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# Effectiveness of Subcutaneous Suction Drains in Preventing Superficial Surgical Site Infections Following Open Abdominal Surgery: A Prospective Comparative Observational Study

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## Abstract

Introduction: Surgical site infections (SSIs) represent a major source of postoperative morbidity and account for a substantial proportion of healthcare-associated infections, with their incidence being particularly high following major abdominal procedures. Superficial SSIs are the most common type and typically occur during the early postoperative period. The use of subcutaneous suction wound drains has been suggested as a strategy to reduce postoperative fluid accumulation in the wound and is thus associated with reduced risk of infection.

Objective: This study aimed to evaluate the effectiveness of subcutaneous suction wound drains in reducing the incidence of superficial SSIs following open abdominal surgery. Secondary objectives included comparing SSI rates between elective and emergency procedures and assessing other factors associated with superficial SSIs.

Methods: A prospective comparative observational study was conducted among 114 patients undergoing open abdominal surgery at a tertiary care center. Clinical and operative data were collected using a structured proforma, case records, and operative notes. The incidence of superficial SSI was compared between patients managed with and without subcutaneous suction drains, and associations with relevant patient- and procedure-related factors were assessed.

Results: Superficial SSI occurred in 12 of 56 patients (21.4%) in the drain group and in 24 of 58 patients (41.4%) in the nondrain group. The use of a subcutaneous suction drain was associated with a significant reduction in SSI risk (odds ratio: 2.58; 95% CI: 1.13-5.90; p = 0.022). No significant associations were observed between SSI occurrence and the type of surgery, wound contamination status, demographic characteristics, wound closure technique, or comorbid conditions.

Conclusion: The use of subcutaneous suction wound drains was associated with a significantly lower incidence of superficial SSI following open abdominal surgery. Other patient- and procedure-related factors did not demonstrate a significant influence on infection rates. These findings support the selective use of subcutaneous suction drains in patients at risk of postoperative wound infection.

**Categories:** Therapeutics, General Surgery, Dermatology
**Keywords:** abdominal surgery, postoperative complications, subcutaneous suction drain, surgical site infection, wound infection

## Introduction

Surgical site infections (SSIs) are important postoperative complications associated with increased morbidity, prolonged hospital stay, delayed wound healing, and higher healthcare costs. Superficial incisional SSIs involve the skin and subcutaneous tissue and remain a concern following open abdominal surgery, particularly in procedures involving wound contamination and extensive tissue handling. The burden is particularly pronounced in abdominal surgery, where contamination from endogenous gastrointestinal flora and extensive tissue handling increase the risk of postoperative wound infection [1].

According to the Centers for Disease Control and Prevention (CDC), an SSI is defined as an infection occurring within 30 days of an operative procedure, or within one year when prosthetic material is implanted [2,3]. SSIs are classified into superficial incisional, deep incisional, and organ/space infections based on the anatomical structures involved [4]. Among these, superficial incisional SSIs are the most frequently encountered and typically manifest within the first postoperative week. Various wound assessment systems, including the Southampton Wound Grading System and the ASEPSIS scoring system, have been developed to facilitate standardized evaluation and surveillance of postoperative wound

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infections [5,6].

Accumulation of blood and serous fluid in the subcutaneous space may promote bacterial proliferation and impair wound healing. Subcutaneous suction drains have therefore been proposed as a preventive measure by facilitating fluid evacuation and reducing dead space. However, despite the potential benefits, evidence regarding their effectiveness remains variable, and their routine use in abdominal surgery continues to be debated [7,8].

Negative-pressure drainage may support wound healing through multiple mechanisms. Continuous fluid removal can help decrease local edema, promote tissue perfusion, and reduce the potential for bacterial growth within the wound [9]. In addition, drainage of hematomas and seromas may improve tissue apposition and create conditions more conducive to normal wound healing.

This study aimed to evaluate the association between subcutaneous suction drain placement and the incidence of superficial SSIs following open abdominal surgery. It also assessed the association of SSI occurrence with surgical urgency, wound contamination status, patient demographics, comorbidities, and wound closure technique.

