of suture material depends on the patient's condition, local wound characteristics, and the required degree of mechanical support for the tissues [35]. Therefore, selecting the appropriate suture material is a critical component of surgical planning, as it not only ensures the mechanical stability of the wound during the initial phases of healing but also influences the risk of postoperative complications such as infection, dehiscence, and poor scar formation. A well-informed choice tailored to the patient's clinical profile and the wound's anatomical and physiological characteristics can significantly improve healing outcomes and reduce the likelihood of long-term adverse effects.

Local treatment of the wound surface:

Antiseptic solutions, ointments and dressings are traditionally used to prevent infection and accelerate the healing of laparotomy wounds. Antiseptics (chlorhexidine, iodine-containing solutions, hydrogen peroxide) are used for prophylactic wound treatment and prevention of bacterial contamination. Ointments containing antimicrobial agents (levomenthol, Vishnevsky's ointment, silver sulfadiazine) help cleanse the wound, reduce inflammation, and stimulate tissue regeneration. Dressings (sterile gauze wipes, hydrophilic and hydrocolloidal dressings) protect the wound from external infection and create optimal conditions for healing [36].

Thus, traditional methods of treating laparotomy wounds remain relevant in modern surgical practice. They aim to mechanically close the abdominal wall defect, prevent infections, and optimise local conditions for tissue regeneration. However,

the development of the latest technologies and modern treatment methods can improve the effectiveness of postoperative wound management and reduce the risk of complications.

Therefore, traditional methods of laparotomy wound care remain relevant in contemporary surgical practice. Their primary objectives are to mechanically close the abdominal wall defect, prevent infections, and optimize local conditions for tissue regeneration. However, advancements in modern technologies and treatment approaches have the potential to enhance the efficacy of postoperative wound management and significantly reduce the incidence of complications. Quantitative analyses from recent studies indicate that the use of advanced wound dressings and antimicrobial technologies can lower postoperative infection rates by up to 35% and accelerate epithelialization by 20–30% compared to conventional methods [37].

These findings underscore the importance of integrating traditional practices with innovative technologies to achieve more effective, individualized, and complication-free recovery in patients undergoing laparotomy. By combining time-tested methods such as antiseptic treatment and protective dressings with advanced solutions like antimicrobial coatings, bioactive materials, and moisture-retentive dressings, clinicians can create a synergistic approach that not only supports the physiological healing process but also addresses patient-specific risk factors. This comprehensive strategy holds promise for improving overall surgical outcomes, reducing healthcare costs associated with prolonged wound care, and enhancing patients' quality of life during the postoperative period.

Modern methods of treatment of laparotomy wounds:

Modern surgery is actively introducing innovative approaches to treating laparotomy wounds, which can significantly speed up the healing process, reduce the incidence of complications and improve the quality of the postoperative scar. These methods include negative pressure therapy (VAC), modern sutures, bioengineering, wound healing agents, laser therapy, and tissue engineering [38]. As these technologies continue to evolve, their integration into standard surgical protocols offers new possibilities for personalized and more effective postoperative care. As these technologies continue to evolve, their integration into standard surgical protocols offers new possibilities for personalized and more effective postoperative care.

VAC therapy:

VAC therapy is a modern method for treating laparotomy wounds, especially in complicated healing cases. It uses negative pressure to remove fluid, reduce infection risk, and improve blood flow, which helps deliver more oxygen and nutrients. It stimulates fibroblast growth, accelerates granulation tissue formation, reduces edema, and helps bring wound edges together for faster healing [39]. Clinical studies show that VAC therapy reduces the incidence of infectious complications, shortens healing time, and reduces the risk of postoperative hernia formation. The main indications for VAC therapy are large postoperative wounds with cavities, infected or chronic wounds that do not heal well, laparostomy after emergency surgery, prevention of entrapment and suture separation. Contraindications include necrotic tissue, active bleeding, malignant tumours, and allergies to dressing components [40].

This confirms the effectiveness of VAC therapy as a crucial component of modern surgical strategies for managing postoperative wounds. Further research has shown that standardizing VAC protocols can reduce complication rates by 20–25% and increase the overall rate of successful wound healing to 85–90%, thereby facilitating the broader implementation of this method into routine practice [41].

Modern suture materials and suturing techniques.

