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THE RELATIONSHIP BETWEEN OXYGEN SATURATION AND EPITHELIALIZATION IN GANGRENE PATIENTS IN THE JEMBER AREA

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Abstract

Introduction: Diabetic ulcers or gangrene is a complication of diabetes mellitus resulting from angiopathy neuropathy and vascular disorders in the foot area. Gangrene wounds are caused by vascular disorders, nerves, and infection. If gangrene wounds are not handled properly and quickly, the wound will get worse.

Methods: This study aimed to analyze the relationship between oxygen saturation and epithelialization in gangrene patients in the Jember area. Correlation analytical research design with a cross-sectional approach. The population of patients with gangrenous wounds consisted of 30 respondents using a quota sampling technique. The measuring tool uses oximetry and the Bates Janson Wound Assessment Tool checklist for Chi-Square (Fisher Exact) test analysis.

Results: Most of the gangrenous patients (63.3%) had normal oxygen saturation values and almost all (80.0%) of patients had epithelialized gangrene >50%. $KK = 0.436$ means the relationship is sufficient.

Conclusions: The conclusion is that there is a sufficient relationship. between oxygen saturation and epithelialization in gangrene patients in the Jember area. It is suggested that this research can be developed more completely and perfectly regarding GDA examination and participating in debridement during wound care.

Keywords: Oxygen Saturation, Epithelialization, Gangrene

Introduction

Gangrene is a clinical manifestation that describes a tissue that dies because there is no blood supply to keep the tissue alive. Gangrene wounds generally occur on the feet and hands. Gangrene can be seen from discoloration or blackening, swelling of the tissue, pain, and peeling. Gangrene is dead tissue (necrosis) that is preceded by the presence of an arterial embolism in a part of the body which results in the cessation of blood supply. Diabetic ulcers or gangrene is a complication of diabetes mellitus which is caused by neuropathy and vascular

disorders in the foot area and is often found in patients with diabetes mellitus (Susila et al., 2022).

Diabetes mellitus in an advanced time will cause complications of angiopathy and neuropathy which are the basic causes of gangrene. Factors that influence the occurrence of angiopathy are genetic factors, metabolic factors, lifestyle, and other supporting factors such as smoking, hypertension, and insulin balance. The main blood vessel that experiences angiopathy is the tibial artery. As a result, the distal tissue perfusion of the lower extremity is reduced and ulcers develop which can then develop into necrosis or gangrene. Diabetes mellitus sufferers who have increased sugar levels will influence the occurrence of gangrene wounds. If the wound is not treated quickly it will get worse. Gangrene wounds are caused by blood vessel disorders, nerves, and infection. Gangrene wound sufferers do not feel pain so dermal or traumatic injury occurs (Nursing Knowledge et al., n.d. 2019).

Indonesia is a country where the rate of diabetic gangrene in Indonesia is around 15% and the amputation rate is 30%. Men suffer from diabetic gangrene as much as 68% and 10% of people with gangrene recur. The prevalence of diabetic gangrene ranges from 2% to 10% among diabetes mellitus patients. It is estimated that 15% of diabetes mellitus patients are at risk of developing diabetic gangrene at some time during diabetes. Each individual with diabetic gangrene is at risk for experiencing a lower limb amputation compared to individuals who do not have diabetes. The rate of diabetes mellitus in East Java Province is still high and ranks 9th with a prevalence of 6.8%. Based on data from the Jember District Health Office in 2021, cases of people with diabetes mellitus have a large number and are a top priority for handling. Diabetes mellitus sufferers increased from 17,486 to 21,304 people. The number of diabetes mellitus patients at RSD Balung in 2022, with a total of 1,440 sufferers (Dhillon et al., 2022).