# Materials And Methods

## Study design and setting

A prospective comparative observational study was conducted in the Department of General Surgery at Government Medical College, Thrissur, a tertiary care teaching hospital in South India. The study was conducted over one year after approval from the Institutional Ethics Committee (IEC approval number: IEC/GMCTSR/2023/162; approval date: September 19, 2023).

## Study population

The study included adult patients aged 18-79 years who underwent open abdominal surgery during the study period and provided written informed consent. Patients were categorized into a drain group or a nondrain group according to the operating surgeon's intraoperative decision regarding subcutaneous suction drain placement. Demographic characteristics, comorbidities, clinical diagnosis, type of surgical procedure, and wound contamination status were recorded prospectively.

## Sample size

The minimum sample size was calculated using the following formula:

$$N = [(Z\alpha + Z\beta)^2 \times p \times q \times 2]/d^2$$

The sample size was estimated using a formula for comparing two groups, based on the anticipated proportion of SSIs, the selected level of statistical significance, the desired statistical power, and the minimum clinically meaningful difference between the groups. In the formula, Zα represents the standard normal deviate corresponding to the significance level, Zβ represents the standard normal deviate corresponding to the desired power, p represents the assumed proportion specified in the calculation, q represents its complement where applicable (q = 1 - p), and d represents the assumed difference between the proportions. The factor of 2 accounts for the two groups under the assumptions of the formula.

The calculated sample-size requirement was approximately 55 patients per group. A total of 114 patients were included in the study, comprising 56 patients in the drain group and 58 in the nondrain group.

## Inclusion criteria

The study included adult patients aged between 18 and 79 years who underwent open abdominal surgery during the study period. Eligible participants were those who provided written informed consent and fulfilled all study eligibility criteria.

## Data collection

Data were collected prospectively using a structured study proforma. Information regarding demographic characteristics, clinical diagnosis, comorbid illnesses, type of surgery, wound contamination status, operative findings, and postoperative outcomes was obtained from patient records and operative notes.

Patients were monitored for superficial SSI for 30 days following surgery, including assessments during hospitalization and follow-up after discharge. Inpatient wound assessments were performed daily using the Southampton Wound Grading System. After discharge, patients were assessed during scheduled outpatient follow-up visits, and additional evaluation was undertaken when SSI was suspected. Wound swabs were obtained for microbiological culture and antibiotic sensitivity testing when clinically indicated.

### Drain placement technique

The linea alba was closed using No. 1 polydioxanone suture in a continuous technique. Sutures were placed 1 cm from the edge of the linea alba on both sides, maintaining a distance of 1 cm between adjacent sutures. After closure of the rectus sheath, a 14Fr subcutaneous suction drain was placed in the drain group, brought out through a separate skin incision, and connected to a closed suction reservoir. No subcutaneous suction drain was placed in the nondrain group. Skin closure was performed according to the operating surgeon's usual practice.

The drain was secured to the skin using nonabsorbable sutures. The external end was connected to a closed reservoir system capable of generating low negative pressure. The reservoir was compressed before attachment to establish continuous suction. Daily care of the drain exit site was performed according to institutional protocol.

Drain output was monitored regularly, including the volume and nature of the collected fluid. After each assessment, negative pressure was reestablished to maintain effective drainage. Nursing staff and caregivers were instructed regarding proper drain management and wound care.

### Outcome measure

The primary outcome was the occurrence of superficial SSI. SSI was defined according to the CDC National Healthcare Safety Network (NHSN) criteria as an infection occurring within 30 days of surgery and involving only the skin and subcutaneous tissue of the incision.

### Statistical analysis

Data were entered into a computerized database and analyzed using appropriate statistical software. Categorical variables were summarized as frequencies and percentages. Associations between study variables and the occurrence of SSI were evaluated using the chi-square test. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to estimate the strength of associations. A p value of less than 0.05 was considered statistically significant.

## Results

The study included 114 patients who underwent open abdominal surgery. Of these, 56 patients received a subcutaneous suction wound drain, while 58 patients underwent wound closure without drain placement. The primary outcome assessed was the occurrence of superficial SSI, defined according to the CDC NHSN criteria [10].

