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Identification of Intestinal Parasites in Spinach at Padamara Market, Padamara District

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ABSTRACT

Introduction: Vegetables are essential for maintaining human health because they are a great source of vitamins, minerals, fiber, and other nutrients. Most people consume raw vegetables to preserve the nutrients in them. However, raw vegetables have a great potential to spread intestinal parasitic infections. Raw vegetables consumed as fresh vegetables also have the potential to transmit geohelminth infection. Protozoan infections can be transmitted through food and some of these diseases.

Objective: This study aims to identify intestinal parasites in spinach at Padamara Market, Padamara District

Methods: A total sampling technique was used to collect 20 bunches of spinach at Padamara Market, Padamara District, and the identification of intestinal parasites using the 0.2% NaOH sedimentation method was carried out at the Laboratory of Microbiology and Parasitology, Faculty of Medicine, Universitas Muhammadiyah Purwokerto in April–May 2021.

Results: 14 samples (70%) of spinach were positive for intestinal parasites, while 6 samples (30%) were negative for intestinal parasites. The results of intestinal parasite identification found the presence of *Ascaris lumbricoides* eggs as many as 10 (30.3%), Minute Intestinal Fluke eggs as many as 6 (18.18%), and *Entamoeba coli* cysts as many as 17 (51.52%).

Conclusions: *A. lumbricoides* egg, Minute Intestinal Fluke eggs, and *E. coli* cyst were identified in spinach at Padamara Market, Padamara District.

Introduction

Soil-transmitted helminths (STH) are intestinal nematodes that infect humans with helminthiasis through direct contact with soil that contains STH eggs or larvae. STH infections are endemic in many countries around the world (Asihka et al., 2014). The World Health Organization

(WHO) reports that STH infections occur in more than 1.5 billion people (24%) of the world's human population. Most STH infections are known to occur in Sub-Saharan Africa, the Americas, China, and East Asia (WHO, 2023).

The incidence of intestinal parasites is high, especially in developing countries.

The eggs/ larvae of intestinal parasites can be found attached to vegetables, fruits, fingers, cutlery, door handles, and money (Kyi & Zin, 2014).

Vegetables play an important role in supporting human health because they contain many nutrients, fiber, minerals, and vitamins. Vegetables can be obtained at affordable prices when compared to meat and livestock. Most people consume raw vegetables to preserve the nutrients in them. However, raw vegetables have a great potential to spread intestinal parasitic infections (Yusof, 2020).

Raw vegetables consumed as fresh vegetables also have the potential to transmit geohelminth infection through food eaten by humans, larvae penetrating the skin, and inhalation (Bestari et al., 2020). *Ascaris lumbricoides*, Hookworm, and *Trichuris trichiura* are most commonly infected in humans. (Mumpuni et al., 2020).

Protozoan infections can be transmitted through food, and some of these diseases cause serious health and economic problems in many developing countries. *Cryptosporidium*, *Cyclospora*, *Giardia*, *Entamoeba histolytica*, *Entamoeba coli*, and *A. lumbricoides* are considered to be the most common parasitic contaminants of fruits and vegetables (Yusof et al., 2017).

The use of irrigation water for crop irrigation as well as animal fecal fertilizer contaminated with intestinal parasites

causes the spread of disease infection to be more widespread (Loganathan et al., 2016).

Jusuf et al. showed that STH contamination in lettuce sold in traditional markets and modern markets in Medan City was indicated by as much as 85% of lettuce in traditional markets were positively contaminated with STH (*Strongyloides stercoralis* as much as 35%, rhabditiform larvae of *S. stercoralis* as much as 30%, Hookworm eggs as much as 15%). STH contamination in lettuce in the Modern Market was 90% with proportions (*Strongyloides* (35%) Hookworm eggs (20%) and *Toxocara* eggs (5%)) (Jusuf et al., 2013).

Wardhana et al. also stated that there was STH egg contamination in the cabbage salad at the University of Lampung food stalls by as much as 26.19%. The presence of *A. lumbricoides* eggs was found at 14.28%, *T. trichiura* eggs at 7.14%, and as much as 4.76% of fresh cabbage was contaminated with these two types of STH (Wardhana et al., 2014).

Spinach sold in Padamara Market, Padamara District, is in high demand by buyers because the price is very economical. Padamara Market was chosen as the research location because the market floor is grounded, the location is very strategic, crowded and dense with visitors, the location is narrow, and there are still many vegetable traders selling on sacks so

that it is easily contaminated with dust or dirt.

Spinach was chosen as the research sample because it is the most demanded by buyers in Padamara Market and the selling location is still on the ground, which has the potential for STH transmission.

This study aims to identify intestinal parasites in spinach at Padamara Market, Padamara District.

Methods

The study is a descriptive observational study with a cross-sectional design conducted during April–May 2021. The sampling involved 20 bunches of spinach, and a total sampling technique was applied at Padamara Market, Padamara District, Purbalingga Regency. The identification of intestinal parasites was conducted using the 0.2% NaOH sedimentation method at the Microbiology and Parasitology Laboratory, Faculty of Medicine, Muhammadiyah Purwokerto University.

Determination of Sampling Coordinates

The determination of coordinate points for sampling locations was conducted at 20 points where spinach samples were collected. This was accomplished using the GPS Essential for Android application. Each coordinate point obtained was meticulously recorded for precise documentation and subsequent use in the study

The identification of intestinal parasites

The process for identifying STH eggs in spinach using the 0.2% NaOH sedimentation method. Each spinach leaf sample was cut into small pieces. The pieces were placed in a beaker glass, and each sample was assigned a unique identity. The spinach samples were soaked for 30 minutes in a beaker containing a 0.2% NaOH solution. After soaking, spinach samples were separated from the 0.2% NaOH bath water. Surface water on the beaker glass was removed, and the water at the bottom was extracted using a volumetric pipette (10–15 ml). The bath water containing the extracted material was centrifuged at 1500 rpm for 5 minutes.

The supernatant (liquid above the sediment) was discarded. The sediment formed at the bottom of the centrifuged sample was carefully collected using a Pasteur pipette. A drop of the sediment was placed on a glass object. A dye, either eosin or lugol, was added to enhance visibility. The prepared slide was observed under a microscope with 40x10 magnification.

This detailed process ensures a systematic examination of spinach samples for the presence of intestinal parasites using a standardized method, and the identification is facilitated by microscopy and reference materials such as the Atlas of

Parasitology identification book (Jasman et al., 2019).

Data Analysis

The data analysis for the results of intestinal parasites identification involved univariate tests, and the findings are presented in the form of frequency distribution tables. By conducting univariate tests and presenting the results in frequency distribution tables, the analysis

provides a clear and detailed account of the prevalence and distribution of intestinal parasites in the studied spinach samples.

Results and Discussion

Based on Table 1, 14 samples (70%) of spinach were positive for intestinal parasites, while 6 samples (30%) were negative for intestinal parasites.

Table 1. Frequency distribution of intestinal parasites in spinach at Padamara Market, Padamara Subdistrict

Intestinal Parasites	Frequency (n)	Percentages (%)
Positive	14	70
Negative	6	30

Table 2. Prevalence of intestinal parasites in spinach at Padamara Market, Padamara Sub-district

Species	Frequency (n)	Percentages (%)
<i>A. lumbricoides</i>	10	30,3
<i>Minute intestinal fluke</i>	6	18,18
<i>E. coli</i>	17	51,52
Total	34	100

The results of intestinal parasites identification (Table 2) found the presence of *A. lumbricoides* eggs as many as 10

(30.3%), *Minute Intestinal Fluke* eggs as many as 6 (18.18%), and *E. coli* cysts as many as 17 (51.52%).

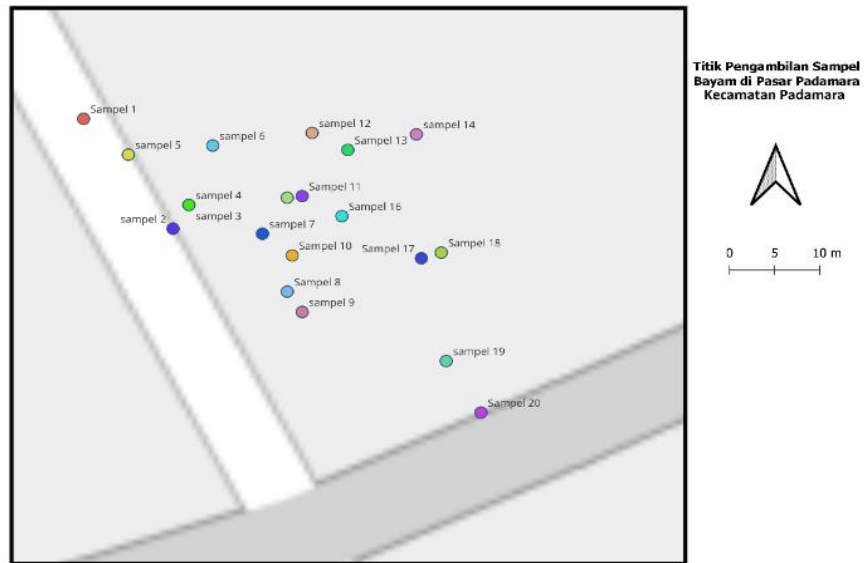


Figure 1. Sampling Point for Spinach in Padamara Market, Padamara Sub-district.

