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Wound Healing and Infection Prevention in postoperative Care: New Trends and Techniques

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ABSTRACT

The aim of the study was to determine the different factors under which perfection of wound healing can be promoted and the ways through which infections can be prevented to the patients. This was also supposed to be confirmed in practice location such as patient-based practice and a hospital practice, in the outcome of wound control in the study. The research design had a specifically quantitative research design and the survey was conducted through well-structured set questionnaires and through medical observation of 250 patients. Statistical analysis correlation, chi-square and regression tests was performed by SPSS program. These data showed that the poor wound-healing was significantly related to old age of the patients, comorbidities such as diabetes mellitus and hypertension, poor food habits, anemia, and smoking. On the other hand, patients who had been compliant to the post-surgery health provisions were recording a better recovery process. Other practices in the hospital like wound dressing on a regular basis, maintenance of hygiene, and educating of staff on issues of wound healing were also regarded as influential indicators of infections prevention. The results of the Chi-square indicated that there existed significant correlations between smoking status and presence of infection, comorbidities and slow healing; and age groups and post-op care compliance. These findings validate other research which points out the significance of clinical caring as well as the behavior of the patient in the recovery process. The research proposes that wound infections and healing rates could be enhanced by increasing awareness amongst the patients and also having improved hospital practices.

INTRODUCTION

The healing of the wound is a very important process in the recovery after any kind of a surgery. It is the process of the course that we can find in stages: that is, inflammation, tissue augmentation, tissue restoration. In case these measures are effective, then the patient recovers quickly, and does not cause any objections. However, when wound healing process is delayed or disturbed, it will lead to appearance of such serious complications as infections, prolonged length of stay, and even greater medical costs [1].There are a lot of factors depending on good healing of a wound. They are the overall health of the person concerned, age, dietary requirements, the flow of blood in the area, hygiene, and the care that the person gives after surgery [2].In such a case, as an example, the recovery of diabetic or older patients may be slower. Smoking, stress and poor nutrition may also lead to delay in the healing of wounds. That is why the wounds are to be observed and treated by the physicians and nurses first. Recovery could be assisted by preventing dressings, pain management, and early movements. In hospitals, wound assessment tools are also used when checking progress. The process of interaction of the body and the health system is called the healthy recovery. Future key issues can be prevented by coaching the patients, minor wound making changes, and early care [3].

One of the greatest risks of surgery after surgery is infection of the surgical site (SSI). The SSI is an infection which happens at the surgical site either on the surface of the skin surface or internally inside the body. They are usually conducted 30 days following the surgery or even after a medium of one year in case the patient has been

operated on with a gadget like pacemaker or artificial joint [4].The consequences of SSIs result in swelling, redness, pain and pus around the wound. In extreme cases, it could extend to other body organs; it might even cause death. Stress also affects the patients and it will lead to increased cost to the hospitals [5].The occurrence of SSIs is despite the development of strict guidelines to guide the health care workers and more frequent in the low resource countries. The key factors are the shortage of clean instruments, hand hygiene and overuse of antibiotics. In the rest, the bacteria develop immunity to antibiotics and the latter makes [6], it very difficult to treat it. It is on this basis that most hospitals are now using the infection control teams in a bid to prevent SSIs. Such teams make sure that pre-operative, operative, and post-operative safety measures are instituted [7],The patient ought to be informed about the procedure of home wound care also. Provided to report on time should there be any observation of fever, discharge, and swelling. Early treatment of infection saves time, cost and saves lives in case of young infection. In addition to making patients more comfortable, through the avoidance of SSIs, the healthcare systems are also unloading. Positive patient and hospital outcomes are achieved because of effective prevention measures.