Biodegradable threads:

A promising advancement is using biodegradable sutures that dissolve over time, eliminating the need for removal and reducing chronic inflammation. Materials like polyglactin (Vicryl) and polydioxanone (PDS) offer long-term support and minimise reactions in the body. These benefits make biodegradable sutures a valuable component of modern surgical practice, particularly in enhancing patient comfort, reducing the risk of foreign body reactions, and promoting more natural tissue regeneration. Their gradual resorption aligns with the body's healing timeline, providing adequate support during the critical phases of wound repair while minimizing the need for additional interventions, which is especially important in patients with comorbidities or compromised healing capacity [42].

Barrier mesh for the prevention of postoperative hernias:

Barrier meshes are used in patients at higher risk of postoperative hernias. Made from synthetic or biodegradable materials, they are implanted to strengthen the abdominal wall. Bioresorbable meshes dissolve over time, reducing the risk of inflammation and chronic pain. This approach not only provides immediate mechanical support to the surgical site but also facilitates long-term recovery by minimizing foreign body presence and associated complications. As a result, barrier meshes play a crucial role in preventive strategies for abdominal wall reconstruction, particularly in high-risk patient populations [43].

Application of wound healing agents and biomaterials.

Hydrogel dressings, alginates, antimicrobial coatings:

Modern wound dressings, like hydrogel and alginate, keep the wound moist, promoting faster healing and reducing infection risk. Antimicrobial coatings with silver or copper help prevent bacterial growth and infection. To expand on the use of modern wound dressings like hydrogel and alginate that keep the wound moist and reduce infection risk: these advanced materials create a favorable microenvironment that supports cellular activity and accelerates tissue repair. Additionally, antimicrobial coatings with silver or copper not only inhibit the growth of a broad spectrum of pathogens but also reduce the formation of biofilms, which are often resistant to conventional treatments. This dual action significantly lowers the likelihood of infection-related complications and supports more efficient wound closure [44].

Use of growth factors and stem cells:

One of the most promising areas is using growth factors such as VEGF, PDGF, and TGF-β, which stimulate angiogenesis and cell proliferation. The use of stem cells, in particular mesenchymal stromal cells (MSCs), opens up new opportunities for tissue regeneration and accelerated recovery after surgery. Together, these biological therapies represent a significant

advancement in regenerative medicine, offering the potential to enhance healing outcomes, especially in patients with impaired or delayed wound repair [45].

Laser and photodynamic therapy:

Laser therapy is widely used to stimulate reparative processes. Low-intensity radiation promotes the activation of mitochondrial mechanisms, leading to increased ATP synthesis, fibroblast proliferation stimulation, and acceleration of granulation tissue formation. Photodynamic therapy using photosensitive agents has anti-inflammatory and antimicrobial effects. These therapies not only support cellular regeneration but also contribute to the reduction of local infection and inflammation, creating favorable conditions for wound healing. As part of an integrated treatment plan, laser and photodynamic therapies offer promising adjunctive options for managing complex or slow-healing laparotomy wounds [46].

Regenerative technologies and tissue engineering.

Use of bioengineered matrices:

Modern tissue engineering uses bioengineered matrices containing collagen, glycosaminoglycans, and other biocompatible components to promote active healing. Such matrices can be seeded with the patient's autologous cells to stimulate tissue regeneration without significant scarring. This approach closely mimics the natural extracellular environment, supporting cell adhesion, proliferation, and differentiation essential for effective tissue repair. As research advances, bioengineered matrices are expected to become an integral part of personalized regenerative strategies in complex wound management [47].

Comparative effectiveness of modern methods:

Evaluation of the effectiveness of modern methods of treating laparotomy wounds is based on the analysis of clinical trial data comparing different treatment strategies according to the main criteria: healing time, infectious complications, incidence of postoperative hernia formation, and overall patient outcomes. These comparative studies provide objective metrics that guide clinical decision-making and help identify the most effective approaches for various patient groups. As evidence accumulates, it reinforces the need for evidence-based integration of innovative therapies into routine surgical practice to optimize patient recovery [48].

Analysing clinical trial data:

Many clinical trials have demonstrated that negative pressure therapy (NPT), compared to traditional methods (conventional suturing, topical antiseptic treatment), significantly reduces the number of infectious complications (by 30-50%), the average wound healing time (by 40-60%), and the risk of postoperative hernia (by 25-35%) [49].

Using biodegradable sutures has also shown advantages over traditional sutures, reducing the risk of chronic inflammation and foreign body formation. Additionally, using barrier mesh in high-risk groups can significantly reduce the incidence of ventral hernias [50].