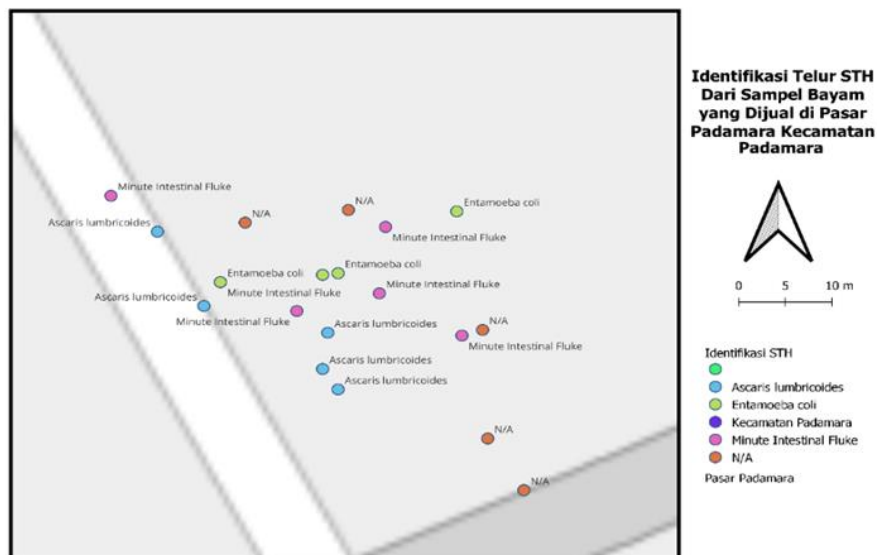


Figure 2. Identification of intestinal parasites from Spinach in Padamara Market, Padamara District

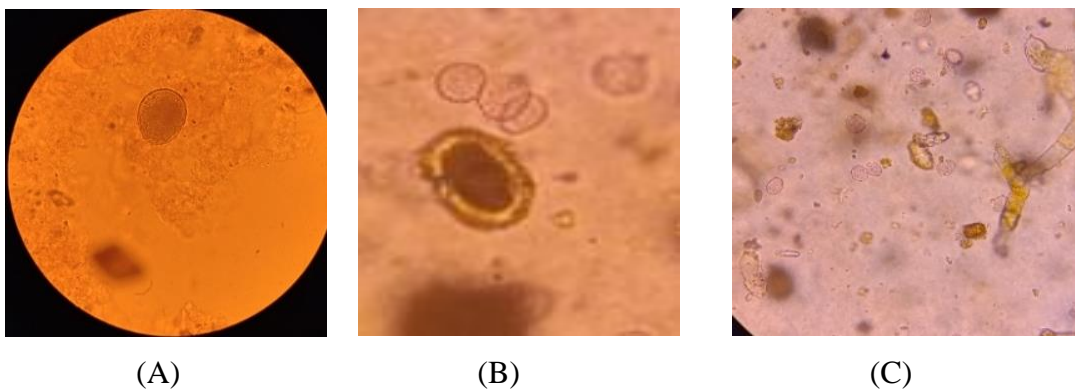


Figure 3. Identification of intestinal parasites

Note: Minute Intestinal Fluke magnification 40x10 (A), *A. lumbricoides* egg magnification 40x10 (B), *E. coli* cysts magnification 40x10 (C)

Padamara District Padamara Market was chosen as the research location because the market floor is on the ground, the location is very strategic, crowded, and dense with visitors, the location is narrow, and many vegetable traders sell vegetables on sacks so that they are easily contaminated by dust or dirt.

The results of this study are in line with the results of Hidayati et al., who found positive STH in 2 (9.5%) kale vegetables, 3 (14.3%) spinach vegetables, and 3 (14.3%) mustard greens. The STH eggs identified in all samples were positive for *A. lumbricoides* (Hidayati et al., 2016).

Also supported by the results of Satria & Yulfi's study, which found the most STH contamination in curly lettuce vegetables as much as 3 (14.29%), and radishes as much as 3 (14.29%), while the least was found in spinach, chicory, and pokchoy vegetables as much as 1 (4.76%) each. No contamination was found in cabbage and celery. The identification results showed the presence of *A. lumbricoides* eggs in as many as seven (11.11%) and hookworm eggs in as many as five (7.95%) (Satria & Yulfi, 2021).

The results of this study found the detection of MIF and *E. coli* in spinach vegetables sold at Padamara Market, Padamara District, Purbalingga Regency. Minute Intestinal Fluke is an infection

caused by small intestinal fluke eggs that infect humans in South Korea. MIF species that frequently infect include *Metagonimus yokogawai*, *M. miyatai*, *M. takahashii*, *Heterophyes nocens*, *Heterophyopsis continua*, *Stellantchasmus falcatus*, *Stictodora fuscata*, *Pygidiopsis summa*, and *Gymnophalloides seoi*. MIF eggs are characterized by round, pyriform, elliptical body shapes with a size range of 21-35 x 12-21 μm . The surface ultrastructure of MIF eggs can be a diagnostic marker for *C. sinensis* eggs (Lee et al., 2012).

The results of this study are contrasted with the results of Yusof et al., who found no worms or protozoa in kale or fruit. Pegaga vegetables were positive for *Strongyloides* larvae, *Diphyllobotrium* eggs, and unidentified trematodes (flukes). *Entamoeba coli* cysts and *Blastocystis* spp. were also found in pegaga vegetables (Yusof et al., 2017).

The advantage of identifying STH eggs with the 0.2% NaOH method is that the specific gravity of the solution is smaller than the worm eggs, thus accelerating the worm eggs to settle at the bottom of the test tube and facilitating examination under a microscope. The 0.2% NaOH sedimentation method has a sensitivity of 66.67% and a specificity of 97.50% for the identification of *A. lumbricoides* eggs. The disadvantages of the 0.2% NaOH

sedimentation method are that it takes a long time because it must soak for 30 minutes for each sample. Debris carried in the soaking solution can interfere with the identification process because artifacts and garbage are often found during identification (Regina et al., 2018).

The contamination of STH eggs in spinach sold in Padamara Market, Padamara Subdistrict, is due to the lack of hygiene of each spinach seller, who often places spinach sold on tiles and only on dirty sacks. Vegetables that are arranged in an open and unclean place can be contaminated by STH eggs in the soil or dust attached to the spinach (Setiawan et al., 2017).

The causes of helminthiasis include consuming raw vegetables directly without washing and incomplete cooking of vegetables. Proper vegetable washing techniques include washing vegetables in running tap water, washing them sheet by sheet, then dipping them briefly in hot water and rinsing them with boiled water so that STH eggs that may be attached to vegetables can be removed with the flow of water (Hidayati et al., 2016). In addition, it can be prevented by not using manure or fertilizer made from animal manure as a medium for fertilizing the soil in vegetable planting (Asihka et al., 2014)

Conclusion

The positive spinach containing STH eggs in Padamara Market, Padamara Subdistrict, was 14 (70%) while the negative STH eggs were 6 (30%). Species identified in spinach sold in Padamara Market include *Ascaris lumbricoides* as many as 10 (30.3%), *Minute Intestinal Fluke* as many as 6 (18.18%), and *Entamoeba coli* as many as 17 (51.52%).

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The Relationship of Nutritional Status on Female Santri's Menstrual Cycle in Al-Jihad Islamic Boarding School in Surabaya

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ABSTRACT

Introduction: Menstruation is triggered by the monthly period, which creates the menstrual cycle. Several factors can lead to irregular menstrual cycles, including stress, smoking, taking hormonal supplements, disorders of the endocrine system, and nutritional deficiencies.

Objective: This research aims to investigate the connection between nutritional status and the period of menstruation in female students at Al-Jihad boarding school in Surabaya, Indonesia.

Methods: This study was conducted using an analytic observation approach. The research sample was determined using a simple random sampling technique, according to the inclusion and exclusion criteria that had been set. Questionnaires were used as data collection instruments, and anthropometric examinations were conducted to assess nutritional status and the menstrual cycle. Univariate analysis and bivariate analysis were performed to analyze the data. The chi-square statistical test was used as a bivariate analysis with a p-value <0.05 indicating significant data.

Results: A total of 65 respondents were used in the study because they met the inclusion criteria. Based on the survey results using questionnaires and anthropometric examinations, it was found that 4.6% of female students had an obese nutritional status, 7.7% were obese, and the remaining 87.7% were normal. The menstrual cycle experienced by female students is 27.7% of female students experience an abnormal menstrual cycle, and the other 72.3% have a normal menstrual cycle. Based on the Chi-Square test, the significance value of $p = 0.290$ means no relationship between nutritional status and the menstrual cycle.

Conclusion: The menstrual cycle in adolescence is not influenced by nutritional status.

Introduction

Menstruation will always occur periodically, this is called the menstrual cycle. Each woman has a different

menstrual cycle distance, the range of menstruation from one menstruation to another is between 15 to 45 days, but in general, women have a menstrual interval of

around 28 days, and the length of time for each cycle is between 2 to 8 days, with the average woman experiencing around 4 to 5 days with blood production of 60 to 80 ml per cycle (Prathita et al., 2017). According to Dya and Adiningsih (2019), several factors can disrupt the regularity of the menstrual cycle, including stress, smoking, taking hormonal drugs, endocrine disorders, and nutritional status (Dya & Adiningsih, 2019). There are several types of disorders in the menstrual cycle including polymenorrhea, oligomenorrhea, and amenorrhea.

Menstrual cycle irregularities can cause several problems. Polymenorrhea is a menstrual cycle that is less than 21 days in one cycle. Continuous polymenorrhea can disrupt hemodynamics in the body and cause ovulation disorders which result in impaired fertility. Oligomenorrhoea, defined as a patient with a menstrual cycle of more than 35 days, on a continuous basis, can lead to something similar to polymenorrhoea, which is a disorder of ovulation that can interfere with fertilisation. In addition, menstrual cycle disorders can cause stress to the sufferer (Sinaga et al., 2017). According to Anastasia et al. (2014), there are 20% of women who experience infertility caused by menstrual problems. The prevalence of women who experience infertilization due to the menstrual cycle is 60%, where

menstrual cycle disorders are caused by an unhealthy lifestyle (Simanjuntak, 2022).

Nowadays, teenagers, especially female teenagers, are very concerned about their appearance. This leads to a lack of nutritional intake, which can lead to malnutrition. There are 40.3% of women in Indonesia who are dissatisfied with their body shape (Normate et al., 2017). In Indonesia, in 2013, the percentage of adolescents aged 13-15 years who were underweight was 11.1%, while for adolescents aged 16-18 years it was 9.4% (Watson et al., 2019). Next in 2018, the percentage of nutrition adolescents in East Java had a nutritional status of very thin 1.1%, thin 6.8%, normal 75.7%, fat 11.3%, and obese 5.1%.

Methods

This research is analytical observational research conducted by observation to explain a certain situation (Adiputra et al., 2021). The research design used a cross-sectional study or research conducted by collecting data simultaneously at one specific time. This study uses primary data from questionnaires and measurements of body weight and height of female santri of Al-Jihad Islamic Boarding School Surabaya.