Wound healing is a quality of tissue life, which is related to tissue regeneration. The healing process can occur normally without assistance, although some wound treatments can help support the healing process. Wound healing has several phases, namely, the inflammatory phase, the proliferative phase, and the maturation phase. The process of epithelialization occurs during the proliferative phase. The layer of cells that die from trauma protects the living cells deeper than the epithelium. Wound repair layers are formed by the integration of collagen synthesized by fibroblasts with the ground substance. During wound healing, cells at the edges of the wound curl into thin sheets that spread to cover gaps in the epithelium. Meanwhile, at the edge of the wound, cell division begins somewhat later to provide the cells needed to restore the epithelium to normal thickness (Siahaan et al., n.d. 2017).

Damage to tissue causes damage to blood vessels. Perfusion is related to the adequate transport or distribution of oxygen to all cell layers and is an important element in the wound healing process which is supported by normal oxygen saturation. One effort to prevent further impacts is by vascular control which was developed to increase oxygen saturation in gangrene sufferers. As a result of not getting enough oxygen, it will cause complications in gangrene sufferers (Nursing Study et al., n.d. 2020).

Microangiopathy causes the wound area to experience hypoxia thus accelerating the occurrence of gangrene. DM with gangrene wounds needs perfusion improvement because it helps in transporting oxygen and blood to the damaged tissue. If peripheral perfusion in the wound is good, the wound-healing process will also be good, and vice versa. Perfusion is closely related to the adequate transport or distribution of oxygen to all cell layers and is important in the wound-healing process. Good perfusion is characterized by the presence of clinical signs in the wound, one of which is normal oxygen saturation (Dewi Tamayanti1 et al., n.d.2018).

Gangrene wounds begin with hypoxia or lack of oxygen in the tissue. Hypoxia in tissue affects tissue vascular and cellular activity, resulting in tissue damage. Cell tissue that is left in a hypoxic state will inhibit collagen release and epithelialization. Gangrene wounds that cause difficulty in the wound-healing process often end in the amputation of one of the extremities. The use of oxygen at high pressure is expected to stimulate collagen formation thereby accelerating wound healing (Dewi Tamayanti1 et al., n.d.2018).

Methods

The design used in this study is a cross-sectional approach. The study population was gangrene patients in the Jember area. The sample in this study was 30 respondents. The criteria for respondents in this study include diabetes mellitus sufferers with gangrene, the occurrence of gangrene no later than 6 months, and not receiving other non-medical therapy for wounds. This study used a non-probability sampling technique with a quota sampling method. Data collection in this study used an oximetry tool and a Bates Janson Wound Assessment Tool checklist. The data analysis technique used is the Chi-Square test (Fisher Exact).

Results

The characteristics of respondents in this study were based on age, gender, oxygen saturation, and epithelialization.

Table 1. Frequency distribution of gangrene patients based on age in the Jember area on 22 May-22 June 2023 with a total of 30 respondents.

Age	Frequency	Percentage%
26-35 year	1	3,3
36-45 year	1	3,3
45-55 year	10	33,3
56-65 year	18	60,0
Total	30	100,0

Based on Table 1, it can be seen that of the 30 respondents, the majority (60.0%) of patients who experienced gangrene were late elderly.

Table 2 Frequency Distribution of Gangrene Patients based on gender in the Jember area on 22 May-June 2023 with a total of 30 respondents.

Age	Frequency	Percentage%
Man	13	43,3
Woman	17	56,7
Total	30	100,0

Based on Table 2, it can be seen that of the 30 respondents, most (56%) of the patients who had gangrene were female.

Table 3 Frequency distribution of Gangrene patients based on oxygen saturation in the Jember area on 22 May-22 June 2023 with a total of 30 respondents.

Oxygen Saturation	Frequency	Percentage%
Normal	19	63,3
Abnormal	11	36,7
Total	30	100,0

Based on Table 3, it can be seen that of the 30 respondents, the majority (63.3%) of patients with oxygen saturation gangrene were in the normal category.

Table 4 Frequency Distribution of Gangrene patients based on epithelialization in the Jember area on 22 May-22 June 2023 with a total of 30 respondents.

