

**Risk Factors Associated with Surgical Wound Healing in Orthopedic Surgery Patients at The Dr. H. Moch Ansari Saleh Banjarmasin General Hospital****Muhammad Nizar<sup>1</sup>, M. Wibowo Ariyanto<sup>2</sup>****<sup>1</sup>Setara Regional Hospital, Barito Kuala, Indonesia****<sup>2</sup>Dr. H.Moch Anshari Saleh General Hospital, Banjarmasin, Indonesia****Email: aocfkunlam@gmail.com, ariewmuhammad@gmail.com**

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**Abstract**

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The healing of surgical wounds holds paramount importance in healthcare, garnering global attention across various healthcare settings. This study investigated the medical records of orthopedic surgery patients at Dr. H. Moch. Ansari Saleh Banjarmasin General Hospital between August and December 2023. The aim was to identify factors influencing surgical wound healing, which are crucial for preventing delays in specific patient cohorts. Employing a descriptive observational approach with a cross-sectional design, data were retrospectively gathered from medical records via purposive sampling. Analysis was conducted using Microsoft Excel and chi-square tests, centered on 133 eligible samples. Results highlighted several significant factors: antibiotic type ( $p = 0.013$ ), gender ( $p = 0.040$ ), comorbidities ( $p < 0.05$ ), surgery type ( $p < 0.05$ ), and length of hospital stay ( $p < 0.05$ ). Particularly, cefazolin emerged as the predominant antibiotic during the study period, demonstrating a significant influence on wound healing. Furthermore, surgery type, duration of hospitalization, gender, and comorbidities emerged as pertinent contributing factors. These findings underscore the importance of tailored interventions and meticulous post-operative care to optimize surgical wound outcomes.

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**Keywords:** Surgical wound healing; antibiotics; gender; length of stay; type of operation; comorbidity

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**INTRODUCTION**

Healthcare services are very worried about surgical wound healing. Injuries represent a major global health issue. In Denmark and the United Kingdom, for every 1000 people, 3–4 have one or more wounds. Many of these develop into long-term wounds. Regretfully, 15% of the wounds do not heal a year after they are displayed. For both patients and caregivers, chronic wound development is a difficult issue (Lindholm & Searle, 2016).

Following surgery, wound healing is a complex and strictly controlled process that is essential to retaining the skin's barrier function and all other skin functions.

Numerous factors, both modifiable and non-modifiable, can impact this process. Infections at the surgical site and wound and tissue dehiscence are recognized postoperative consequences in orthopaedic surgery, so management is crucial (Almadani, Vorstenbosch, Davison, & Murphy, 2021).

Among developed as well as developing countries, surgical site infections (SSI) are the most often reported health-acquired infection and surgical complication (JMukagendaneza, Munyaneza, & Muhawenayo, 2019). According to research done at a few hospitals in Indonesia, the frequency of surgical site infections (SSIs) varied from 5.32 to 13.9% for both clean and clean-contaminated procedures (Syaiful, Yarman, Prasetyo, & Toar, 2020). Dry wounds were linked to a higher risk of surgical wound infections in earlier studies (Harwiyanti & Nugraha, 2022).

Hemostasis, inflammation, proliferation, and remodeling are the four synchronized steps that make up the normal biological process of wound healing in the human body. All four stages need to happen in the right order and within the right amount of time for a wound to heal properly. Numerous variables may obstruct one or more stages of this process, leading to incorrect or compromised wound healing (DiPietro, 2010).

Acute wounds include wounds from incisions. If the healing process proceeds according to plan, but if there are any signs of infection or delayed healing, the wound may also be considered chronic. Wound healing becomes problematic if the number of bacterial colonies grows to the point where critical colonization occurs in infection situations (Harwiyanti & Nugraha, 2022). In addition to the psychological, social, and physical effects, lost productivity at work and high-cost medical procedures for wound care put a financial strain on the healthcare system. With the right treatments, delayed wound healing in certain populations may be avoided or enhanced (Järbrink, et al., 2016).

Variables like the level of contamination and the type of surgery have historically been thought to be good indicators of wound healing and surgical site infection. However, more recent study has minimized the significance of surgical method, with other researchers finding that systemic factors such as advanced age, gender, lifestyle, and associated morbidity play a significant role in the pathophysiology of these problems (Sørensen, Hemmingsen, & Kallehave, 2005).