The population in this study was all female students at Al-Jihad Islamic Boarding School Surabaya, with a total of

550 people. The research sample was determined in accordance with the inclusion criteria and exclusion criteria. The inclusion criteria are as follows: (1) female students who are registered at Al-Jihad Islamic Boarding School Surabaya, (2) willing to become research subjects and attend the study, (3) aged between 14-25 years, (4) have experienced menstruation for about 3 years. Meanwhile, the exclusion criteria set were (1) not yet menstruating, (2) having a history of reproductive disease, (3) having a history of thyroid disease, (4) taking drugs that interfere with hormones, (5) taking diet or weight loss drugs.

The sample size used in this study was determined using the Slovin calculation formula. The results of calculations using this formula show that the sample size required is 65 samples. A simple random sampling technique was used as a sampling method in this study.

Weight measuring devices (scales) and height (stature meter) were used as research instruments. In addition, a questionnaire taken from Nunung's (2017) research was used as a research data collection instrument. This questionnaire consists of 3 parts, the first part consists of the researcher's identity and research objectives, the second part contains the respondent's identity and consent statement, and the last part contains data on the

respondent's height, weight, and menstrual cycle.

The research data that has been collected through the distribution of questionnaires and weight measurements will then be processed using univariate analysis and bivariate analysis. The Chi-Square test was used as a bivariate analysis to analyze the correlation between the nutritional status of female students at Al-Jihad Islamic Boarding School Surabaya and the menstrual cycle. A p-value of <0.05 indicates the data is significant.

Results and Discussion

Through a questionnaire distributed to 65 respondents, we collected data related to the general description of the respondents' nutritional status and menstrual cycle. The data is presented in Table 1.

Table 1. Characteristics of respondents based on nutritional status and menstrual cycle

	Frequency	Percentage(%)
Nutritional Status		
Obesity	3	4.6
Obese	5	7.7
Normal	57	87.7
Skinny	0	0
Very skinny	0	0
Menstrual Cycle		
Normal	47	72.3
Not Normal	18	27.7

The data presented in Table 1 shows that 4.6% of female students at Pondok

Pesantren Al-Jihad Surabaya have an obese nutritional status, while 7.7% fall into the obese category, and the rest (87.7%) have a nutritional status in the normal category. Furthermore, in the observation of the respondents' menstrual cycles, we found that 18 female students had an abnormal

menstrual cycle, while the other 47 female students had a normal menstrual cycle. The Chi-Square test was conducted to analyze the relationship between the respondents' nutritional status and the menstrual cycle. The test results are presented in Table 2.

Table 2. Chi-Square test results of the relationship between nutritional status and the menstrual cycle of respondents

Menstrual Cycle	Status Gizi			Total	p-value
	Obesity	Obese	Normal		
Not Normal	n	2	1	15	0.290
	%	3.1	1.5	23.1	
Normal	n	1	4	47	
	%	1.5	6.2	64.6	
Total	n	3	5	57	
	%	4.6	7.7	87.7	

Based on Table 2, it is known that there are 57 female students who have normal nutritional status. Furthermore, 15 other female students experience an abnormal menstrual cycle and 42 female students experience a normal menstrual cycle. There are 5 female students recorded as having obese nutritional status with 1 female student experiencing an abnormal menstrual cycle, and there are 3 female students with obese nutritional status where 2 of them experience an abnormal menstrual cycle. The Chi-Square test results showed a significance value of $p=0.290$. This result indicates that there is no relationship between nutritional status and menstrual cycle.

Women will experience menstrual periods that will begin when puberty takes place. In general, a woman's menstrual cycle will last about 25 to 35 days, with an average of 28 days (Baker & Scheuermaier, 2013; Szmelskyj et al., 2015). The difference in the length of the menstrual cycle in each individual occurs due to differences in hormones, i.e. the hormones estrogen, progesterone, FSH, and LH (Fitri, 2017). Furthermore, several researchers have identified several factors that are thought to interfere with or affect a woman's menstrual cycle, such as genetic factors, lifestyle, smoking, alcohol consumption, stress, environment, and nutritional status

(Ghare Naz et al., 2022; Godari Akhila et al., 2020).

Nutritional status is a description of the fulfillment of nutritional needs from foods and drinks that have been consumed. Nutritional status is also one of the factors that affect a person's intelligence and growth (Muchtar et al., 2022). Assessment of nutritional status in adolescents can be done using the calculation of Body Mass Index or Age (IMT/U) (Hafiza et al., 2021).

The results of observations and analysis of the nutritional status of respondents showed that the majority of female santri at the Al-Jihad Surabaya Islamic Boarding School were in normal status. A person's nutritional status can be influenced by several factors, both internally and externally. The development of the economy, technology, and knowledge has a role in improving a person's nutrition (Sitepu, 2018). In addition to this, there are several other factors, which are divided into primary factors and secondary factors. Primary factors are factors that affect the entry of food or nutrients into the body, while secondary factors are factors that affect the absorption of nutrients (Harjatmo et al., 2017).

The results of this study showed that 72.3% of respondents had a normal menstrual cycle, while 27.7% of respondents experienced an abnormal menstrual cycle (< 21 days or > 35 days).

The results of research conducted by Aesthetica Islamy and Farida (2019) are in line with this study, that 77.5% of respondents have a normal menstrual cycle and 22.5% of respondents have an abnormal menstrual cycle. These results indicate that the majority of respondents' menstrual cycles are mostly normal. Several factors can affect the menstrual cycle, including physical activity, stress, nutrition, and age of menarche (Andriana & Aldriana, 2018). Based on what has been mentioned, it is known that there are factors other than nutrition that can affect the menstrual cycle.

Based on the results of the Chi-Square test, we found that nutritional status and menstrual cycle have no relationship or correlation with each other. The results of this study are in line with the results of research conducted by Armayanti et al. (2021) also showed similar results where a significance value of $p = 0.219$ was obtained. It is possible that in this study, menstrual cycle irregularities can occur due to other factors such as stress, hemoglobin levels, age, and a lot of physical activity. According to Armayanti et al. (2021), hemoglobin levels can affect menstrual cycle regularity (Armayanti & Damayanti, 2021). In addition, research by Islamy and Farida (2019) showed that age, stress, and physical activity also play a role in influencing the menstrual cycle (Islamy & Farida, 2019).

Conclusion

The menstrual cycle experienced by female students at Pondok Pesantren Al-Jihad Surabaya is not related to the nutritional status of the students. We conclude that there are other factors that affect the menstrual cycle, such as stress, activity, and so on, that were not examined in this study.

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Conflict of Interest

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Effect of Oral Administration of *Mytragina Speciosa* on Blood Ketone Level and Glomerular Histology in Streptozotocin Induced Diabetic Mice

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ABSTRACT

Introduction: Diabetes mellitus is a chronic metabolic disease characterized by increased sugar levels that cause serious damage to various organs. Diabetic ketoacidosis is one of the complications of diabetes mellitus. It is characterized by a decrease in the patient's consciousness, increased blood sugar levels, and the presence of acidic ketone bodies. It is a serious condition that can cause a coma or even death. *Mytragina Speciosa*, known as kratom, is a plant often found in Southeast Asia, including Indonesia. This herb is frequently used as a stimulant to treat fatigue and help improve productivity. Based on previous research, *Mytragina Speciosa* is rich in alkaloids, flavonoids, and phenols. These compounds are very useful for inhibiting the activity of α -glucosidase and lipase enzymes in the pancreas, so they have a potential effect on diabetes mellitus. However, there has been no research related to the administration of *Mytragina Speciosa* its effect on blood ketone levels and glomerular diameter.

Objective: to determine whether there is an effect of *Mytragina Speciosa* on blood ketone levels and glomerular diameter in mice with a diabetes mellitus model.

Methods: Hyperglycemia is induced by Streptozotocin. On the 14th day, the mice will be checked for hyperglycemia and blood ketone levels. Administration of *Mytragina Speciosa* begins on day 15 for 2 weeks. At the end of the second week, the mice will be checked for blood ketone levels using a special kit to detect ketone bodies. Furthermore, the glomerular diameter will also be assessed.

Results: In this study, treatment for 2 weeks only caused an increase in blood sugar levels in mice, but did not cause an increase in blood ketone levels in the diabetes group or other treatment groups ($p > 0.05$). Histological preparation of the Glomerulus showed a decline in glomerular diameter.

Conclusions: The administration of *Mitragyna speciosa* extract did not result in a significant increase in blood ketone levels in diabetic mice. Many factors are involved in increasing blood ketone. It is necessary to monitor ketone levels during treatment as well as have a longer treatment time to see the effect of *Mitragyna speciosa* on ketones.

Introduction

Diabetes mellitus is a chronic metabolic disease characterized by increased sugar

levels that cause serious damage to various organs. It is estimated that around 422 million people in the world suffer from

diabetes and 1.5 million die from diabetes (WHO, 2023). Diabetes mellitus has several categories, type 1, type 2, maturity-onset diabetes of the young (MODY), and gestational diabetes (Sapra, 2023). The chronic course of the disease includes acute and chronic complications. One of the acute complications of diabetes mellitus is diabetic ketoacidosis, which is characterized by a decrease in the patient's consciousness, increased blood sugar levels, and the presence of acidic ketone bodies. It is a serious condition that can lead leads to coma or event death (CDC, 2022).

Myragina Speciosa, known as kratom, is a plant often found in Southeast Asia, including Indonesia. This herb is used by the community as a stimulant to treat fatigue and improve work productivity (BPPK, 2022). According to previous research, *Myragina Speciosa* is rich in alkaloids, flavonoids, and phenols. These compounds are very useful in inhibiting the activity of α -glucosidase and lipase enzymes in the pancreas, so they have a potential effect on diabetes mellitus (Limcharoen, 2022). However, there has been no research related to the administration of *Myragina Speciosa* to reduce ketone levels when acute complications occur.

The presence of various compounds contained in *Myragina Speciosa* extract requires an in-depth study of the health potential, reducing ketone bodies in

conditions of diabetes mellitus with an acute increase in blood sugar levels.