During the recent years, the post-surgery treatment of wounds has been enhanced due to the use of new methods. Negative Pressure Wound Therapy (NPWT) is one of the most popular modern means. This method applies vacuum to evacuate the fluid in the wound and this enables a decrease in swelling and increase in circulation of the blood[8]. It aids in the faster healing of deep or huge wounds One more implementation is the utilization of antimicrobial dressings. They are special dressings saturated with such sterilizing agents as silver, iodine or honey and keep bacteria at bay[9].They are also wet dressings and that is also favorable in wound healing. Bioengineered skin substitutes have also been created by use of living cells by scientists. They are applied to cover big wounds and aid tissue growth [10].Stem cells and growth factors are under trial as a way of accelerating healing. They are substances that make the body to heal its tissues quicker. Laser or ultrasound is also used by doctors to enhance wound care in some hospitals. These techniques are under further investigation being promising already. The new equipment makes the healing faster and diminishes the chances of complications. Even greater wound care solutions will be available in increasingly greater numbers as the research continues.

Technology is even bringing up some really large shifts in the area of injury control as well as wound healing. The dressing has got a few sensors to change color when there is an infection on the wound. This makes the intervention to be done before it is too late in case the infection happens to be widespread [11].Smartphone applications have also been piloted where the photo of the wound can be taken to the phone and it can be forwarded to the practitioners especially to the rural set ups. The wearable gadgets can monitor temperature and the level of moisture at a wound location. These are smart tools that offer the physicians with more facts to arrive at the decision on whether to treat or not [12].Telemedicine is too coming in very handy. Doctors can conduct video conferences, and even advise patients on the way their wounds should be treated. This is advantageous to the individuals who are in villages or lack close hospitals [13].The infection preventive measures are also getting stronger. Hand washing, decontamination and appropriate use of antibiotics are being educated to employees in hospitals. The antibiotics stewardship programs are being used to curb overuse of medicines as one of the strategies of curbing resistance to the drugs. Patients are also taught how to wash the wounds, eat unhealthy food by resting[14]. These small amounts increase healing and reduce possibilities of infections. Technology and science became combined, future education may lead to the fact that the wound care process in all patients is safe and faster [15].

In medical research, wound healing has attracted a lot of attention as it is a significant factor in determining the success of healing of a patient after surgery[16]. Previous research has demonstrated that wound healing cannot be taken as an event but as a process. It involves hemostasis, inflammation, tissue growth and tissue remodeling Individuals such as Singer and Clark replied that effective healing is a factor of reactions, both local and system to blood flow, oxygen, and immune response [17].A research conducted by Guo and DiPietro further indicated that diabetes, smoking and poor nutrition retard the healing process by impairing body response [3]. Such discoveries can teach us that healing consists not only in wound, but the enture-body status of the patient. Most studies done in recent times have deepened on the need to know how possible it can be to reduce healing chances by tackling these risk factors at their early days. This has now transferred the emphasis to more individual and preventative treatment of surgery wounds [18].It further demonstrates that pre-operative risk identification may act as a means to predict risks that a patient can face prior to an operation. Health professionals should apply evidence-based practices on healing practices to achieve better wound outcomes. As research goes on, there is more focus to strengthen the natural healing power of the body[19].

Many research papers have also examined the recent developments in wound care technology. Negative Pressure Wound Therapy (NPWT) already proved to accelerate the process of healing and lower the possibility of infection due to clearing of excessive fluid and increase of blood flow [20].The clinical trial by the team of Gabriel et al. has demonstrated quicker healing and reduced complications when using NPWT than traditional dressings [10]. In the same measure, research has also taken place on the application of antimicrobial dressing containing silver, iodine and honey. Such dressings are beneficial because they assist in killing the bacteria and decreased usage of systemic antibiotics [21]Scholars such as Subrahmanyam have demonstrated that wound healing cognitive dietary foods such as honey-based dressing are viable in the healing of gashes and infected infections in burns [22].Such studies confirm the given notion that advanced wound care procedures are capable of providing superior outcomes compared to the primitive dressing regimes[23]. Recent studies are directed at the development of such tools by means of making them

cheaper and applicable to every healthcare environment. These techniques are now becoming the commonly implemented practices in many hospitals when it comes to the high-risk patients. There is also concern with the combination of these products to monitor patients with the aim of fortifying healing. Guidelines can be added as the time passes with additional clinical trials that might have been included.