Dr. H. Moch. Ansari Saleh Banjarmasin general hospital is one public hospital that offers a variety of surgical operations, involving orthopedic surgery. Orthopedic surgery through open reduction is done at this hospital. Amputation and debridement, arthroscopy, ligament reconstruction, internal fixation, open reduction external fixation, arthroplasty, and many more operations are available.

Previous studies at this institution detailed patient demographics, such as age, type of surgery, length of stay, comorbidities, and antibiotic types used in orthopedic surgery patients (Nizar & Ariyanto, 2024). However, this research has not explained whether there is a relationship between these factors and surgical wound healing.

The study conducted at Dr. H. Moch. Ansari Saleh Banjarmasin General Hospital aims to determine the relationship between patient demographics and surgical wound healing, as well as to identify predictors associated with delayed wound healing in orthopedic surgery patients. Through the analysis of factors such as age, gender, comorbidities, lifestyle, type of surgery, and length of hospital stay, the research seeks to understand the influence of systemic and surgical factors on surgical wound healing. The ultimate goal is to enhance patient care and prevent

complications in orthopedic surgery patients by identifying factors that can predict delayed wound healing.

## RESEARCH METHODS

This study applied a retrospective methodology and a cross-sectional descriptive observational research design. The study participants utilized the orthopedic surgery hospitalized patients' medical records status at Dr. H. Moch. Ansari Saleh Banjarmasin adopted purposive sampling techniques from August to December 2023. Purposive sampling involves restricting the types of samples to meet specific criteria and obtain the desired information for the researcher (Sekaran, 2017).

The 165 patients with orthopedic surgery cases were receiving surgery and medical care at Dr. H. Moch. Ansari Saleh General Hospital in Banjarmasin provided the medical records that contributed to the data for this study. Note the following information about the patient's medical condition: age, comorbidities, length of stay, type of operation, type of antibiotic, and surgical wound follow-up based on the doctor's examination noted in the medical record. Within two weeks, patients were evaluated.

Patients who had orthopedic surgery and had full medical records, including a list of surgical reports and surgical wound follow-up, were included in the sample. As seen in Image 1, the selection procedure and the gathering of data from medical records are represented as a flowchart.

According to data gathered using several operational definitions, prophylactic antibiotics such as cefazolin, ceftriaxone, and ceftazidime are administered prior to surgery based on antibiotics used throughout the research period. Running Research has shown that one of those categories is the amount of time patients need for surgery. Operation duration is <1 hour or longer. Type operations can be divided into two groups: clean and contamination. Surgical wounds may become dry or still wet or leaking when it comes to healing.

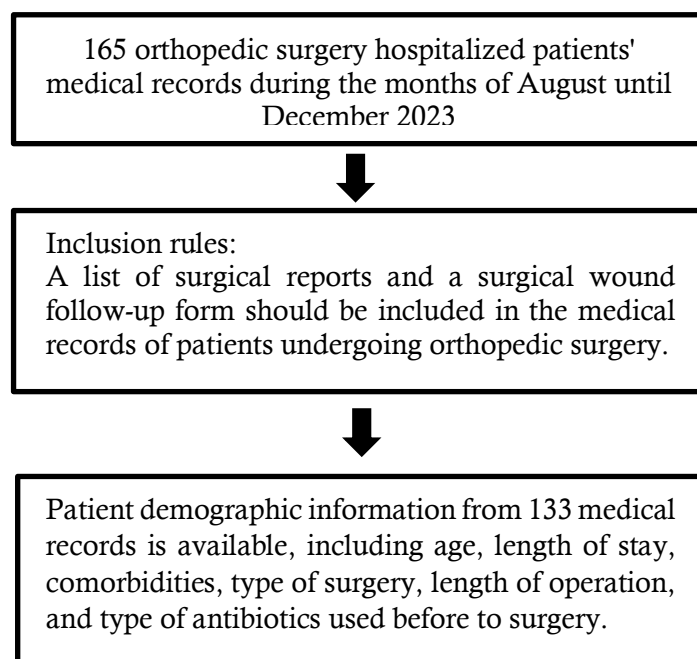


Figure 1. Flowchart-Based Research Data Retrieval

Microsoft Excel software was then utilized to group the collected data. Relationship between the healing of surgical wounds and some of the data taken was analyzed using SPSS (Statistical Package for the Social Sciences) software with *chi-square tests*.