Methods

This research is purely experimental and bioinformatics using a database. The research design used was a design with a Post Test Only Control Group Design. The study will be conducted in the integrated research laboratory of the Faculty of Medicine, Unusa.

Myragina speciosa

The extraction method used in this study was maceration. A total of 3 kg of dried *Mitragyna speciosa* Korth simplicia powder was extracted using a 96% methanol solvent. Change the solvent every 1x24 hours and macerate for 7x24 hours. The macerate is concentrated using a rotary evaporator and a water bath to obtain a thick extract.

Streptozotocine

N-(Methylnitrosocarbamoyl)- α -D glucosamine with formula C₈H₁₅N₃O₇ with serial number A610130-0001.

Subject

Before testing, mice were acclimatized for one week in the UNUSA Faculty of Medicine Research Laboratory cage. Before treatment, animals were weighed, marked, and recorded. Mice used are those

that meet inclusion criteria and have passed the ethical review. Then, they were grouped according to the intervention. The analyses carried out in this research included: blood sugar levels in mice, ketone levels, and histological preparation of kidneys.

Data on blood sugar levels and ketone levels were calculated as the average (mean) and standard deviation (SD). Data processing was then continued with normality analysis using the Shapiro-Wilk test and Levene's homogeneity test. If the data obtained is normally distributed and homogeneous, the One Way ANOVA test will be carried out ($p < 0.05$), followed by with the LSD test to compare between groups. If the data does not meet one of the requirements for parametric analysis, a non-parametric statistical test can be carried out using the Kruskal-Wallis test, then continued with the Mann-Whitney test with a confidence level of 95% ($\alpha = 0.05$) to see the differences between treatment groups. Furthermore, kidney histology will be carried out descriptively, with a focus on glomerular diameter.

Results and Discussion

The research used 24 mice divided into four groups. After being treated for two weeks, the mice were euthanized, and blood ketones were checked by taking blood from the tail. The blood sugar results in mice can be seen in the graph (Figure 1).

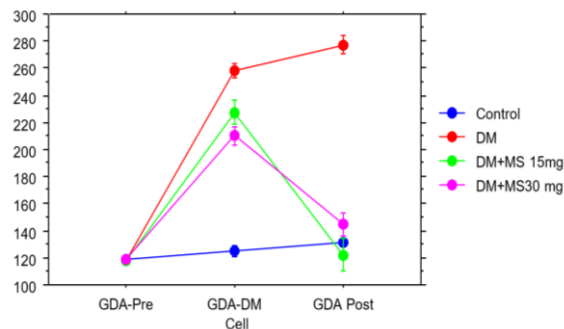


Figure 1. Mytaragina speciosa extract down-regulate blood glucose level in diabetic mice. Blood glucose was measured by glucometer in each group ($n = 6$) other than control group.

Figure 1 shows the blood glucose level changes in the diabetic and experimental animals of each group. STZ-induced diabetic mice showed increases of blood glucose level after STZ injection and at the end of study (red line). Blue line represent blood glucose level in the normal limit. Whereas DM+MS 15mg and DM+MS 30 mg groups increased in blood glucose and declenated after each doses of *Mytaragina speciosa extract*.

It was found that blood sugar levels decreased after administration of mitaragine extract, which was close to the control group or normal group. Meanwhile, blood ketone results can be seen in the following table. It shows that there is no significant difference in the ketone levels between diabetic mice and other groups (Table 1).

Table 1. Blood Ketone Level (mmol/L)

Groups	1	2	3	4	5	6
Normal	0,2	0,3	0,3	0,2	0,3	0,4
Diabetes	0,4	0,3	0,3	0,3	0,3	0,2
Extract 15 mg/kgBB	0,3	0,3	0,3	0,2	0,2	0,3
Extract 30 mg/kgBB	0,3	0,3	0,3	0,2	0,3	0,3

The average ketone level obtained from this study was 0.3 mmol/L with the highest level being 0.4 mmol/L and the lowest level being 0.2 mmol/L (Table 2). Furthermore, Figure 2 shows that blood ketone levels are the same as lower than the normal group (KN) in the 15 mg/kgbb extract group and the same as KN in the 30 mg/kgbb extract group.

Table 2. Mean, minimum and maximum of blood ketone Level (mmol/L)

	N	Min	Max	Mean	Std. Dev
Ketone	24	.20	.40	.2833	.05647

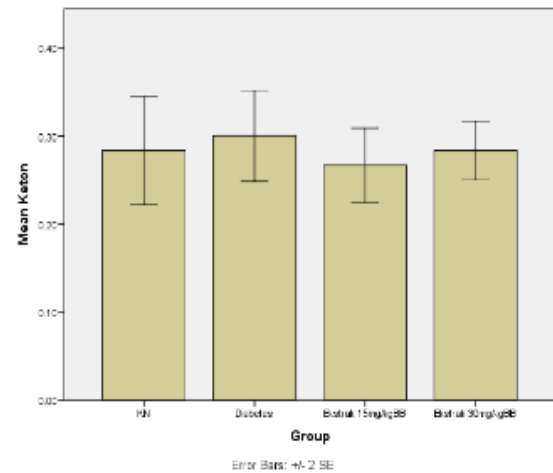


Figure 2. Mean and standard deviation of blood ketone

The normality test using Shapiro-Wilk produced a p-value <0.05 , so further analysis used the Kruskal-Wallis method. After carrying out the Kruskal-Wallis test, a p-value > 0.05 was obtained, indicating that there were no significant differences between the normal group and the treatment group.

Meanwhile, in the histology of the kidneys, it appears that there is a widening of the Bowman space in the diabetes group, 15 mg/kgbb extract and 30 mg/kgbb extract, which indicates damage to the kidneys. This can be compared with the histology in the normal group (Figure 3).

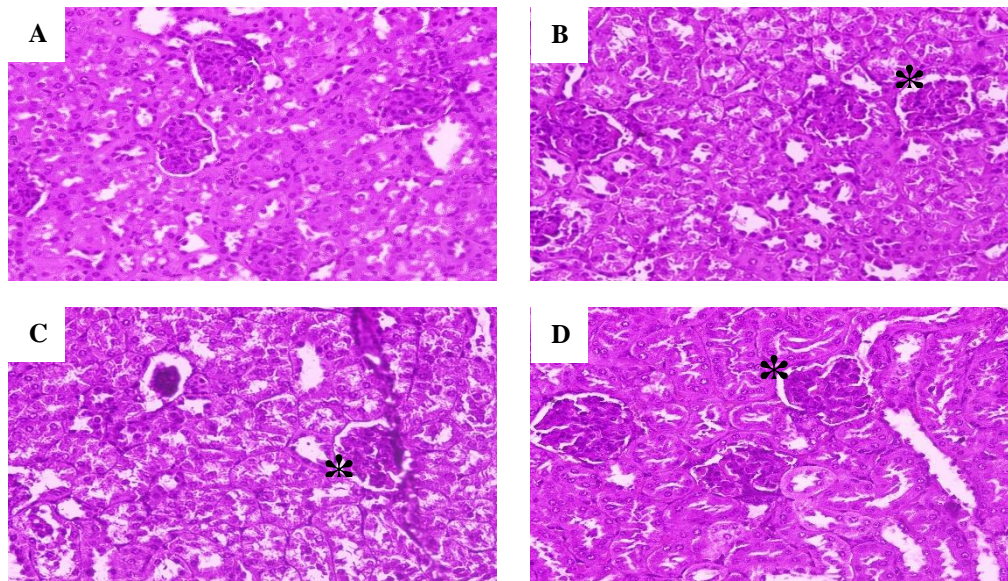


Figure 3. A shows the glomerular condition of the control/normal group, B shows the glomerulus of the diabetes group, C is the 15 mg/kg BW extract treatment group and D is the 30 mg/kg BW extract group. It appears that the condition of the glomerulus in images B C and D is almost the same, namely there is widening of the Bowman space

Discussion

Ketone bodies are a source of energy used by the body when glucose is not available in sufficient quantities. Ketones are always present in the blood and levels will increase when fasting and exercising for a long time. Diabetes is the most common cause of high blood ketone levels (Laffel, 1999).

Normal blood ketone levels are <0.5 mmol/L, and can reach up to 6-7.5 mmol/L during prolonged fasting up to 25 mmol/L in uncontrolled diabetes patients. Excessive accumulation of ketones in the blood can cause dangerous effects on the body because it can induce oxidative stress, play an important role in inducing insulin resistance by downregulating insulin receptors and phosphorylation of insulin

receptor substrate-1, and induce pro-inflammatory factors to cause systemic inflammation (Kanirkala, 2016). In addition, an increase in ketones, or ketosis, can develop into ketoacidosis, which can reduce blood pH and cause problems with the body's organs (Laffel, 1999).

Several studies state that *Mitragyna speciosa*, or Kratom, has antioxidant activity and is a potent α -glucosidase inhibitor. Administration of *Mitragyna speciosa* to diabetic mice significantly showed improvements in body weight, changes in blood sugar, dyslipidemia, and also improved pancreatic damage histologically and immunohistochemically (Zhang, 2023). Furthermore, Zailan et al. stated that *Mitragyna speciosa* showed antioxidant scavenging activity because it

has a higher flavonoid content. Apart from that, it was also found that *Mitragyna speciosa* can inhibit the α -amylase enzyme and has the potential to act as an antidiabetic (Zailan, 2022).

In this study, treatment for 2 weeks only caused an increase in blood sugar levels in mice but did not significant increase in blood ketone levels in the diabetic mice following the administration of *Mytaragina speciosa* extract. In diabetes mellitus, there is an increase in the production of ketone bodies and a decrease in their clearance. The accumulation of ketones in the blood will then cause damage to cells. Therefore, controlling blood sugar and monitoring ketones is the best way to prevent complications and even death in diabetes patients (Kanirkala, 2016).

Conclusion

This study did not show an increase in blood ketone levels in both DM mice and after administration of *Mitragyna speciosa* extract. Multiple factors influence the levels of ketone bodies in the blood, it is essential to monitor ketone levels throughout the treatment and consider longer treatment durations to fully evaluate the effect of *Mitragyna speciosa*, it is necessary to monitor ketone levels during treatment as well as a longer treatment time to see the effect of *Mitragyna speciosa* on ketones.