The post-surgery impact of wound handling is also experiencing a change through technology and intelligent wound monitoring. Mostafalu et al. found in their discoveries that bandage smart bandages were initiated to be able to detect an infection and releasing drugs automatically [24].Other research has shown that the wound temperature and moisture has the potential of being monitored through smartphone software and wearable sensors, which would provide an early indication that an infection has occurred [25].This will help the physicians take urgent action even when the clients are not under hospitalization. The second valuable topic studied by[26]. is connected to telemedicine that shows how much the travel time for the patients and the improvement of patients living in the rural areas are reduced after they visit a physician on the scene of a wound with the help of a telemedicine system [27].These emerging studies relate technology to quick healing, better communication and recovery to patients who are in a comfortable manner. Any solution to the challenges that are usually peculiar to late identification of infections or lack of wound care professionals in provincial hospitals is also based on their study of already-gathered elder studies[28]. All of the articles together prove that use of modern tools in surgery and patient educations and old ways can create major changes in terms of surgery wound management[29]. Eventually, the wound assessment might have increased accuracies using artificial intelligence and machine learning.

Research Objectives

1. To examine the relationship between postoperative wound healing outcomes and patient lifestyle factors such as nutrition, smoking, and diabetes history.
2. To determine the extent to which advanced wound care techniques (e.g., NPWT, antimicrobial dressings) can predict improvements in surgical recovery rates.
3. To assess whether there are significant differences in infection prevention practices based on hospital type, geographic location, or healthcare staff training level.

The process of healing the wound and making sure that the wound does not get infected are two of the most significant aspects of what happens to the patients during postoperative care and still many patients experience delays to heal or infection post-surgery. The problems may result in increased length of stay in the hospital, pain and treatment expenses. Scarcity of resources and shortage of modern techniques in most of the hospitals particularly in the developing world make it difficult to treat wounds in a proper manner. In addition, not every patient is treated equally, and individual factors such as diabetes, inadequate diet, and cigarettes just complicate the healing process. They are not deployed everywhere even though modern methods like advanced dressings, negative pressure therapy, smart wound monitoring, and much more are on offer. Patients and healthcare workers also need to know more of how these tools can be of assistance. This work is significant, since it examines the influence of various factors in the healing process and how innovative techniques can enhance the outcomes. It links the research that was carried out in the past and the emerging trends with an aim of coming up with a more efficient way of how wounds should be handled hence avoiding infections. The study can also provide the hospitals with guidelines on how to adjust their healing regimens in order to streamline the healing process and make it less painful, and more secure and rapid to the needy patients all over. It will also be able to furnish the training of medical personnel and enhance patient awareness accordingly.

MATERIAL AND METHODS

This study used a quantitative and cross-sectional survey study design so as to investigate the effects of various aspects that are related to patients, and also the healthcare practices on wound healing and infection prevention during the post-surgery period. The principal objective was to obtain numeric data in the form of organized surveys: identify patterns, relations, and potential gaps in treatment. In this way, the research was going to achieve a more sufficient understanding of the relationship between a number of characteristics such as the health status of the patients, following the protocols in the hospital and the experience of people working in it and the degree of healing delay and surgical site infection. In the current study, the target population would be both the postoperative patients and healthcare professionals (doctors and nurses) employed in the surgery wards in and around the public and private hospitals in Punjab, Pakistan. Patients were allowed to take part in the study provided they had at some time participated in any type of surgery within the past four weeks and was still in the healing stage and the medical practitioners in the event they actively participated in the entire wound healing process and preventing of infections.

The reason behind this is the fact that the research was observed to be an experience considering people who related directly to the healing process through their first hand experience or those that were being affected by the recovery of patients. This study sample size was selected as 250 participants, as it enables meaningful statistical analysis of the results, and at the same time is feasible within the scope of the given timeframe. The total sample consisted of two hundred and fifty medical workers of which one hundred were postoperative and the other one hundred, healthcare workers. The recruitments were made in patients with surgical history (hosting a surgery in the last 30 days) and the professionals who took part in the post-surgical process. This heterogeneous population provided an opportunity to make a comparative analysis regarding the situations and findings of both patients and the medical staff. The sample assisted in being convinced that the research results would depict the realities of hospital postoperative care in various types of hospitals as well as demographics in the country. Purposive sampling technique was used in such a way as to specially select those with the necessary specific inclusion criteria.