Epithelialization	Frequency	Percentage%
Epithelialization >50%	24	80,0
Epithelialization <50%	6	20,0
Total	30	100,0

Based on Table 4, it can be seen that of the 30 respondents, almost all (80.0%) of the patients experienced epithelialized gangrene >50%.

Table 5 Data on the Relationship between Saturation and Epithelialization in Gangrene Patients in the Jember Area on 22 May 2023 with a total of 30 respondents

		Epithelialization				Total	P Value
		epithelialization >50%	F	epithelialization <50%	F		
Oxygen Saturation	Normal	18	94,7%	1	5,3%	100%	0,016
	Abnormal	6	54,5%	5	45,5%	100%	
	Total	24	80%	6	20%	100,0%	

Based on Table 5. The relationship between oxygen saturation and epithelialization in gangrene in the Jember area. Of the 19 respondents, almost all of them had normal oxygen saturation (94.7%) epithelialization was >50% and a small portion (5.3%) had epithelialization <50% while 11 respondents had saturation most of the abnormal oxygen (54.5%) epithelialized >50% and nearly all of them (45.5%) epithelialized <50%. The results of the Chi-Square test obtained a significance value of Fisher Exact p-value = 0.016 < α 0.05 and CC .436, namely the sufficient category. So H0 is rejected and Ha is accepted, which means it can be concluded that there is a relationship between oxygen saturation and epithelialization in gangrene patients in the Jember area.

Discussion

Identifying Oxygen Saturation in Gangrene Patients in the Jember Region

Research results Based on Table 5.3, it can be seen that of the 30 respondents, almost all (63.3%) of the patients who experienced gangrene had oxygen saturation in the normal category and a small portion (36.7%) had oxygen saturation in the abnormal category.

Oxygen saturation level in the blood (SpO₂) is one of the important body variables to measure and monitor to determine the health condition of the body. The oxygen saturation level is the percentage of hemoglobin that binds oxygen compared to the total amount of hemoglobin in the blood. The normal value of oxygen saturation when measured with an oximeter is below 90-95%, which indicates that the oxygen level in the blood is low so that the blood requires oxygen supplementation. Oxygen saturation is said to be normal in humans with a range between 97% to 100% (Kemalasari & Rochmad, 2022).

Measuring oxygen saturation is a way to assess the adequacy of a patient's oxygenation or tissue perfusion. Decreased oxygen saturation will cause failure in oxygen transportation because oxygen in the body is mostly bound by hemoglobin and dissolved in blood plasma in small amounts. So a decrease in oxygen saturation indicates that the blood supply to the peripheral blood vessels is experiencing obstacles so that oxygen in the blood cannot be distributed properly (Prawito & Samito Bagus Nanang, 2021).

Oxygen plays an important role in the body's metabolic processes so if humans lack oxygen levels, it will result in the body's metabolism being imperfect, characterized by hypoxia. Hypoxia can be detected if the body lacks oxygen saturation levels in the blood vessels with symptoms in diabetes mellitus patients, especially in gangrenous wounds where there is damage to the tissue and necrosis occurs. Factors that affect oxygen saturation include hemoglobin, activity, and mobilization (Kemalasari & Rochmad, 2022).

Oxygen saturation in tissues affects the vascular and cellular activity of tissues resulting in tissue damage. Cell tissue that is left in a hypoxic state will inhibit collagen release and epithelialization. Gangrene wounds that occur with difficulty in the wound healing process, often end in an amputation of one of the extremities. The use of oxygen at high pressure is expected to stimulate collagen formation thereby accelerating wound healing (Dewi Tamayanti¹ et al., n.d.2018).

From this presentation, researchers think that the majority of patients' oxygen saturation is in the normal category. One of the factors that influence a patient's oxygen saturation is physical activity, which according to research that has been carried out shows that patients always do light activities or carry out extremity movements, such as walking from their room to the terrace of the house. This helps the blood circulation process and oxygen can flow throughout the body and occur. increase in oxygen saturation to normal 95-100%.