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Healing Garden as a Green Open Space in Hospital

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ABSTRACT

Introduction: Natural environments within healthcare settings have received growing interest for their potential role in supporting health and well-being. Healing gardens are typically green open spaces within hospitals that promote the physical, mental, and emotional rehabilitation of patients, also benefiting the staff and visitors. This paper presents a narrative review pertaining to the theoretical underpinnings, history, and empirical research on the effectiveness of healing gardens in health care settings.

Result: It has been reviewed in recent literature that healing gardens have a huge effect on stress reduction, mood enhancement, improved cognitive functioning, and accelerated physical recovery. Some key design principles, such as access, sensory stimulus, and restorative components, are essential in maximizing this potential therapy. Healing gardens, therefore, become one of the most cost-effective ways for patient care and staff well-being; however, there might be some little challenges in implementing and maintaining them.

Conclusion: Future research should be directed toward long-term impacts and design innovations that ensure maximum efficacy of these therapeutic spaces. Future work into the healing garden would focus on developing more patient-centered, restorative, and sustainable healing environments that underscore this deep connection between nature and health.

Introduction

In the past years, natural environments have gained emphasis as a factor toward health and well-being (Shanahan et al., 2019; Totaforti, 2018). One such manifestation of this trend is their being integrated into healing gardens within hospitals. These green open spaces are intentionally designed to serve as therapeutic landscapes that support the physical, mental, and emotional recovery of patients, while also providing benefits to

hospital staff and visitors (Belčáková & Galbavá, 2018; Kim, 2021; Mahmood, 2018).

Healing gardens are rooted in the concept of biophilia, which states that human beings have an innate love for nature (Totaforti, 2018). This connection to nature is not merely aesthetically beautiful; it is also basic to human health. (Bulakh et al., 2021; Shanahan et al., 2019). The design and implementation of healing gardens in hospitals reflect a holistic approach to

healthcare, one that goes beyond treating symptoms to fostering overall well-being.

According to Shanahan et al. and Totaforti, 2018, healing gardens can be said to be part of the enhanced interest in having patient-centered care incorporated into hospital environments. By creating spaces that promote relaxation, reduce stress, and encourage physical activity, hospitals can enhance the healing process (Chang & Chien, 2017; Iqbal & Abubakar, 2022). Researcher notes that these gardens are particularly striking in that they stand as an antithesis to usually sterile and stressful hospital environments by offering a tranquil sanctuary from the busy activities to patients, families, and healthcare workers.

This narrative review seeks to discuss the complex benefits that healing gardens in hospitals have. This paper is intended to give a review of theoretical underpinnings and history, empirical evidence explaining their efficacy, and basic principles governing designs so that therapeutic potential could be brought out maximally. The review also wants to bring out the challenges in setting up and maintaining such spaces and point toward future directions in research.

As healthcare systems around the world face increasing pressures, the adoption of healing gardens represents an innovative and cost-effective strategy to improve patient care and staff well-being (Iqbal &

Abubakar, 2022; Shanahan et al., 2019). By integrating nature into the healing process, hospitals can create environments that support recovery and foster a sense of tranquility and hope (Bulakh et al., 2021).

The next sections of this review examine some of the specific benefits associated with healing gardens, drawing on both qualitative and quantitative studies. It will outline best practice in designing them and note practical considerations when implementing them. This review would seek to make a case for healing gardens as one of the essential components of modern healthcare design and practice.

Methods

The literature used in this review was obtained from several sources such as Google Scholar, SINTA Journal, and Pubmed. The keywords used to conduct literature searches are "Healing Garden", "Therapeutic Garden", "Green Open Space" and "Hospital". The publication of articles/literature is limited to 2018-2024 only. 10 articles were obtained that fit the criteria for further analysis in this literature review.

Results and Discussion

The Concept of Healing Gardens

Healing gardens are outdoor spaces that are thoughtfully designed to promote health and well-being through the direct use of

nature (Kim, 2021). The healing gardens, therefore, do not simply make for beautification; instead, it is an area from the health care environment tailored to support therapy and restoration among patients, staff, and visitors. (Belčáková & Galbavá, 2018; Mahmood, 2018).

Healing gardens have extreme depth in both historical and theoretical contexts. Throughout history, across the various cultures, the gardens were associated with healing and spirituality (Bulakh et al., 2021). The health benefits realized from nature were appreciated by ancient civilizations such as the Egyptians, Greeks, and Romans, who used them in their medical practices and healing sanctuaries. In more recent history, the medieval cloister gardens of Europe served as places of contemplation and healing, often associated with monastic hospitals (Dinu Roman Szabo et al., 2023). These quiet retreats provided a place in which to recover amidst the healing atmosphere of plants and elements of nature.

The theoretical underpinnings of healing gardens are grounded in the principles of biophilia and environmental psychology. The term "biophilia," was coined by biologist E.O (Totaforti, 2018). Wilson, suggests that humans have an innate affinity for nature and natural processes. This connection is believed to enhance our physical and mental well-being (Dinu

Roman Szabo et al., 2023). The biophilia hypothesis posits that exposure to natural environments can reduce stress, enhance mood, and improve overall health (Chang & Chien, 2017; Dinu Roman Szabo et al., 2023; Totaforti, 2018).

Theories, usually in environmental psychology, further support the design and actualization of healing gardens, including the Attention Restoration Theory (ART) and Stress Reduction Theory (SRT). ART, proposed by Kaplan, states that fascination and entailments of natural environments help restore depleted cognitive resources by providing an escape from routine stressors. According to SRT, introduced by Ulrich, views of nature can result in large reductions in physiological markers of stress, such as blood pressure and heart rate. (Mahmood, 2018).

Healing gardens can take various forms depending on their specific purpose and the needs of the hospital population (Belčáková & Galbavá, 2018). Common types include:

1. **Therapeutic Gardens:** These are planned and designed sensitively to support horticultural therapy, physical rehabilitation, occupational, psychiatric, and other forms of therapy. They often include features like raised planting beds, accessible pathways, and spaces for group activities.
2. **Restorative Gardens:** Restorative gardens are typified as providing restful

experiences and involve elements that create an environment where one feels relaxed and stress-free (Iqbal & Abubakar, 2022). They usually contain the following features: water features, shaded seating areas, and lush, diverse plantings (Dinu Roman Szabo et al., 2023).

3. **Rehabilitation Gardens:** These are designed and fitted to ensure facilitation of physical recovery. These gardens will include those features that would promote movement and exercise. This includes paths with varying textures, exercise stations, open space for stretching, and mobility exercises (Kim, 2021).
4. **Meditation Gardens:** These would be those that would further support mindfulness and meditation practices. They typically feature quiet, secluded areas, minimalistic design, and elements that foster a sense of tranquility and contemplation (Dinu Roman Szabo et al., 2023).

Benefits of Healing Gardens

Psychological Benefits

1. Stress Reduction and Mental Health Improvement

Healing gardens have been shown to significantly reduce stress and improve mental health (Cordoza et al., 2018; Mahmood, 2018). The presence of natural

elements like plants, water features, and natural light can create a calming environment that helps to alleviate anxiety and depression. Studies have indicated that patients with access to views of nature experience lower levels of stress and anxiety, which can enhance their overall sense of well-being (Chang & Chien, 2017; Iqbal & Abubakar, 2022).

For example, a study by Ulrich (1984) demonstrated that patients recovering from surgery who had a view of trees from their hospital window experienced less postoperative anxiety, required fewer pain medications, and had shorter hospital stays compared to those with a view of a brick wall. Similarly, healthcare workers who take breaks in healing gardens report reduced burnout and improved mental health, as found in the study by Cordoza et al. (2018).

2. Cognitive Restoration

Healing gardens can also support cognitive restoration. According to the ART, natural environments restore reduced cognitive resources through fascination and escape from routine stressors. This can be applicable more specifically to patients who may suffer from cognitive fatigue due to illness or treatment. For health personnel, mental workers who need mental rest from their demanding jobs, the stress reduction can be beneficial for work performance and potentially lower the level of burnout

(Cordoza et al., 2018; Iqbal & Abubakar, 2022; Ulrich et al., 2020).

Physiological Benefits

1. Enhanced Physical Recovery

Healing gardens contribute to faster physical recovery and pain reduction. The natural environment can distract patients from their discomfort, promoting a more positive outlook and reducing the perception of pain (Andriani et al., 2021). Research has shown that patients with access to gardens or natural views recover more quickly and require fewer analgesics compared to those without such access (Cordoza et al., 2018).

In a study by Park and Mattson (2009), surgical patients with access to a garden required fewer pain medications and had shorter hospital stays compared to those without garden access. The presence of plants, water features, and other natural elements can create a soothing atmosphere that enhances the healing process (Dinu Roman Szabo et al., 2023).

2. Improved Physiological Functioning

Exposure to natural settings has been related to reduced physiological functioning, which includes lower blood pressure, reduced heart rate, and enhanced immune function (Dinu Roman Szabo et al., 2023). These benefits are particularly important for patients in hospitals, as they can support overall health and recovery.

Social Benefits

1. Enhanced Social Support

Healing gardens provide a welcoming environment that encourages social interaction and support (Kim, 2021). These spaces can facilitate informal gatherings and conversations among patients, families, and healthcare workers, helping to reduce feelings of isolation and promote a sense of community. Social support is a critical component of emotional health and can significantly enhance the recovery process. Belčáková et al., n.d.(2018) propose that growing herbs helps patients develop management and responsibility skills while fostering an interest in the natural environment. These activities example can enhance social skills and team communication. It might also reduce their stress during treatment and make them feel more effective and successful in whatever they do.

Healing gardens are places of calmness and peace for visiting family members: a place where they can restore themselves in calmness. This can improve their emotional state, making them better able to support their loved ones during the hospital stay.

2. Community Building

Healing gardens can also serve as community-building spaces within the hospital. They offer a neutral and aesthetically pleasing environment where patients, visitors, and staff can come

together, fostering a sense of connection and shared experience (Bulakh et al., 2021; Kim, 2021). This sense of community can be particularly important in large hospital settings where individuals may feel isolated.