### Association between subcutaneous suction drain and SSI

As demonstrated in Figure *1*, among the 56 patients in the drain group, 12 (21.4%) developed a superficial SSI, whereas 24 of the 58 patients (41.4%) in the nondrain group developed SSI. Patients who did not receive a subcutaneous suction drain had 2.58 times higher odds of developing SSI than those who received a drain (OR: 2.58; 95% CI: 1.13-5.90). This association was statistically significant ($\chi^2 = 5.24$, $p = 0.022$), indicating that the use of a subcutaneous suction drain significantly reduced the incidence of postoperative superficial SSI (Table *1*).

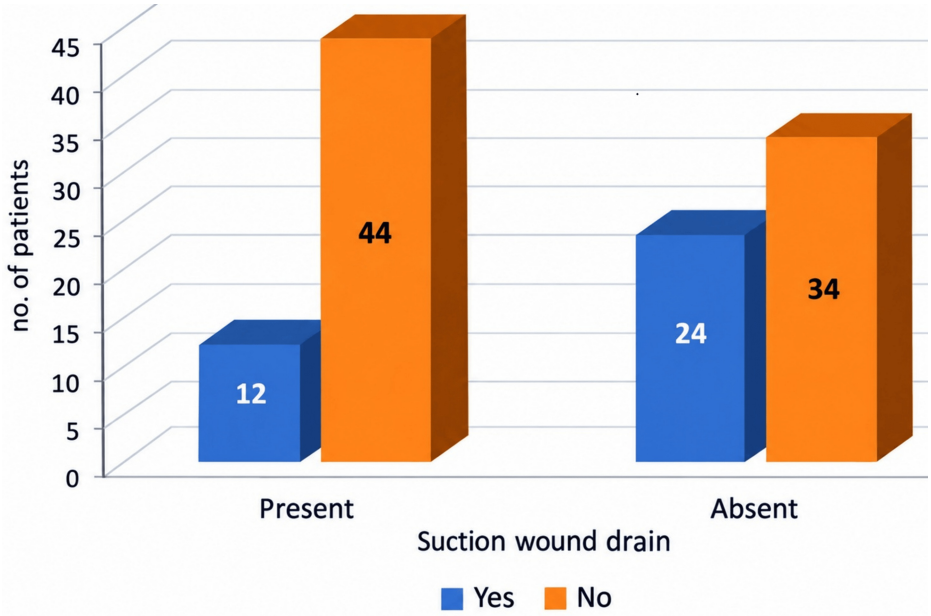



**FIGURE 1: Graph showing the distribution of surgical site infection incidence based on suction wound drain placement**

| Variable | Chi-square value | p value | Odds ratio (95% CI) |
|---|---|---|---|
| Subcutaneous suction wound drain | 5.24 | 0.022* | 2.58 (1.13-5.90) |
| Type of surgery | 0.055 | 0.82 | 1.09 (0.49-2.42) |
| Gender | 1.858 | 0.17 | 1.81 (0.76-4.26) |
| Type of wound closure | 0.024 | 0.87 | 1.06 (0.76-4.26) |
| Wound contamination level | 1.03 | 0.31 | 1.50 (0.68-3.36) |
| Presence of comorbidities | 0.26 | 0.61 | 1.22 (0.55-2.71) |

**TABLE 1: Association between study variables and surgical site infection**

CI: confidence interval

## Association between type of surgery and SSI

Among the 52 patients who underwent emergency surgery, 17 (32.7%) developed SSI. In comparison, 19 of the 62 patients (30.6%) who underwent elective surgery developed SSI (Figure *2*). Although the incidence of SSI was marginally higher in emergency procedures, the difference was not statistically significant ($\chi^2$ = 0.055, OR: 1.09; 95% CI: 0.49-2.42; p = 0.82) (Table *1*).