## **RESULTS AND DISCUSSION**

The strength of the skin barrier is compromised, leading to an injury to the skin. A wound is any area of tissue damage that results in a loss of function and anatomical structure. Tissue healing is essentially what wound healing involves. After a superficial trauma, wound healing starts right away and may take weeks. The highly structured cellular, humoral, and molecular systems are part of this dynamic process (Reinke & Sorg, 2012). The three overlapping stages of wound healing are remodeling, proliferation, and inflammation. Any interference results in atypical wound healing (Kangal & Regan, 2024).

Sometimes, primary and secondary healing are used to categorize wound healing. Primary healing is the simple healing of a well-approximated, non-infected wound. The best illustration of primary healing is a surgical wound. The secondary healing stage starts if an infection, disintegration, hypoxia, or immunological disorder interferes with the wound's ability to heal. Granulation tissue forms and epithelization occurs over this newly formed tissue during secondary healing. These kinds of wounds are more prone to infections and inadequate recovery (Gantwerker & Hom, 2011).

Wound healing after surgery is a complex and tightly controlled process that is required to maintain the skin's barrier function as well as all other skin functions. Many variables, both changeable and not, can affect this procedure (Almadani, Vorstenbosch, Davison, & Murphy, 2021).

The incidence of surgical wound healing in this study demonstrated the effectiveness of prophylactic antibiotics, as a suitable choice of prophylactic antibiotic decreases the risk of infection (Alemkere, 2018). Healing of surgical wounds was determined by tracking down the patient's medical records while receiving medical treatment in the hospital, either when the patient was admitted for orthopedic surgery or when the control patient was discharged from the hospital after 14 days of treatment. Fisher's exact test was used in bivariate analysis to perform a difference analysis of the effectiveness of the three antibiotic kinds. Table 1 shows a correlation between the data.

**Table 1 Comparison of types of antibiotics and the incidence of surgical wound healing**

| <b>Prophylactic antibiotics</b> | <b><u>Surgical wound healing</u></b> |                                       | <b>Total (n=133)</b> | <b>p value</b> |
|---------------------------------|--------------------------------------|---------------------------------------|----------------------|----------------|
|                                 | <b>The wound is dry (%)</b>          | <b>The wound is still leaking (%)</b> |                      |                |
| Cefazolin                       | 107 (85,6%)                          | 18 (14,4%)                            | 125                  | 0,013          |
| Ceftazidime                     | 2 (100%)                             | 0 (0,0%)                              | 2                    |                |
| Ceftriaxone                     | 2 (33,3%)                            | 4 (66,7%)                             | 6                    |                |

Wounds that were still leaking or had not healed during this trial period were observed in 16.5% of all individuals, or 13.5% of patients given cefazolin, 0% of patients given ceftazidime, and 3% of patients given ceftriaxone. Bivariate testing using *Fisher's exact test* were used to analyze differences in the three groups' chances of surgical wound healing.

A common first-generational cephalosporin antibiotic used for following surgery prophylaxis across several surgical specialties is cefazolin (Peppard, Eberle, Kugler, Mabrey, & Weigelt, 2017). In patients undergoing orthopedic surgery, cefazolin is most frequently used as a preoperative prophylactic antibiotic at Dr. H. Moch. Ansari Saleh Banjarmasin General Hospital. This is clarified by means of several prior research findings. It has been demonstrated that cefazolin inhibits the development and growth of microorganisms in the skin surrounding a surgical wound. Cefazolin is capable of inhibiting bacterial mutations and is also compatible with anesthetic medications. Based on data with a category A –high recommendation, cefazolin is advised in cases of open fractures and closed fractures (implant placement) (Ministry of Health, 2021).

According to a number of studies, prophylactic use of third-generation cephalosporin antibiotics such ceftriaxone and ceftazidime is not advised by any recommendations. This is due to the fact that the majority of these medications are more expensive than cefazolin, although having less of an effect on *Staphylococcus* sp. bacterial reproduction. *Staphylococcus aureus*, the most prevalent natural flora in the epidermis, is the bacteria that the World Health Organization reports is most frequently discovered to cause infections in wounds. Given their stronger ability to combat gram-negative microbes, third- and fourth-generation cephalosporins are expected to be utilized as helpful antibiotics rather than as a preventative measure once an infection has already occurred (Claire, et al., 2021).