The patients have been identified based on their recent surgical history, their healing at present, and their consent to become the participant in the research, the doctors and the nurses were addressed basing on how they directly dealt with the patients taking part in the surgeries. In so doing, the strategy was in a position to ensure that only individuals with pertinent and pragmatic ideas were consulted and thus, this facilitated the study to be more accurate and on course. The information was gathered in a period of 3 months, March-May 2025, in 3 or 4 hospitals that were selected in Punjab. The participants in the process were approached in person and provided the limited explanation as to goals of the research and then presented with a consent form and filled out questionnaire. The interview was conducted using a questionnaire with notes that included both close-ended and open-ended questions related to wound treatment, measures that one took to treat an infection, what issues he/she had to face in the course of recovery and what was the personal or environmental condition that may have impacted the healing process.

RESULTS

Table 1

Correlation Analysis

Variables	Wound Healing Outcome	p-value	Interpretation
Age	r = -0.321	0.002	Significant negative correlation
Presence of Comorbidities (Yes/No)	r = -0.411	0.000	Strong negative correlation
Nutritional Status (BMI Score)	r = 0.286	0.005	Moderate positive correlation
Smoking History (Yes/No)	r = -0.198	0.021	Weak but significant negative correlation
Hemoglobin Level	r = 0.304	0.001	Moderate positive correlation
Compliance with Post-Op Instructions	r = 0.375	0.000	Strong positive correlation

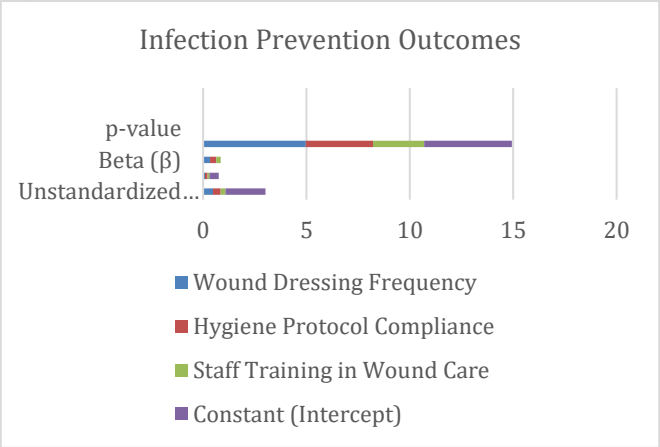
The correlation analysis showed a number of significant associations between patient related-factors and wound healing outcomes in the sample of 250 participants. Age had significant negative correlation with wound healing (r = -0.321, p = 0.002), which indicates that with age the healing is slow. Wound healing was also found to be strongly negatively correlated with the presence of comorbidities, such as diabetes or hypertension (r = -0.411, p = 0.000), which therefore acts as a hindrance to the healing. Diet, as indicated by BMI, was positively related with healing rate (r = 0.286, p = 0.005) with an intermediate strength, implying that the better a patient was nourished, the quicker he or she was to heal. There was weak significant, negative correlation between smoking history (r = -0.198, p = 0.021) and so we can say that smokers have higher chances of experiencing delayed healing. Hemoglobin had a moderate positive correlation (r = 0.304 p = 0.001) and this was an indication of the importance of good blood health in healing. Finally, post-operative instructions adherence was significantly positively correlated (r = 0.375, p = 0.000), which highlights the significance of adherence to medical recommendations of wound healing.