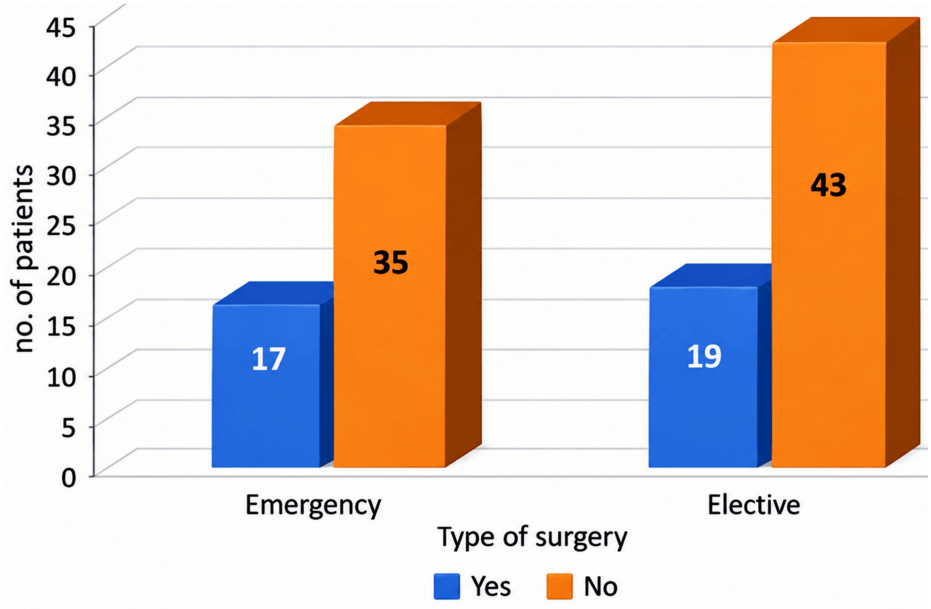



**FIGURE 2: Graph showing the distribution of surgical site infection incidence based on the type of surgery**

## Association between wound contamination and SSI

Of the 46 patients with contaminated or dirty wounds, 17 (37.0%) developed SSI, whereas 19 of the 68 patients (27.9%) with clean-contaminated wounds developed SSI (Figure *3*). Although contaminated and dirty wounds demonstrated a 1.5-fold higher odds of SSI, the association did not reach statistical significance (OR: 1.50; 95% CI: 0.68-3.36; $\chi^2 = 1.03$; $p = 0.31$) (Table *1*).

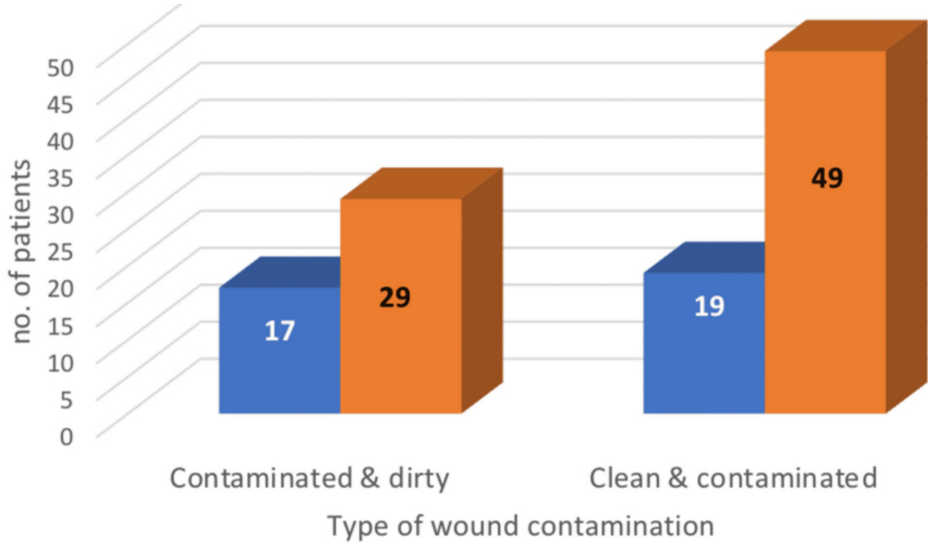



**FIGURE 3: Graph showing the distribution of SSI based on the level of wound contamination**

The blue bar denotes the number of patients who developed SSI, and the orange bar denotes the number of patients who did not develop SSI

SSI: surgical site infection

## Association between patient-related factors and SSI

No statistically significant association was observed between patient gender and the occurrence of SSI ($\chi^2 =$

1.858, OR: 1.81; 95% CI: 0.76-4.26; p = 0.17). Similarly, the method of skin closure was not significantly associated with postoperative wound infection ($\chi^2$ = 0.024, OR: 1.06; 95% CI: 0.76-4.26; p = 0.87).