Environmental Benefits

1. Improved Environmental Quality

Healing gardens are associated with improved environmental quality, including better air, decreased urban heat island effects, and increased biodiversity. Plants and trees can purify, provide shade, and create habitat for a great number of species, enhancing thereby the healthiness and sustainability of the hospital setting. (Andriani et al., 2021).

2. Sustainable Healthcare Practices

The integration of healing gardens into health-care facilities is part of a broader agenda of sustainability and public health. Green spaces in hospitals can decrease energy consumption through natural cooling and insulation, according to Andriani et al., 2021, and Bulakh et al., 2021. They could also serve as learning platforms to teach patients, staff, and visitors about caring for the environment.

Design Considerations for Healing Gardens

Designers should collaborate with healthcare professionals, landscape architects, and the hospital community to

create spaces that meet the specific needs of users (Mahmood, 2018). The involvement of patients and staff in the design process can ensure that the garden addresses their preferences and requirements. Healing gardens are distinguished by several key characteristics that set them apart from other types of gardens (Dinu Roman Szabo et al., 2023). These include:

Accessibility

1. Universal Design Principles

Healing gardens must be accessible to all users, including those with mobility impairments (Belčáková & Galbavá, 2018; Kim, 2021). It should allow for the incorporation of universal design principles so that everyone, regardless of physical ability, can use and enjoy it. This would include wide, smooth pathways; ramps rather than steps or stairs in any location where elevation needs to be traversed; and seating areas at different heights.

2. Wayfinding and Signage

Clear wayfinding and signage are vital for the easy movement of the user across the garden. The signage should, therefore, be intuitive and include visual, tactile, and auditory cues to suit different needs. The paths should also be well-indicated, thus easy to follow, hence no confusion or frustration. (Dinu Roman Szabo et al., 2023).

Sensory Engagement

1. Multisensory Experience

A healing garden should engage all the senses to create a rich, immersive experience. This can be achieved through the careful selection of plants and features that provide visual, auditory, olfactory, tactile, and even gustatory stimuli (Andriani et al., 2021; Belčáková & Galbavá, 2018; Dinu Roman Szabo et al., 2023).

- Visual: Plants can be very stimulating to visual equivalency with diverse plantings of color, shape, and texture. This should also consider garden changes during seasons for visual interest throughout the year.
- Auditory: It creates audio features, which can include soft, gentle sounds of water in motion created by fountains or streams; wind chimes or rustling leaves also provide sounds that enhance the audio experience.
- Olfactory: Fragrant plants, such as lavender, rosemary, and roses, can provide pleasant and therapeutic scents.
- Tactile: Plants of varying textures—soft moss, rough bark—are stimuli to the sense of touch. Paths with varied textures can also heighten tactile stimulation.
- Gustatory: Edible plants such as herbs, vegetables, and fruits will create the possibility of taste and make picking and tasting interactive experiences.

Restorative Elements

1. Natural Elements

Elements of nature, such as water, plant, rocks and soil, give significant enhancement in the restorative property of the garden'. Water features also provide stimuli of vision and hearing, besides imparting a calming and soothing effect (Andriani et al., 2021; Belčáková & Galbavá, 2018; Dinu Roman Szabo et al., 2023).

2. Shaded Areas

Providing shaded areas is crucial for comfort and usability, especially in hot climates. Shade can be provided by trees, pergolas, or shade sails. These areas offer a respite from the sun and create comfortable spots for relaxation and contemplation (Chang & Chien, 2017; Dinu Roman Szabo et al., 2023).

3. Seating and Resting Areas

Comfortable and strategically placed seating areas encourage users to spend time in the garden (Kim, 2021; Mahmood, 2018). Seating should be varied in type and placement, including options for individuals, small groups, and larger gatherings (Chang & Chien, 2017). Benches, chairs, and loungers can be placed to offer views of the garden's most engaging features (Belčáková & Galbavá, 2018).

4. Safety and Privacy

Healing gardens should provide a sense of safety and privacy (Mahmood, 2018).

Enclosed areas, hedges, or partitions can create private spaces for reflection and solitude (Andriani et al., 2021). Ensuring that the garden is well-lit and easily monitored can also enhance the sense of security (Dinu Roman Szabo et al., 2023).

Flexibility

1. Versatile Spaces

Designing flexible spaces that can accommodate various activities and uses is essential (Kim, 2021). This includes areas for quiet contemplation, social interaction, physical therapy, and recreational activities (Ulrich et al., 2020). Multipurpose spaces allow the garden to meet the diverse needs of its users.

2. Adaptable Features

Features within the garden should be adaptable to changing needs and preferences (Chang & Chien, 2017). For example, movable seating, adjustable shade structures, and modular garden beds can provide flexibility and adaptability over time.

Challenges and Future Directions

While the benefits of healing gardens are well-documented, several challenges remain in their implementation. These include:

- **Funding and Resources:** Securing funding for the creation and maintenance of healing gardens can be challenging. Hospitals must balance budget constraints with the potential benefits of

these spaces (Chang & Chien, 2017; Totaforti, 2018).

- **Maintenance:** The successful implementation of a healing garden requires ongoing maintenance and management (Chang & Chien, 2017). This includes regular upkeep of plants, pathways, and garden features to ensure the space remains inviting and functional. Regular maintenance is crucial to ensure that the garden remains an inviting and functional space. This requires dedicated staff and resources.
- **Integration with Hospital Operations:** Healing gardens must be integrated into the overall operations of the hospital, ensuring that they are accessible and used by patients, staff, and visitors (Iqbal & Abubakar, 2022; Kim, 2021). The integration of healing gardens into healthcare settings requires careful planning and collaboration between healthcare professionals, landscape architects, and the hospital community.
- **Needs Assessment:** Understanding the specific needs and preferences of patients, staff, and visitors is crucial. This can be achieved through surveys, focus groups, and consultations with stakeholders (Belčáková & Galbavá, 2018; Chang & Chien, 2017).
- **Site Selection:** Choosing the right location for the healing garden is essential for its accessibility and

effectiveness. Proximity to patient rooms, ease of access, and visibility from indoor areas are important considerations (Dinu Roman Szabo et al., 2023; Kim, 2021).

- **Design Process:** The design of healing gardens should be guided by principles of therapeutic design and evidence-based practices (Belčáková & Galbavá, 2018; Iqbal & Abubakar, 2022). Collaboration with landscape architects experienced in healthcare design can ensure that the garden meets its intended purpose.
- **Evaluation and Feedback:** Continuous evaluation and feedback from users can help improve the garden's design and functionality. Surveys, interviews, and observational studies can provide valuable insights into how the garden is being used and its impact on health outcomes (Chang & Chien, 2017; Mahmood, 2018).
- **Inclusivity:** Gardens should be designed to be inclusive and accessible to all users, regardless of physical or cognitive abilities (Dinu Roman Szabo et al., 2023). This includes considering the needs of diverse populations (Chang & Chien, 2017).

Future research should focus on long-term studies to better understand the sustained impact of healing gardens. Exploring innovative design solutions, such

as incorporating technology or enhancing sustainability, can further maximize the therapeutic potential of these spaces (Bulakh et al., 2021).

Conclusion

Healing gardens serve as a transformative element within hospital settings, offering a multitude of benefits that enhance the overall healthcare experience. These green open spaces are not merely aesthetic additions but are integral to promoting holistic health and well-being for patients, staff, and visitors. The evidence supports the use of healing gardens as a complementary intervention that enhances the overall healthcare experience.

In detail, the establishment and maintenance of a healing garden involve a collaborative relationship between health professionals, landscape architects, and the community of a hospital. Evaluation and continuous user feedback serve to keep up the effectiveness and relevance of the garden. Further, regular maintenance and patio ideas of sustainability ensure these spaces are kept beneficially working and environmentally responsible.

Healing gardens are thus part of the contemporary health care facility, forming part of the therapeutic benefits that a patient may derive from a hospital beyond the conventional medical remedies. It is a natural haven for holistic treatment and

wellness—a place that enriches the quality of clinical care. Therefore, when it comes to health facility development, more focus should be on having healing gardens as a way of coming up with patient-centered, restorative, and sustainable healthcare environments. These gardens epitomize that strong relation between nature and health, specifically showing just how strongly thoughtfully designed green spaces can have drastic effects on human health and recovery.

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Comprehensive Multimodal Rehabilitation for Chronic Musculoskeletal Problems in Geriatric Patient: A Case Study

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ABSTRACT

Introduction: Musculoskeletal problems are a major cause of morbidity in the geriatric population. These issues can decrease independence, increase functional decline and mortality, and negatively affect the psychological well-being and overall quality of life of elderly individuals. Returning to full function in such cases is highly challenging and requires comprehensive management.

Case: A 67-year-old married female housewife presented with sharp, localized chronic pain in her left wrist for one year. The pain was non-radiating, without any tingling sensation, and aggravated by movements such as ulnar deviation and lifting objects (pain scale: 8/10). Tenderness was observed in the lateral anatomical snuffbox of the left wrist, with a positive Finkelstein test. The patient also experienced sharp, localized pain in her left shoulder for seven months following a coronary artery bypass graft (CABG) surgery for coronary artery disease. The shoulder pain worsened with overhead activities (pain scale: 6/10) and improved with rest (pain scale: 3/10). The patient exhibited limited active range of motion (ROM) in flexion, extension, abduction, and external rotation, with positive Neer and Hawkins tests. Her metabolic equivalent of task (METs) score was 3.46, and she scored 5 on the Geriatric Depression Scale. The Barthel Index was 75, and she was diagnosed with several geriatric syndromes: instability (standing balance), impaired vision (cataract), isolation (depression), iatrogenesis (polypharmacy), and impotence (menopause). The patient had difficulties performing daily activities and participating in the community. A multimodal rehabilitation program was implemented, including therapeutic exercise, pharmacotherapy, kinesiotaping, thumb splint, physical modalities, and consultations with an internist and psychiatrist. After several sessions, the patient's pain decreased significantly to 1/10 (wrist) and 0/10 (shoulder). Active ROM improved to near normal, METs increased to 5.27, and she regained full independence in daily activities (Barthel Index 100).