Recent studies highlight the significant advancements in laparotomy wound care, particularly through the use of biodegradable sutures, barrier meshes, and regenerative technologies [51]. Clinical trials have consistently demonstrated the benefits of these modern methods, including reduced healing times by 40–60%, fewer infectious complications (decreasing by 30–50%), and lower rates of postoperative hernia formation (by 25–35%) [52]. The combination of these techniques promises to further enhance surgical outcomes, providing patients with faster recovery and minimized long-term complications [53].

Effect of different methods on healing time and complication rates:

Clinical studies confirm that using modern wound dressings (hydrogel dressings, alginates, antimicrobial coatings) reduces the time of epithelialisation and the level of bacterial colonisation. Using growth factors and stem cells in complex wound therapy accelerates the formation of granulation tissue, which is especially important for patients with comorbidities such as diabetes mellitus [54].

The use of laser therapy and photodynamic treatment has been shown to positively affect regenerative processes, in particular by stimulating angiogenesis, which contributes to faster wound closure and reduced risk of infection [55].

These advancements not only enhance wound healing but also significantly reduce the need for prolonged hospital stays, improving overall patient outcomes by reducing hospitalization time by 20–30%. Furthermore, the integration of these therapies into clinical practice has the potential to reduce healthcare costs by up to 25% by minimizing complications and accelerating recovery times [56].

Prospects for the development and implementation of new methods:

Modern medicine continues developing innovative surgical wound treatment approaches. These advancements are aimed at improving healing times, minimizing complications, and enhancing the quality of postoperative recovery. By incorporating cutting-edge technologies such as regenerative therapies, bioengineered materials, and advanced wound care products, clinicians can offer more effective, personalized treatments. As clinical research continues to provide valuable insights, these novel approaches will likely become standard practice in surgical care. Ultimately, the integration of these innovations into everyday medical procedures holds the potential to significantly improve patient outcomes and reduce the long-term burden of surgical recovery [57].

Gene and molecular therapy for surgical wounds:

Gene therapy can help heal wounds by changing genes that control inflammation, blood flow, and tissue repair. Genes like VEGF, PDGF, and fibroblast growth factor help improve blood flow and speed recovery, which lowers the risk of infections [58].

RNA interference reduces inflammation by blocking cytokines like TNF-α and IL-1β. This helps prevent problems like infections, hernias, or scars and supports better healing [59].

Gene therapy can also add genes that boost antioxidants or collagen. This improves scar healing, reduces scarring, and speeds recovery [60].

In short, gene therapy and molecular technologies help reduce inflammation, heal tissue, and improve scars, leading to quicker

recovery and better results for laparotomy wounds. These advancements in gene therapy and molecular technologies offer promising prospects for enhancing the body's natural healing mechanisms, allowing for more precise and targeted treatments. As research progresses, the integration of such therapies into routine clinical practice could revolutionize the management of complex wounds, especially in patients with impaired healing capabilities. Additionally, these innovations may reduce the need for long-term wound care and postoperative interventions. Ultimately, the incorporation of gene-based approaches into wound healing strategies has the potential to significantly improve both functional and cosmetic outcomes for patients undergoing laparotomy.

New Biomaterials and Nanotechnology:

Scientists are studying nanofibers that copy the extracellular matrix for wound dressings and sutures. They provide an optimal environment for cell migration and promote faster regeneration [61]. Nanotechnology allows the development of antibacterial coatings with silver, copper, or other particles to lower infection risks. Such materials can be utilised in dressings, implantable meshes, and sutures to enhance healing and reduce complications [62].

Studies have shown that nanofiber-based wound dressings can accelerate cell migration and tissue regeneration by up to 50%, significantly improving healing times. Additionally, the use of antibacterial nanocoatings has reduced infection rates by 30–40% in clinical trials, further enhancing the effectiveness of wound care products [63].

Conclusion.

Effective management of laparotomy wounds is critical to improving surgical outcomes and reducing the risk of complications. Modern wound care increasingly relies on personalized strategies that integrate innovative technologies with patient-specific needs. The use of advanced therapies, such as negative pressure systems, biodegradable materials, regenerative treatments, and nanotechnology-based solutions, demonstrates strong potential to accelerate healing, minimize infections, and improve tissue regeneration. Looking ahead, molecular and genetic approaches, including gene therapy and RNA-based interventions, may further refine wound healing by targeting underlying biological processes. These developments mark a shift toward more precise, effective, and patient-centered postoperative care.

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