The presence of comorbid illnesses also showed no significant association with SSI development ($\chi^2$ = 0.26, 95% CI: 0.55-2.71; p = 0.61). Furthermore, age was not found to influence the incidence of postoperative wound infection in the study population.

Overall, the use of a subcutaneous suction wound drain was the only factor that demonstrated a statistically significant association with a reduced incidence of superficial SSI. None of the other variables evaluated, including age, gender, type of surgery, wound contamination status, skin closure technique, and comorbid conditions, showed a significant relationship with postoperative SSI.

## Discussion

The present study compared the incidence of superficial SSI between patients who received subcutaneous suction drains and those who did not following open abdominal surgery. The findings provide a basis for examining the potential role of subcutaneous drainage in SSI prevention and interpreting the observed differences in relation to existing evidence and other clinical factors that may influence postoperative wound healing.

The principal finding of this study was that the use of a subcutaneous suction wound drain significantly reduced the incidence of superficial SSI. Infection developed in 21.4% of patients who received a drain compared with 41.4% of those who underwent conventional wound closure without drainage. Patients in the nondrain group had approximately 2.6 times higher odds of developing SSI than those in whom a drain was used. These findings suggest that subcutaneous suction drainage is an effective adjunct in preventing postoperative wound infection following open abdominal surgery.

The beneficial effect of subcutaneous suction drainage is biologically plausible. Following abdominal wound closure, accumulation of blood, serous fluid, and necrotic tissue within the subcutaneous space creates an environment that promotes bacterial proliferation. Continuous evacuation of these collections minimizes dead space, reduces tissue tension, improves local tissue perfusion, and decreases bacterial colonization, thereby facilitating wound healing and reducing the risk of infection [11,12].

The findings of the present study are consistent with several previously published investigations. Manzoor et al., Naik et al., Gupta and Kumar, Manoharan et al., and Pai et al. all reported lower SSI rates among patients managed with subcutaneous suction drains than among those undergoing conventional wound closure [13-17]. In addition to reducing wound infection, several of these studies also demonstrated lower rates of wound dehiscence, shorter postoperative hospital stay, and fewer secondary wound procedures, indicating broader clinical benefits associated with subcutaneous drainage.

The results of the present study are further supported by the recent systematic review and meta-analysis by Ishinuki et al., which analyzed eight randomized controlled trials involving more than 1,500 patients undergoing abdominal surgery [18-20]. The pooled analysis demonstrated a significant reduction in SSI among patients receiving subcutaneous drains compared with controls, providing high-quality evidence for the effectiveness of this intervention. The consistency of our findings with both randomized trials and pooled evidence strengthens the validity of the observed association between subcutaneous suction drainage and reduced postoperative wound infection.

Although emergency surgery has traditionally been considered a major risk factor for SSI because of delayed presentation, contamination, and intra-abdominal sepsis, the present study did not demonstrate a statistically significant difference in SSI rates between emergency and elective procedures. This observation may reflect standardized perioperative antibiotic administration, meticulous surgical technique, and uniform postoperative wound care practiced at our institution, which may have minimized differences between the two groups.

Similarly, wound contamination status was not significantly associated with SSI, although contaminated and dirty wounds demonstrated a 1.5-fold higher odds of infection than clean-contaminated wounds. While this finding did not reach statistical significance, it suggests a clinically relevant trend that may have become significant with a larger study population. The relatively modest sample size may have limited the statistical power to detect smaller differences between contamination categories.

No significant association was observed between SSI and patient-related variables such as age, sex, comorbid illnesses, or the method of skin closure. Although conditions such as diabetes mellitus and other systemic diseases are well-established risk factors for impaired wound healing, their influence may have been reduced by appropriate perioperative optimization and standardized infection prevention measures [13-20]. These findings suggest that operative factors, particularly the use of subcutaneous suction drainage, may have a greater influence on postoperative wound infection than baseline demographic characteristics in this patient population.