According to meta-analysis research, it was said that cefazolin is still the drug of choice or surgical prophylaxis in many procedures due to its excellent safety profile, affordable price, and focused action against common surgical operation-related microorganisms (Ahmed, et al., 2022).

The relationship between the risk factors present in the patient and surgical wound healing was analyzed using the *Chi square test* and presented in Table 2.

**Table 2 Risk factors associated with surgical wound healing**

| Risk factors         | Total<br>(n=133) | Surgical wound healing               |                             | p value |
|----------------------|------------------|--------------------------------------|-----------------------------|---------|
|                      |                  | The wound is still<br>leaking (n=22) | The wound<br>is dry (n=111) |         |
| <b>Gender</b>        |                  |                                      |                             | 0,040   |
| Man                  | 83               | 18                                   | 65                          |         |
| Woman                | 50               | 4                                    | 46                          |         |
| <b>Age</b>           |                  |                                      |                             | 0,065   |
| <18 years            | 41               | 7                                    | 34                          |         |
| 18-59 years old      | 75               | 9                                    | 66                          |         |
| >60 years            | 17               | 6                                    | 11                          |         |
| <b>Comorbidities</b> |                  |                                      |                             | 0,000   |
| There exists         | 23               | 12                                   | 11                          |         |

|                           |     |    |     |       |
|---------------------------|-----|----|-----|-------|
| Nothing exists at all     | 110 | 10 | 100 |       |
| <b>type of surgery</b>    |     |    |     | 0,000 |
| Clean                     | 111 | 9  | 102 |       |
| Contamination             | 22  | 13 | 9   |       |
| <b>Operation duration</b> |     |    |     | 0,199 |
| <1 hour                   | 71  | 9  | 62  |       |
| >1 hour                   | 62  | 13 | 49  |       |
| <b>Length of stay</b>     |     |    |     | 0,000 |
| <3 days                   | 61  | 2  | 59  |       |
| ≥3 days                   | 72  | 20 | 52  |       |

It was reported in this study that the genders differed significantly from one another ( $p=0,040$ ). Several studies have supported the theory that men and surgical wound healing are more significantly related. Men and women wound healing differently, depending on the type of tissue. The superficial wounds heal more quickly in women while mucosal wounds heal more quickly in men. Gender has been identified as a significant determinant of epidermal wound healing, with females generally showing better healing rates than males. In comparison, women's healing of soft tissues following surgery was significantly slower and needed more post-surgical interventions than men's (Tripathi, et al., 2019).

There are a number of hypothesized processes explaining sex-based variations in wound closure. Many researchers believe that the hormones testosterone and estrogen play an important role in the healing of surgical wounds. Nonetheless, our findings show that during the active early phases of wound healing, sex is not a significant biological determinant (Tripathi, et al., 2019).

In this study, there was no significant connection found between the age component ( $p=0,065$ ). Surgical wounds do not heal differently in older or younger patients. This is contradictory to other studies, which show that aging has significant effects on wound healing. The aging of the skin is also associated with impaired wound healing, which prolongs and disturbs the healing process. Elderly patients are more likely to experience delayed wound closure following surgery, which increases the risk of scarring and infections (Khalid, Nawi, Zulkifli, Barkat, & Hadi, 2022).

Then, this study shows a significant connection between the patients' comorbidities ( $p=0,000$ ). Underlying illnesses or medical problems known as comorbidities may delay the healing of wounds. Several additional studies have reported that a number of comorbidities, including diabetes, malnutrition, stress, autoimmune, and decreased immune function, cause surgical wounds to heal slowly (Robel, Stephen, & Adrian, 2020). Individuals with diabetes frequently experience poor limb circulation. The cause of low perfusion is atherosclerosis, which causes the arterial walls to stiffen and constrict, limiting the wound of blood and oxygen necessary for cell movement and regeneration. Hyperglycemia, or high blood sugar, also reduces the ability of leukocytes to defend against infection, which slows the healing of surgical wounds (Stephanie & Robert, 2020).