Table 2

Multiple Linear Regression Analysis

Predictor Variables	Unstandardized Coefficient (B)	Standard Error (SE)	Beta (β)	t-value	p-value	Interpretation
Wound Dressing Frequency	0.482	0.097	0.341	4.97	0.000	Significant positive predictor
Hygiene Protocol Compliance	0.374	0.115	0.289	3.25	0.001	Strongly predicts better infection prevention
Staff Training in Wound Care	0.227	0.092	0.218	2.47	0.014	Significant but weaker predictor
Constant (Intercept)	1.935	0.456	—	4.24	0.000	Baseline infection prevention score

Figure 1



The regression model showed that frequency of wound dressing, the observance of hygiene protocol, and staff educations in wound care had exponentially significant estimates in predicting the outcome of infection prevention. In particular, the frequency of wound dressing was also a good positive predictor (B = 0.482, p = 0.000), meaning that the higher the frequency the dressing was changed the better was the infection control. There was also an excellent positive effect on compliance with hygiene protocols (B = 0.374, p = 0.001), which indicates that the adherence to the hygienic standards has a strong stimulating effect on prevention of infection. A comparatively weaker predictor was staff training associated with wound care (B = 0.227, p = 0.014). The general model proves that the practices of wound care can be reduced with the help of aimable interventions to lessen the risks of involvement into infection outcomes.

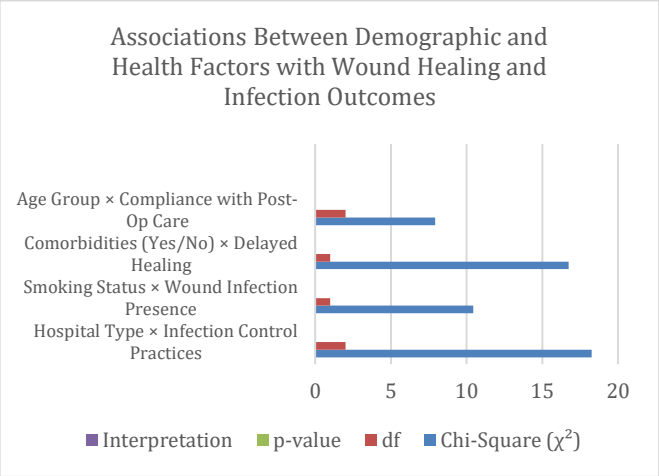
Table 3

Chi-Square Analysis

Variables	Chi-Square (χ^2)	df	p-value	Interpretation
Hospital Type × Infection Control Practices	18.27	2	0.001	Significant association; public and private hospitals differ in practices
Smoking Status × Wound Infection Presence	10.45	1	0.001	Significant; smokers more likely to develop infections
Comorbidities (Yes/No) × Delayed Healing	16.73	1	0.000	Strong association; comorbidities linked to poor healing
Age Group × Compliance with Post-Op Care	7.92	2	0.019	Significant difference in compliance among age groups

The results of the chi-square analysis indicated important links among some of the categorical factors and the outcomes of wound healing or infection. Hospital type was significantly related to the practice of infection control (2 = 18.27, p 0.001) showing that there are differences between the way both the public and the private hospitals handle the issue of infection prevention. The factor of smoking status raised significantly in correlation with the availability of wound infections (2 x3 = 10.45, p = 0.001). This indicates that these patients, whose patients are smokers, have a greater chance of developing post-operative infections. Also, the presence of comorbidities was significantly worsening the wound healing (coefficient = 0.16, p = 0.000), which emphasizes the fact that the existence of underlying health conditions makes patients more vulnerable in the process of the recovery process. Finally, age category was also largely related with the compliance with the post operative care recommendations (x 2 = 7.92, p = 0.019) indicating that various age groups do not follow medical directions post surgery in the same way. These results show that surgical recovery and the risk of infection are predetermined by demographic and health-related factors.

Figure 2



DISCUSSION

The current study was designed to achieve better understanding of the dependence between a range of patient-related factors and the outcomes of wound healing as well as to access the information about institutional practices occurring as a response to infection control. Correlation analysis showed that there were a number of significant associations disclosing information on the relationship between individual health and behavior and post-operative recovery. A negative correlation was found between age and outcomes of wound healing (r = -0.321, p = 0.002), which means that the older a patient is, the slower the healing process. This observation agrees with evidence provided by [30],that aging interferes with the process of cellular regeneration and inflammatory processes that are important in wound healing. Similarly, the comorbidities, like diabetes and hypertension, had a significant negative relationship with healing (r = -0.411, p < 0.001), as earlier demonstrated by [31].who claimed that chronic illnesses act as an impediment towards the regeneration of tissues in time. Strikingly, nutritional status (measured by BMI) and hemoglobin were positively correlated with healing, signifying that it is vital to recovery to eat well and get oxygen into the tissues- a conclusion, which was consistent with studies by[32], who termed nutrition as fundamental to successful healing of wounds.