The strengths of this study include its prospective design and systematic postoperative wound assessment using the Southampton Wound Grading System. The study also provides a direct comparison of superficial SSI rates between patients who received subcutaneous suction drains and those who did not following open abdominal surgery. Nevertheless, several limitations should be acknowledged. This was a single-center observational study with a relatively small sample size, which may limit the generalizability of the findings. Allocation to the drain and nondrain groups was based on the operating surgeon's decision rather than randomization, introducing the possibility of selection bias. Furthermore, only superficial SSIs were evaluated, while long-term outcomes such as wound dehiscence, incisional hernia, duration of hospital stay, postoperative pain, and cost-effectiveness were not assessed.

Overall, these findings support the selective use of subcutaneous suction wound drains in patients undergoing open abdominal surgery. Future multicenter randomized controlled trials with larger sample sizes are warranted to identify patient populations that derive the greatest benefit and to establish evidence-based recommendations regarding the routine use, optimal drain type, and timing of drain removal.

SSIs impose an additional economic burden on healthcare systems and patients by increasing treatment requirements and extending hospital stays. Management may involve prolonged antibiotic therapy, repeated wound dressings, microbiological investigations, and, in more severe cases, readmission or further surgical intervention. These additional interventions increase healthcare expenditure and resource utilization. In resource-constrained settings, the financial impact may extend beyond direct medical costs, as patients and their families may experience loss of income, reduced productivity, delayed return to work, and additional travel expenses for follow-up care. Thus, preventing SSIs is important not only for improving clinical outcomes but also for reducing avoidable healthcare expenditure and the wider economic burden on patients and their families. Therefore, preventive interventions that can reduce the incidence of SSI may offer not only important clinical benefits but also a potential economic advantage. In this context, subcutaneous suction drainage, a relatively simple intervention aimed at preventing postoperative fluid accumulation and wound infection, may reduce the downstream healthcare utilization associated with SSI.

## Conclusions

In the present study, it was observed that subcutaneous suction wound drainage was associated with a significant reduction in the incidence of superficial SSIs following open abdominal surgery. But no statistically significant association was observed between the development of SSI and factors such as the type of surgery, wound contamination level, patient demographics, comorbidities, or wound closure technique. Superficial SSIs are a common postoperative complication that can increase patient morbidity, hospital stay, and healthcare costs. This study provides evidence that subcutaneous suction wound drainage may reduce the incidence of superficial SSIs following open abdominal surgery, while also suggesting that the benefit of drainage may be independent of other compared variables; thus, it may help surgeons make more informed decisions about the selective use of subcutaneous drains.

As this was a single-center observational study with a relatively small sample size, larger multicenter randomized controlled trials are needed to validate these findings and to establish evidence-based recommendations regarding the routine use of subcutaneous suction drains in abdominal surgery.

## Additional Information

### Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

**Concept and design:** Sowndarya Sellamuthu , Nimisha C. R., Sumin V. Sulaiman, Ravindran Chirukandath, James Pius, Vikas M. V., Keerthana Mohan

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**Critical review of the manuscript for important intellectual content:** Sowndarya Sellamuthu , Nimisha C. R., Sumin V. Sulaiman, Ravindran Chirukandath, James Pius, Keerthana Mohan

**Supervision:** Sowndarya Sellamuthu , Nimisha C. R., Sumin V. Sulaiman, Ravindran Chirukandath, James Pius, Keerthana Mohan

### Disclosures

**Human subjects:** Informed consent for treatment and open access publication was obtained or waived by all

participants in this study. Institutional Ethics Committee, Government Medical College, Thrissur issued approval IEC/GMCTSR/2023/162. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