Identifying Epithelialization in Gangrene Patients in the Jember Region

Based on Table 5.4, it can be seen that of the 30 respondents, almost all (80%) of the patients had gangrene epithelialization >50%, and a small proportion (20%) epithelialization <50%.

Epithelialization is defined as the process of covering the exfoliated epithelial surface. The cellular and molecular processes involved in the initiation, maintenance, and completion of epithelialization are critical for successful wound closure. Epithelialization, which is an important component of wound healing, is often used as a parameter of success. Reepithelialization can be described as the resurfacing of a wound with new epithelium, which

begins approximately 16-24 hours after the wound occurs, that is, precisely during the proliferation phase (Asti Meizarini, 2020).

The healing process of gangrenous wounds involves blood clot formation, inflammation, re-epithelialization due to keratinocyte migration and proliferation, granulation tissue formation, neovascularization, and tissue contraction. Keratinocytes, the main cellular component of the epidermis, are essential for wound healing through the process of epithelialization, consisting of the typical filament-forming proteins of epithelial cells, called keratin or cytokeratin which are important for healthy tissue structure. Factors that influence gangrenous wounds include oxygen saturation, debridement, impaired sensation or movement, and nutritional status (Asti Meizarini, 2020).

In the inflammatory phase, if there is no infection, the healing process then enters the proliferation phase, where this phase is a process of epithelialization growth. The main purpose of proliferation is: the granulation process, which is to fill the space in the wound, then angiogenesis (growth of new capillaries) will clinically appear reddish in the wound and occur together with fibroplasia and finally the contraction process (to pull the two edges of the wound close to each other) physiological events which causes closure of the wound and the size of the wound will appear smaller or merge (Agustina Maria, 2022)

From this presentation, the researcher believes that the growth of new tissue (epithelialization) in patients who have gangrene wounds requires wound care, where this explanation is in line with research by Agustina Maria, 2022, namely one of the influencing factors, namely debridement which is very effective as the main component in wound care to remove non-viable tissue and poses a risk of infection. Based on gender, diabetes mellitus patients who experience gangrene are mostly women (56.7%) because women are rarely physically active and have normal oxygen saturation ranges, while almost half of men (43.7%) do more activities. physique. Based on age, the physiological function of the body decreases because there is a decrease in insulin secretion or resistance so the ability to function to control high blood glucose causes oxygen saturation to also decrease

The Relationship between Oxygen Saturation and Epithelialization in Gangrene Patients in the Jember Region

Based on Table 5.5 Of the 19 respondents the oxygen saturation was normal, almost all (94.7%) were epithelialized >50%, and a small portion (5.3%) epithelialized <50%... while for the 11 respondents, the oxygen saturation was mostly abnormal (54.5%) epithelialization >50% and almost the same (45.5%) epithelialization <50%. The results of the Chi-Square test obtained a Fisher Exact p-value = 0.016 < α 0.05 and CC .436, meaning a sufficient

relationship. So H_0 is rejected and H_a is accepted, which means it can be concluded that there is a sufficient relationship between oxygen saturation and epithelialization in gangrene patients in the Jember area

Oxygen saturation level in the blood (SpO_2) is one of the important body variables to measure and monitor to determine the health condition of the body. The oxygen saturation level is the percentage of hemoglobin that binds oxygen compared to the total amount of hemoglobin in the blood. The normal value of oxygen saturation when measured with an oximeter is 90-95% it identifies that the oxygen level in the blood is low so the blood needs supplemental oxygen. Oxygen saturation is said to be normal in humans with a range between 97% to 100% (Kemalasari & Rochmad, 2022).

Oxygen plays an important role in the body's metabolic processes so when humans lack oxygen levels, the body's metabolism is imperfect, characterized by hypoxia. Hypoxia can be detected if the body lacks oxygen saturation levels in the blood vessels with symptoms in patients with diabetes mellitus, especially gangrenous wounds where there is tissue damage and necrosis occurs (Kemalasari & Rochmad, 2022).