Discussion: Chronic musculoskeletal problems, especially when coupled with geriatric syndromes, are particularly challenging to manage. A comprehensive geriatric assessment, combined with a thorough multimodal rehabilitation approach, is key to successful outcomes. Improvements in pain, ROM, depression, and METs can lead to better functional performance, thereby reducing disability and enhancing the patient's quality of life. A supportive caregiver also plays a crucial role in achieving satisfactory results.

Conclusions: This case highlights that comprehensive multimodal rehabilitation is crucial for the successful management of chronic musculoskeletal problems in the geriatric population.

Introduction

Musculoskeletal problems are one of the major causes of morbidity in geriatric. As increasing number of elderly and geriatric population, the prevalence of musculoskeletal problems is also increasing (Gheno et al, 2012). Musculoskeletal problems are the most common cause of disabilities in elderly and geriatric. Approximately one-third Canadian will have pain caused by chronic musculoskeletal problems more than 6 months (Health Canada, 2019). It may decrease the independence and increasing functional and morality. It also may affect the psychological conditions and overall well-being of elderly and geriatrics. Thus, it may impact the economical and increasing the demand of health care systems (Reynold, 2022). However, to overcome the chronic musculoskeletal problem, comprehensive multimodal rehabilitation maybe the most beneficial management that can be given.

Case Report

A female 67 years old, married housewife, came to the physical medicine and rehabilitation outpatient clinic with the chief complaint left wrist pain. It was felt for 1 year ago, and became more severe in last 2 months. The pain was sharp, and not

radiating, no tingling sensation, numbness nor weakness of the hand. It was aggravated by moving hand to little finger side, especially like lifting or holding something (WBS 8), and reduced when taking a rest (WBS 3).

She also had limited movement when she lifted her left arm forward and to the side with sharp localized pain at shoulder for 7 months ago after having CABG surgery. No tingling sensation, numbness nor weakness of upper extremity. The pain was aggravated by activity like lifting or drying clothes (WBS 6) and reduced by taking a rest (WBS 3).

The history of medication shown on Figure 1. She got medication from neurology OPC: Mecobalamin, Natrium Diclofenac, and Gabapentin. The history of past illness was:

1. Diabetes mellitus for 10 years. Internal medicine OPC gave metformin, Tuzalos tab, Insulin.
2. Hypertension for 10 years. Cardiology OPC gave Clopidogrel, Hydroclorotiazide, Candesartan.
3. Cardiac ring / stent 3 times and last in 2017
4. Coronary Artery Bypass Graft surgery 7 months ago
5. Trigger finger release surgery 3 months ago

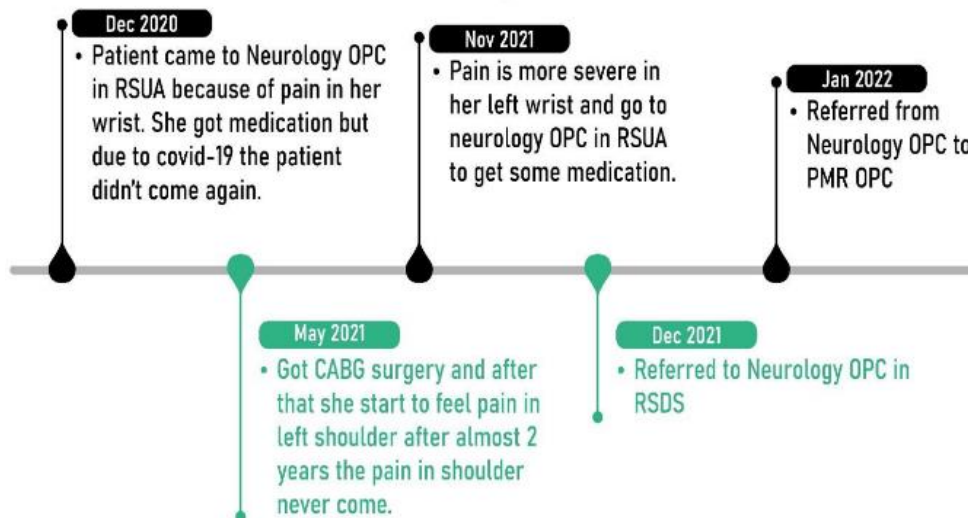


Figure 1. Timeline of the illness

There was tender point in anatomical snuffbox wrist sinistra with Finklestein test positive. The physical examination also showed ROM limitation in shoulder sinistra for abduction and flexion due to pain. The apprehension test of left shoulder: 1200 of abduction, Neer sign and Hawkin test were positive, with Appley Scratch Test results were Abduction-ext.rotation : C7 and Adduction-int. rotation : sacrum. The wrist X-ray found no abnormality as shown on Figure 2. The METS was 3.46 with geriatric depression scale scored 5. The Barthel Index was 75 with geriatric syndrome: Instability (standing balance), Impairment of Vision (cataract), Isolation (depression), Iatrogenesis (multi pharmacy), and Impotence (Menopause). She had difficulties in daily activities and participating in the community.



Figure 2. Wrist X-Ray

The initial assessment was Left Wrist Pain ec De Quervain’s Tenosynovitis + Left Shoulder Pain et ROM Limitation ec Suspect Supraspinatus Impingement + Diabetes Melitus Type II + Hypertension (Uncontrolled) + Geriatric Giant Syndrome + History of CABG (7 Months) + Trigger Finger Digiti II Left Hand Post Release (3 Years). The goals set were divided into short-term (establish diagnose, decrease pain, improve range of motion, and posture correction) and long-term goal (improve cardiopulmonary endurance, giving

psychological support, maintain joint flexibility, and increase quality of life).

We planned to do planning diagnostic Shoulder Radiological examination and Consult to Geriatric OPC. The radiological shoulder result was Narrowing of acromioclavicular joint space and coracoclavicular space. The psychiatrist at the Geriatric OPC had performed motivation and psychoeducation.

The modality given were Laser 4 Joule / cm² on tender point area in left hand (anatomical snuffbox) and Hi-TENS 100Hz on left shoulder for 20 minutes. We also gave therapeutic exercise:

1. Posture correction
2. Breathing exercise active with deep breathing and pursed lip breathing
3. AROM exercise AGA D / AGB S
4. Wrist Stretching Exercise for De Quervain's
5. Shoulder : gentle stretching shoulder S to abduction and flexion direction by Finger Ladder exercise, overhead pulley
6. Endurance exc : F : 3-5x/weeks, I : Borg Scale 11-12, T : 30 minutes, T: walking

The pharmacotherapy given for the pain-killer was paracetamol, considered her elderly age, and also continue the medicine from Neurology, internal medicine, and cardiology OPC. Gabapentin was also used to overcome the neuropathic pain that

occur. We also performed kinesiointaping and thumb splint.

After several months of follow up, the pain reduced to WBS 1 (wrist) and 0 (shoulder). Active ROM increased to almost normal, METS increased to 5.27, and could do activities independently (Barthel index 100). The progression chart shown on Figure 3.

Discussion

Chronic musculoskeletal problems are common in geriatrics. Pain is among the factors that can cause disability and adverse effects on health, such as reduced physical activity, mobility limitations, frailty, depression, cognitive impairment, high risk of falls, and sleep disturbances. The combination of musculoskeletal pain with other pain conditions is commonly experienced by the elderly, and the number of pain sites is a contributing factor to the level of disability experienced (Hasan et al., 2021).

Musculoskeletal pain poses both diagnostic and therapeutic challenges. There is growing evidence that muscle hyperalgesia, referred pain, and widespread hyperalgesia play important roles in chronic musculoskeletal pain. Besides the sensory consequences, musculoskeletal pain also affects the motor control system and related biomechanics (El-Tallawy et al., 2021).

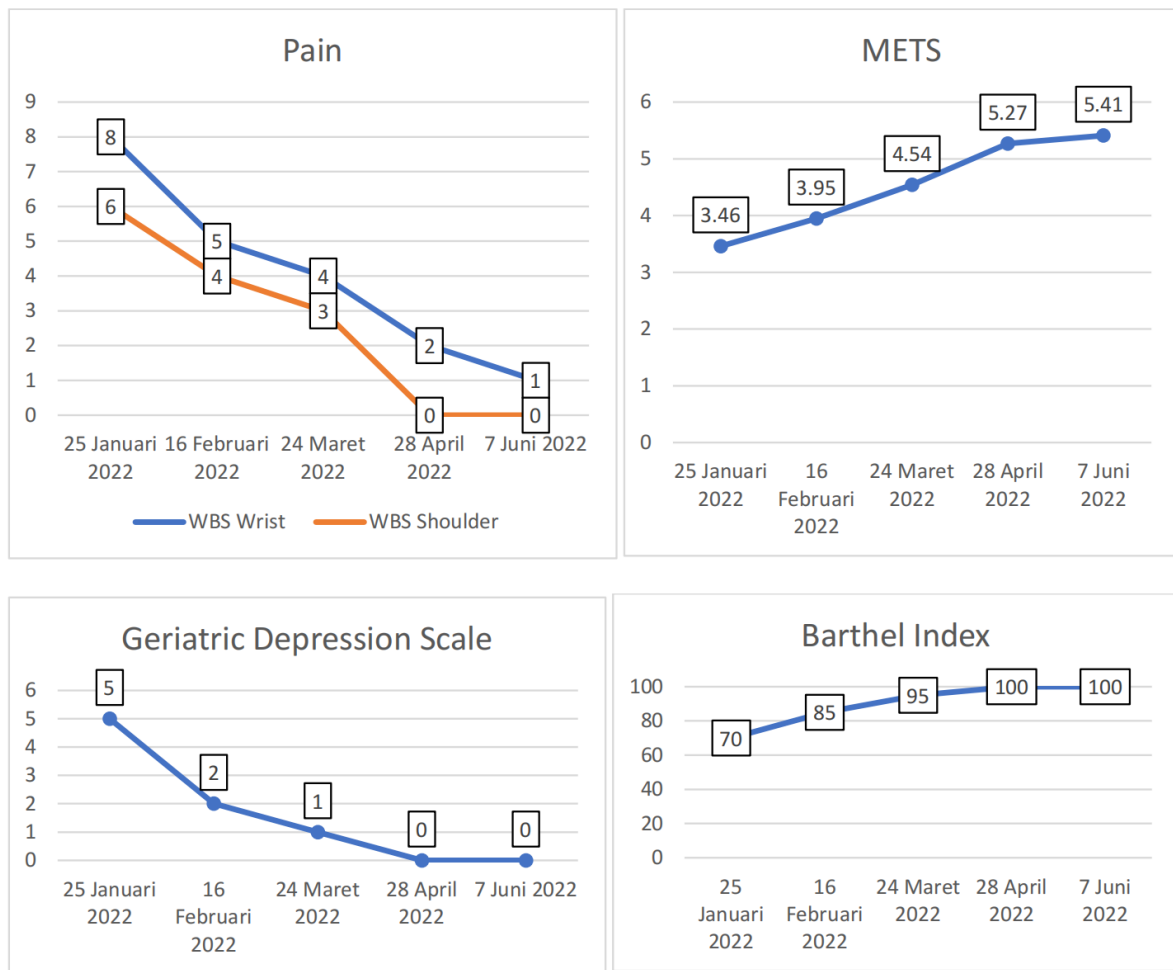


Figure 3. Pain, METS, Geriatric Depression Scale, and Barthel Index Progression Chart