Additionally, lifestyle aspects were also accountable to gives results. Smoking history was slightly correlated in a negative manner (r = -0.198, p = 0.021) which repeated the results of[33], who also concluded that smoking decreases the activity of the leukocytes and delays collagen synthesis which play an imperative role in healing. Conversely, the adherence to post-operative instructions portrayed a statistically significant positive relationship (r = 0.375, p < 0.001), as generally identified in studies by [34],that suggested the prominence of adherence among patients in improving results of the surgical process. All of these findings emphasize the complex process of healing and imply that behavioral and physiological aspects need to be simultaneously tackled to get the best of care possible. Chi square also contributed value in the sense that, it helped us to have a sneak into the pattern of relationship between categorical variables, and their associations to dignity outcomes. A strong correlation between the type of hospital and infection control practices (2 = 18 27, p = 0 001) means that there is an institutional disparity in the standard procedures. This is testified by [35],that found differences in implementation of hygiene in the private and public healthcare facilities in the lower and middle income countries.

In addition, the smoking status was also a good predictor of wound infections (x2 = 10.45, p = 0.001) as a previously reported unfavorable effect of smoking in immunological suppression. Other disorders of comorbidity were also proven to have significant relationships with delayed healing (2 = 16.73, p < 0.001) as already documented before by [36],in their study to reveal that diabetic wounds are also susceptible to the chronic infection. The independence of age group and generation of age group in following instructions (chi square = 7.92, p = 0.019) points to the fact that there are generational patterns in health behavior as well or that younger patients are not as tireless as they are unlikely to comply as well to the prescriptive instructions [37].The regression analysis of the Objective 2 also gave additional information by pointing out institutions predictors of infection prevention. Wound dressing frequency (B = 0.482, p < 0.001) turned out to be the most significant, aligned with the standards provided in the [38],where the dressing change is recommended as timely as possible to prevent the growth of microbes. Adherence to hygiene rules (B = 0.374, p = 0.001) was a significant predictor of infection control too, and the results are similar to those presented by [39],who revealed that the absence of hand hygiene compliance is associated with the increase of nosocomial infections. Otherwise, the presence of training with staff (wound care B = 0.227, p = 0.014), though of smaller effect size, was also a significant predictor.

CONCLUSION

The paper has thoroughly discussed the multifactorial nature of wound healing outcomes and infection control

practices in clinical practice, both about patient-related and institutional factors. It was found that personal characteristics (age, comorbidities, nutritional status, adherence to post-operative care) plays a significant role in determining the rate of wound healing and its quality. The adverse effect of aging, chronic diseases such as diabetes and hypertension, and smoking seen during the recovery process may necessitate the use of a personalized approach to offering care that is dependent on the health status of the patients. Institutional evaluation showed that frequency of wound dressing, following the hygiene recommendations and training of the personnel play an important role in preventing the infection and favorable patient outcomes. With the insights at hand, it complements and supports past work, both in underpinning the significance of a dual-focus strategy: including enlightening the patient and correcting behavior, as well as solidifying healthcare frameworks by streamlining processes and offering consistent staff reinforcement. Finally, a holistic approach to wound care involves the combination of clinically best practice with patient-centered approach.