Damage to tissue causes damage to blood vessels. Perfusion is related to the adequate transport or distribution of oxygen to all cell layers and is an important element in the wound healing process which is supported by normal oxygen saturation. One effort to prevent further effects is by controlling the vascular system which was developed to increase oxygen saturation in patients with gangrene (Study of Nursing et al., n.d. 2020).

The process of epithelialization occurs during the proliferative phase. The layer of cells that die from trauma protects the living cells deeper than the epithelium. Wound repair layers are formed by the integration of collagen synthesized by fibroblasts with the ground substance. During wound healing, cells at the edges of the wound curl into thin sheets that spread to cover gaps in the epithelium. Meanwhile, at the edge of the wound, cell division begins somewhat later to provide the cells needed to restore the epithelium to normal thickness (Siahaan et al., n.d. 2017).

In the proliferative phase, macrophages continue to express growth factors, including stimulating angiogenesis and the formation of granulation tissue consisting of endothelial cells, fibroblasts, and inflammatory cells. In the gradual angiogenic to proliferative phase, these cells migrate into the wound and repair tissue. High oxygen levels are needed for the proliferation phase, especially when epithelialization occurs around the wound along with keratinocytes to close the wound from the extracellular environment, In the remodeling phase, oxygen is very

important to assist in the removal of granulation tissue through the apoptosis process (Septiana Farihah, 2020).

Management of gangrene wounds in the community is still relatively poor. Patients who come to the hospital on average have wounds that are not in good condition. Poor control of blood sugar levels and inadequate circulation worsen the condition of gangrene. From the explanation above, the researcher believes that from the results of the data that has been tested, it is stated that there is a relationship between oxygen saturation and epithelialization in gangrene patients. The more normal the oxygen saturation, the more epithelialization will grow in the wound-healing process. This is what was obtained from the results of the researchers' research. Patients who were hospitalized at Balung Hospital did not have their wounds treated by debridement so the wounds became infected and 1 patient had an amputation. Likewise with abnormal oxygen saturation. This is different from the Independent Clinical Practice where patients have normal oxygen saturation because patients who always have the enthusiasm for routine wound care can do it 2-3 times in 1 week. During wound care, debridement is also carried out which aims to remove non-living tissue or necrotic tissue because if this is not done it will hinder wound healing and prevent the formation of granulation tissue. One of the factors that influence debridement is nutritional status. Patients always maintain a healthy lifestyle by consuming foods high in protein. Patients also always monitor oxygen saturation and GDA independently and lab results.

Conclusion

Research results and discussion regarding the relationship between oxygen saturation and epithelialization in gangrene patients in the Jember area.

- 1) Most of the patients who experienced gangrene in the Jember area had 19 (63.3%) oxygen saturations in the normal category.
- 2) Almost all of the patients who experienced gangrene in the Jember area had epithelization >50%.
- 3) There is a sufficient relationship between oxygen saturation and epithelialization of gangrene in the Jember area.

Good management of gangrene does not only lie in the quality of wound care but also blood sugar control and stability of tissue perfusion. Good tissue perfusion, reflected in oxygen saturation, will increase the epithelialization of wound tissue, resulting in faster recovery from gangrene. Therefore, all efforts to maintain oxygen saturation in diabetes mellitus sufferers with gangrene are very required.

Author Contributions

Novita Zahro as first author was the main author of the research from the initial framework to the final interpretation of the research. Andi Eka Pranata as second author and correspondent is responsible for developing research instruments and interpreting research results. Hendra Dwi Cahyono as the third author helped with all data collection and data analysis activities.

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Conflict of Interest

Nothing conflict of interest was caused by these research.

Data Availability Statement

The researcher guarantees the validity of all data from this research which was obtained through direct observation of respondents by the research team. All data is guaranteed confidentiality based on the applicable code of ethics.

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