According to Table 2, the most common orthopedic surgery procedure was clean surgery. There is a significant relationship between the type of surgery and surgical wound healing ( $p=0,000$ ). The clean surgery includes arthroscopy, ligament

repair, complete knee and total hip replacement, arthroplasty, and open reduction and internal fixation. The technique is usually arranged as an optional one. The identical process was carried out at Dr. H.Moch. Ansari Saleh General Hospital concurrently. The contaminated procedure given is an example of open reduction external fixation in open wounds, amputations, tendon repair, and debridement. The process is usually finished fast or without any delays. Patients who require immediate surgery are more at risk of wound contamination than those with elective surgery (Jadoon, et al., 2023).

Predicting the right surgical classifying will support in estimating the risk of wound healing, postoperative problems, and surgical site infection. An accurate classification of wounds may be useful in determining mortality, morbidity, and the quality of life. Patients undergoing unclean surgical procedures are more likely to become contaminated by bacteria both during the surgical procedure and after the wound closure phase. However, a number of variables, including the location, comorbidities of the patient, and the extent of the damage, can affect the type of surgery that is chosen. Due to the classification's lack of detail, this specific type of surgery plan has been shown to be inefficient in a number of subspecialties, including orthopedic trauma surgery (Herman & Bordoni, 2024).

There was no significant link found between operation time and surgical wound healing ( $p=0,199$ ). This contrasts with other research that suggests the length of operation influences the patient's prognosis. Additional findings from earlier research indicate a relationship between longer surgery times and both in-hospital cost and patient outcomes. Longer operations naturally result in longer exposure times in the operating field, which may exacerbate hemorrhage, surgical site infections (Cheng, et al., 2017) and stress reactions. It is commonly known that immune function can be impacted by systemic inflammation and resulting in delayed surgical wound healing (Shen, et al., 2022).

The length of stay is the last factor that affects surgical wound healing ( $p=0,000$ ). The development of infection in the surgical wound will fluctuate depending on how long the treatment is administered. A patient's risk of nosocomial infections increases with length of stay in the hospital. Many earlier research that claimed that prolonged treatment would raise the risk of infection support these findings. Thus, among surgical patients, it is the primary cause of morbidity and mortality (Mujagic, et al., 2018).

## **CONCLUSION**

In this research, there were 22 samples (16.5%) with surgical wounds that delayed longer than expected to heal. During the research period, cefazolin was the most widely used antibiotic and was found to have an important effect on the healing of surgical wounds. The type of surgery, length of stay, gender, and comorbidities are other factors that are related. This study has a small sample size and restricted data availability. If you want to use the research findings, additional factors must take into consideration the situation in each hospital. The researcher recommends doing more studies with a bigger sample size.