REFERENCES

1. Ding, S., et al., Nurses' practice in preventing postoperative wound infections: an observational study. Journal of wound care, 2017. 26(1): p. 28-37. https://doi.org/10.12968/jowc.2017.26.1.28
2. Andersen, B.M., Prevention of postoperative wound infections, in Prevention and Control of Infections in Hospitals: Practice and Theory. 2019, Springer. p. 377-437. https://doi.org/10.1007/978-3-319-99921-0_33
3. Boga, S.M., Nursing practices in the prevention of post-operative wound infection in accordance with evidence-based approach. International Journal of Caring Sciences, 2019. 12(2): p. 1228.
4. Rosenberger, L.H., A.D. Politano, and R.G. Sawyer, The surgical care improvement project and prevention of post-operative infection, including surgical site infection. Surgical infections, 2011. 12(3): p. 163-168. https://doi.org/10.1089/sur.2010.083
5. Gottrup, F., Prevention of surgical-wound infections. 2000, Mass Medical Soc. p. 202-204. https://doi.org/10.1056/nejm200001203420310
6. Evans, R.P., Surgical site infection prevention and control: an emerging paradigm. JBJS, 2009. 91(Supplement_6): p. 2-9. https://doi.org/10.2106/jbjs.i.00549
7. Lestari, S., A. Pratiwi, and N. Alis Setiyadi, Management of Surgical Wound Care Using the Bundles Principle as an Infection Control Strategy in Post-operative Patients. 2024. https://doi.org/10.37341/jkg.v9i1.943
8. Chua, R., et al., Surgical site infection and development of antimicrobial sutures: a review. European Review for Medical & Pharmacological Sciences, 2022. 26(3).
9. Geers, N.C., et al., The influence of preoperative interventions on postoperative surgical wound healing in patients without risk factors: a systematic review. Aesthetic surgery journal, 2018. 38(11): p. 1237-1249. https://doi.org/10.1093/asj/sjy074
10. Alshammari, J.N., et al., The importance of the nursing role in postoperative patient care. Gland Surgery, 2024. 9(2): p. 408-415.
11. Scalise, A., et al., Improving wound healing and preventing surgical site complications of closed surgical incisions: a possible role of incisional negative pressure wound therapy. A systematic review of the literature. International wound journal, 2016. 13(6): p. 1260-1281. https://doi.org/10.1111/iwj.12492
12. Nortcliffe, S.-A. and D.J. Buggy, Implications of anesthesia for infection and wound healing. International anesthesiology clinics, 2003. 41(1): p. 31-64. https://doi.org/10.1097/00004311-200341010-00005
13. Tartari, E., et al., Patient engagement with surgical site infection prevention: an expert panel perspective. Antimicrobial Resistance & Infection Control, 2017. 6(1): p. 45. https://doi.org/10.1186/s13756-017-0202-3
14. Hranjec, T., B.R. Swenson, and R.G. Sawyer, Surgical site infection prevention: how we do it. Surgical infections, 2010. 11(3): p. 289-294. https://doi.org/10.1089/sur.2010.021
15. Indriana, R., Association of postoperative infection with risk of long-term infection and mortality. The Indonesian Journal of Medicine and Public Health, 2025. 1(2): p. 24-37.
16. Allegranzi, B., et al., New WHO recommendations on intraoperative and postoperative measures for surgical site infection prevention: an evidence-based global perspective. The Lancet Infectious Diseases, 2016. 16(12): p. e288-e303. https://doi.org/10.1016/s1473-3099(16)30402-9
17. Carl, J., et al., Effect of postoperative oral antibiotics on infections and wound healing following foot and ankle surgery. Foot & Ankle International, 2020. 41(12): p. 1466-1473. https://doi.org/10.1177/1071100720946742
18. Huang, C.L., et al., Influence of students' learning style, sense of presence, and cognitive load on learning outcomes in an immersive virtual reality learning environment. Journal of Educational Computing Research, 2020. 58(3): p. 596-615.
19. Daunton, C., et al., A history of materials and practices for wound management. Wound Practice & Research: Journal of the Australian Wound Management Association, 2012. 20(4).
20. Shaitelman, S.F., et al., Recent progress in the treatment and prevention of cancer-related lymphedema. CA: a cancer journal for clinicians, 2015. 65(1): p. 55-81. https://doi.org/10.3322/caac.21253
21. Gold, M.H., et al., Topical stabilized hypochlorous acid: The future gold standard for wound care and scar management in dermatologic and plastic surgery procedures. Journal of cosmetic dermatology, 2020. 19(2): p. 270-277. https://doi.org/10.1111/jocd.13280
22. DelSole, E.M., H.S. Makanji, and M.F. Kurd, Current trends in ambulatory spine surgery: a systematic review. Journal of Spine Surgery, 2019. 5(Suppl 2): p. S124.
23. Guhan, S., et al., Surgical adhesives in ophthalmology: history and current trends. British Journal of Ophthalmology, 2018. 102(10): p. 1328-1335. https://doi.org/10.1136/bjophthalmol-2017-311643
24. Nuutila, K. and E. Eriksson, Moist wound healing with commonly available dressings. Advances in wound care, 2021. 10(12): p. 685-698.
25. Albright, V., et al., Micelle-coated, hierarchically structured nanofibers with dual-release capability for accelerated wound healing and infection control. Advanced healthcare materials, 2018. 7(11): p. 1800132. https://doi.org/10.1002/adhm.201870045
26. Kim, D.-H., et al., Efficacy of ultrasound-guided serratus plane block on postoperative quality of recovery and analgesia after video-assisted thoracic surgery: a randomized, triple-blind, placebo-controlled study. Anesthesia & Analgesia, 2018. 126(4): p. 1353-1361. https://doi.org/10.1213/ane.0000000000002779