## References

1. Zabaglo M, Leslie SW, Sharman T: Postoperative Wound Infections. StatPearls Publishing, Treasure Island, FL; 2025.
2. O'donnell KF: Wisdom from Ignaz Semmelweis. Nursing. 2021, 51:69-70. 10.1097/01.NURSE.0000791776.01619.8e
3. Cavaillon JM, Chrétien F: From septicemia to sepsis 3.0 - from Ignaz Semmelweis to Louis Pasteur . Microbes Infect. 2019, 21:213-21. 10.1016/j.micinf.2019.06.005
4. Newsom SW: Pioneers in infection control-Joseph Lister. J Hosp Infect. 2003, 55:246-53. 10.1016/j.jhin.2003.08.001
5. Wilson AP, Treasure T, Sturridge MF, Grüneberg RN: A scoring method (ASEPSIS) for postoperative wound infections for use in clinical trials of antibiotic prophylaxis. Lancet. 1986, 1:311-3. 10.1016/S0140-6736(86)90838-X
6. Bailey IS, Karran SE, Toyn K, Brough P, Ranaboldo C, Karran SJ: Community surveillance of complications after hernia surgery. BMJ. 1992, 304:469-71. 10.1136/bmj.304.6825.469
7. Lepenos T, Sanoudou D, Protogerou A, Laios K, Androutsos G, Karamamou M: Louis Pasteur (1822-1895), Ignaz Semmelweis (1818-1865), Joseph Lister (1827-1912) and the link between their works toward the development of antisepsis: a narrative review. Cureus. 2024, 16:e62543. 10.7759/cureus.62543
8. Surgical site infections: prevention and treatment . (2020). Accessed: July 20, 2021: https://www.ncbi.nlm.nih.gov/books/NBK542473/.
9. Diana M, Hübner M, Eisenring MC, Zanetti G, Troillet N, Demartines N: Measures to prevent surgical site infections: what surgeons (should) do. World J Surg. 2011, 35:280-8. 10.1007/s00268-010-0862-0
10. Centers for Disease Control and Prevention: Surgical site infections. National Healthcare Safety Network (NSHN) - Patient Safety Component Manual. National Healthcare Safety Network, Atlanta, GA; 2023.
11. Mulholland MW, Doherty GM: Complications in Surgery. Lippincott Williams & Wilkins, Philadelphia, PA; 2011.
12. Subramonia S, Pankhurst S, Rowlands BJ, Lobo DN: Vacuum-assisted closure of postoperative abdominal wounds: a prospective study. World J Surg. 2009, 33:931-7. 10.1007/s00268-009-9947-z
13. Manzoor B, Heywood N, Sharma A: Review of subcutaneous wound drainage in reducing surgical site infections after laparotomy. Surg Res Pract. 2015, 2015:715803. 10.1155/2015/715803
14. Naik AK, Arya SV, Sharma AK: Role of subcutaneous suction drain in reducing surgical site infection in emergency laparotomy. Int Surg J. 2022, 28:616-9. 10.18203/2349-2902.isj20220631
15. Gupta P, Kumar R: Role of subcutaneous suction drain in reducing surgical site infections after emergency laparotomy. Int Surg J. 2017, 24:2717-20. 10.18203/2349-2902.isj20173141
16. Manoharan GV, Sivakumar T, Kumar MA: Evaluation of the use of subcutaneous drains to prevent wound complications in abdominal surgeries. Int Surg J. 2018, 23:1368-72. 10.18203/2349-2902.isj20181112
17. Pai V, Aboosalih S, Balaji D, Prabu KRM: The role of subcutaneous negative suction drains in exploratory laparotomy for peritonitis. Int J Sci Res. 2019, 8:11.
18. Khan AQ, Kodalkar M: Role of negative suction drain in subcutaneous plane in reducing laprotomy wound infection. Int J Sci Res. 2016, 5:692-4. 10.21275/V5I1.NOV152871
19. Watanabe J, Ota M, Kawamoto M, et al.: A randomized controlled trial of subcutaneous closed-suction Blake drains for the prevention of incisional surgical site infection after colorectal surgery. Int J Colorectal Dis. 2017, 32:391-8. 10.1007/s00384-016-2687-2
20. Ishinuki T, Shinkawa H, Kouzu K, et al.: Recent evidence for subcutaneous drains to prevent surgical site infections after abdominal surgery: a systematic review and meta-analysis. World J Gastrointest Surg. 2023, 15:2879-89. 10.4240/wjgs.v15.i12.2879