## **BIBLIOGRAPHY**

- Ahmed, N., Haseeb, A., Alamer, A., Almalki, Z., Alahmari, A., & Khan, A. (2022). Meta-Analysis of Clinical Trials Comparing Cefazolin to Cefuroxime, Ceftriaxone, and Cefamandole for Surgical Site Infection Prevention. *Antibiotics (Basel)*, 1543.
- Alemkere, G. (2018). Antibiotic usage in surgical prophylaxis: A prospective observational study in the surgical ward of Nekemte referral hospital. *PLoS One*, 1-12.
- Almadani, Y. H., Vorstenbosch, J., Davison, P. G., & Murphy, A. M. (2021). Wound Healing: A Comprehensive Review. *Semin Plast Surg*, 141–144.
- Cheng, H., Chen, B., Soleas, I., Ferko, N., Cameron, C., & Hinoul, P. (2017). Prolonged Operative Duration Increases Risk of Surgical Site Infections: A Systematic Review. *Surg Infect (Larchmt)*, 722-735.
- Claire, R., Valentine, P., Latifa, N., Simona, B., Clara, D., & Frédérique, B. (2021). Treatment of bone and joint infections by ceftazidime/avibactam and ceftolozane/tazobactam: a cohort study. *Journal of Global Antimicrobial Resistance*, 282-286.
- DiPietro, S. G. (2010). Factors Affecting Wound Healing. *J Dent Res*, 219–229.
- Gantwerker, E., & Hom, D. (2011). Skin: histology and physiology of wound healing. *Facial Plast Surg Clin North Am*, 441-453.
- Harwiyanti, N. T., & Nugraha, D. P. (2022). Effectiveness Analysis of Cefazoline and Ceftriaxone as Cesarean Section Prophylactic Antibiotics. *Jurnal Sains dan Kesehatan*, 500-510.
- Herman, T., & Bordoni, B. (2024). *Wound Classification*. Treasure Island (FL): StatPearls Publishing.
- Jadoon, S., Khan, R., Khan, T., Akhtar, N., Qayyum, Y., & Kumar, K. (2023). Comparative study of wound infection between elective and emergency abdominal surgeries: a retrospective cohort study. *Ann Med Surg (Lond)*, 1490-1495.
- Järbrink, K., Ni, G., Sönnnergren, H., Schmidtchen, A., Pang, C., Bajpai, R., & J, C. (2016). Prevalence and incidence of chronic wounds and related complications: a protocol for a systematic review. *Syst Rev*, 152.
- JMukagendaneza, M. o., Munyaneza, E., & Muhawenayo, E. (2019). Incidence, root causes, and outcomes of surgical site infections in a tertiary care hospital in Rwanda: a prospective observational cohort study. *Patient Saf Surg*, 1-8.
- Kangal, M. o., & Regan, J. P. (2024). *Wound Healing In: StatPearls*. Treasure Island (FL): StatPearls Publishing.
- Khalid, K., Nawi, A., Zulkifli, N., Barkat, M., & Hadi, H. (2022). Aging and Wound Healing of the Skin: A Review of Clinical and Pathophysiological Hallmarks. *Life (Basel)*, 1-12.
- Lindholm, C., & Searle, R. (2016). Wound management for the 21st century: combining effectiveness and efficiency. *Int Wound J*, 5-15.



- Ministry of Health, I. (2021). *Regulation of the Minister of Health of the Republic of Indonesia Number 28 of 2021 concerning Guidelines for the Use of Antibiotics in Hospitals*. Jakarta: Ministry of Health of the Republic of Indonesia.
- Mujagic, E., Marti, W., Coslovsky, M., Soysal, S., Mechera, R., & von, S. M. (2018). Associations of Hospital Length of Stay with Surgical Site Infections. *World J Surg*, 3888-3896.
- Nizar, M., & Ariyanto, M. W. (2024). An Overview of Pre-Operative and Post-Operative Antibiotic Use in Inpatients in Orthopedic Surgery at Dr. H. Moch. Ansari Saleh Banjarmasin. *Journal of Medical and Health Studies*, 75-83.
- Peppard, W., Eberle, D., Kugler, N., Mabrey, D., & Weigelt, J. (2017). Association between Pre-Operative Cefazolin Dose and Surgical Site Infection in Obese Patients. *Surg. Infect*, 485-490.
- Reinke, J., & Sorg, H. (2012). Wound repair and regeneration. *Eur Surg Res*, 35-43.
- Robel, T. B., Stephen, L. D., & Adrian, B. (2020). The Effect of Comorbidities on Wound Healing. *Surgical Clinics of North America*, 695-705.
- Sekaran, U. a. (2017). *Research Methods for Business: A Skills-Development Approach, 6th Edition Book 2*. Jakarta: Salemba Empat.
- Shen, X., Zhou, C., Hua, Q., Yang, L., Zhao, W., & Xu, P. (2022). Impact of operation duration on short-term and long-term prognosis in patients undergoing radical colorectal surgery. *J Cancer*, 1160-1167.
- Sørensen, L. T., Hemmingsen, U., & Kallehave, F. (2005). Risk Factors for Tissue and Wound Complications in Gastrointestinal Surgery. *Ann Surg*, 654-658.
- Stephanie, R. G., & Robert, F. D. (2020). What Makes Wounds Chronic. *Surgical Clinics of North America*, 681-693.
- Syaiful, R. A., Yarman, M., Prasetyo, M. L., & Toar, J. (2020). Surgical site infection after digestive surgery in a single tertiary hospital in indonesia. *Medical journal of indonesia*, 310-315.
- Tripathi, R., Giuliano, E., Gafen, H., Gupta, S., Martin, L., & Sinha, P. (2019). Is sex a biological variable in corneal wound healing? *Exp Eye Res*, 1-12.

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