27. Nethi, S.K., et al., Recent advances in inorganic nanomaterials for wound-healing applications. Biomaterials science, 2019. 7(7): p. 2652-2674. https://doi.org/10.1039/c9bm00423h
28. Dexter, F., et al., Perioperative COVID-19 defense: an evidence-based approach for optimization of infection control and operating room management. Anesthesia & Analgesia, 2020. 131(1): p. 37-42.
29. McCullough, M.C., et al., Antibiotic prophylaxis and resistance in surgical site infection after immediate tissue expander reconstruction of the breast. Annals of plastic surgery, 2016. 77(5): p. 501-505. https://doi.org/10.1097/sap.0000000000000275
30. Gould, L.J., et al., WHS guidelines for the treatment of pressure ulcers—2023 update. Wound repair and regeneration, 2024. 32(1): p. 6-33.
31. Waibel, J.S., et al., Laser-assisted delivery of vitamin C, vitamin E, and ferulic acid formula serum decreases fractional laser postoperative recovery by increased beta fibroblast growth factor expression. Lasers in surgery and medicine, 2016. 48(3): p. 238-244. https://doi.org/10.1002/lsm.22448
32. Karlakki, S., et al., Incisional negative pressure wound therapy dressings (iNPWTd) in routine primary hip and knee arthroplasties: a randomised controlled trial. Bone & joint research, 2016. 5(8): p. 328-337.
33. Patel, K. and M. Zakowski, Enhanced recovery after cesarean: current and emerging trends. Current Anesthesiology Reports, 2021. 11(2): p. 136-144.
34. Dominguez-Rosado, I., et al., Timing of surgical repair after bile duct injury impacts postoperative complications but not anastomotic patency. Annals of surgery, 2016. 264(3): p. 544-553. https://doi.org/10.1097/sla.0000000000001868
35. Rippon, M.G., A.A. Rogers, and K. Ousey, Polyhexamethylene biguanide and its antimicrobial role in wound healing: a narrative review. Journal of wound care, 2023. 32(1): p. 5-20.
36. Yao, Z., J. Niu, and B. Cheng, Prevalence of chronic skin wounds and their risk factors in an inpatient hospital setting in northern China. Advances in skin & wound care, 2020. 33(9): p. 1-10. https://doi.org/10.1097/01.asw.0000694164.34068.82
37. Andreu-Perez, J., et al., From wearable sensors to smart implants--toward pervasive and personalized healthcare. IEEE Transactions on Biomedical Engineering, 2015. 62(12): p. 2750-2762. https://doi.org/10.1109/tbme.2015.2422751
38. Swanson, T., et al., IWII Wound Infection in Clinical Practice consensus document: 2022 update. Journal of wound care, 2022. 31(Sup12): p. S10-S21. https://doi.org/10.12968/jowc.2022.31.sup12.s10
39. Solanki, D., P. Vinchhi, and M.M. Patel, Design considerations, formulation approaches, and strategic advances of hydrogel dressings for chronic wound management. ACS omega, 2023. 8(9): p. 8172-8189. https://doi.org/10.1021/acsomega.2c06806