A multimodal approach, including rehabilitation exercises, has been shown to have a positive effect on pain and disability in older adults with chronic musculoskeletal pain, compared to usual medical care. However, the effect size is generally small to moderate, particularly regarding disability. Since a prolonged duration of symptoms is a risk factor for a poor prognosis, even modest improvements in symptom severity especially in pain intensity can positively impact the well-

being of this population (Kechichian et al., 2020).

Pharmacotherapy to manage pain must be carefully selected, with risk-benefit considerations tailored to the patient's condition. In this case, the initial pain scale ranged from 6 to 8 during activity. Kinesiotaping and a thumb splint were used to limit activities that aggravated pain. Additionally, physical modalities were included as part of the comprehensive rehabilitation strategy. It is also important to consider the possibility of mixed pain, as

chronic pain may involve both nociceptive and neuropathic pathways.

Paracetamol is preferred over opioids as an analgesic. Studies show that long-term opioid use for chronic noncancer pain, compared to anticonvulsants or cyclic antidepressants, is associated with a significantly increased risk of all-cause mortality, including deaths from non-overdose causes, with a modest absolute risk difference (Ray et al., 2016). Comparisons between opioids and non-opioid alternatives have suggested that the benefits for pain and functioning are similar (Busse et al., 2018). Paracetamol is well-tolerated and, due to its greater safety compared to traditional NSAIDs, is recommended as first-line therapy for pain management in the elderly (American Geriatric Society, 2009).

Clinicians must carefully monitor how much acetaminophen a patient is taking before deciding to switch to stronger pain medications. Often, increasing the acetaminophen dose to 1,000 mg can provide sufficient pain relief, eliminating the need for stronger medications. Patients should be educated on the maximum safe dose of acetaminophen (<4 g/24 hours) from all sources (Milani et al, 2024).

Conclusion

Chronic musculoskeletal problems in geriatric patients often coexist with multiple

comorbidities. A comprehensive multimodal rehabilitation approach, which may include therapeutic exercises, pharmacotherapy, kinesiotaping, thumb splints, physical modalities, and consultations with internists and psychiatrists, can be beneficial. This case highlights the effectiveness of such an approach for managing chronic musculoskeletal issues in geriatric patients. Further research, particularly involving larger groups of patients, is necessary to validate these findings and optimize interventions.

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Clinical Forensic Assessment of Victims with Stab Wound

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<p>Keywords: Assault, Chest, Scoring system, Stab Wound, Wound Classification</p> <p>Submitted: May 24th 2024 Reviewed: May 29th 2024 Accepted: June 28th 2024</p>	<p>Introduction: Violent crimes using sharp objects are a common problem in Indonesia because sharp weapons can be easily accessed. When evaluating sharp-force injuries, the correct interpretation of the morphology of individual wounds, as well as the overall pattern of findings, is of paramount importance in the reconstruction aspect of the crime. Any knowledge of the occurrence and distribution of sharp force injuries in knife attack victims and perpetrators can help to verify statements or expose defensive lies.</p> <p>Case: We present, a patient from another hospital came to the emergency room at Doctor Soetomo Hospital with a stab wound to the right chest. The 35-year-old male victim, with the initials SPJ, admitted that he was stabbed by his brother. The victim's vital signs were stable when examined. On the right chest, an open wound with flat edges and sharp and blunt angles was found, measuring three centimeters long and five centimeters wide. The victim underwent radiological and laboratory examinations, installed water-sealed drainage, and was administered anti-pain and antibiotics.</p> <p>Discussion: The qualification for this patient's wound based on the Indonesian Criminal Code and the scoring carried out is a moderate wound.</p> <p>Conclusions: Based on the law and the scoring carried out by the author, the wounds on the patient's body are injuries resulting from a criminal act and are included in the category of moderate abuse, which means that the injuries that occurred to the victim did not cause death or cause permanent disability but caused temporary obstacles in carrying out work.</p>

Introduction

Trauma to the chest is associated with the highest mortality rate (Adal et al., 2024). Sharp or blunt objects can cause chest trauma. Although blunt trauma is more common, trauma from sharp objects can be acutely life-threatening (Ludwig and Koryllos, 2017). Law enforcement officers

may send the injured victim for routine treatment and, of course, for a medicolegal report on the case. Examination methods, legal aspects, and psychopathology are part of forensic procedures (Barek and Haque, 2013). A forensic examination report in the form of a postmortem et repertum is required to prove violence.

For the period January to November 2023, crimes involving sharp weapons occurred more frequently in Indonesia than crimes involving firearms. There were 3601 cases of crimes involving sharp weapons, with a total of 553 victims and 4,107 reported persons (Pusiknas Bareskrim National Police, 2024).

Case

On April 2, 2024, at 22.15 WIB (GMT +7), a man with a stab wound came to the emergency room at Dr. RSUD. Soetomo Surabaya was accompanied by his family. The victim was a referral patient from a different hospital. According to the victim, he had an argument with his brother, and he was hit until he fell. When he was about to get up, the victim's brother took a knife from his jacket pocket, stabbed the victim in the right chest, and pulled the knife back. The victim held his chest in pain, then ran outside to seek help from local residents. Residents took the victim to the hospital closest to the incident location.

The general examination revealed that the patient, a 35-year-old male, measured 165 centimeters (cm) in height, weighed 70 kilograms (kg), had dark skin, and had a good nutritional status. The victim was fully conscious, exhibiting a blood pressure of 126/70 millimeters of mercury (mmHg), a pulse rate of 76 times per minute, a

respiratory frequency of 20 times per minute, and an oxygen saturation of 98 percent. The victim's armpit temperature was measured at 36 degrees Celsius (oC). Pain scale 4 (somewhat interferes with activities), with the frequency of pain coming and going and the quality of the pain being dull and radiating. Karnofsky's 70 results.

Physical examination revealed no anemic or icteric conjunctiva, symmetrical chest movement, and no retraction. There is a slight decrease in the right vesicular lung sounds compared to the left, and no rales or wheezing are present. The right hemithorax is duller to percussion than the left. There were no abnormalities in the heart sounds. The abdominal examination revealed no abnormalities. Upon examination, we found no edema, the extremities felt warm, and the capillary refill time (CRT) was less than 2 minutes (Figure 1a).

Examining the wound on the chest, 3 cm to the right of the mid-front line, 5 cm below the nipple, and 120 cm above the heel, revealed an open wound that measured 3 cm x 0.5 cm and was elliptical in shape with flat edges, sharp-blunt angles, a tissue wound base, and no tissue bridge (Figure 1b).

A complete blood count revealed a decreased hematocrit level of 38.9%, a high pO₂ of 108 mmHg, and hypokalemia of 3.1 mmol/L. Upon radiological examination,

no visible infiltrates were found in the lungs. A homogeneous covering appeared in the right lower hemithorax, the middle lateral covering of the right phrenicocostal sinus, and the right hemidiaphragm (Figure 2).

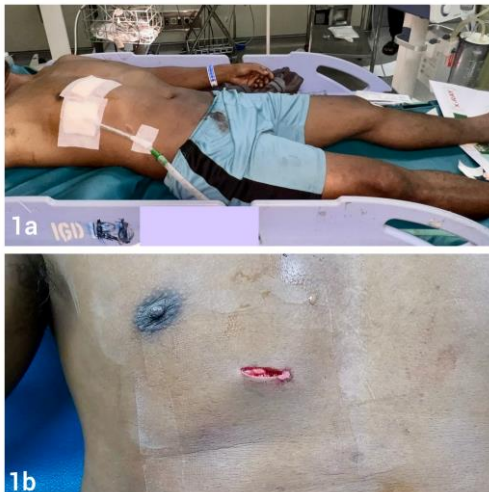


Figure 1. Patient Examination. General condition inspection (a); Wound examination (b)

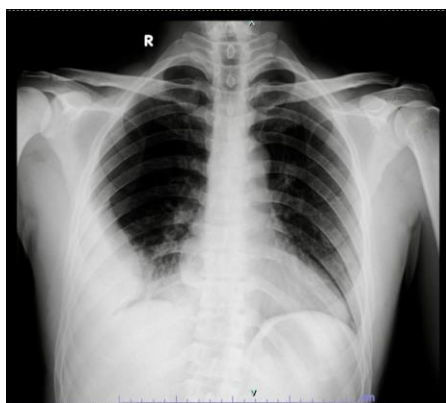


Figure 2. Chest Radiological Examination. A homogeneous lesion was found in the lower right hemithorax

We administered intravenous fluid drops (IVFD), analgesic nasal oxygen, antibiotics, bronchodilators, expectorants, and installed a water-sealed drainage (WSD) with a 28-fr

chest tube in the patient's ICS 6-7 right thorax. Next, we placed the patient in a semi-fowler position and conducted an evaluation. Continue assessing the patient's breathing patterns, breath sounds, sputum and blood, and pain levels. The patient improved on the third day of treatment.

Discussion

Forensic examination of trauma injuries is a concept of trauma examination from a medicolegal perspective in certain jurisdictions. Wounds caused by physical trauma can be immediately evaluated clinically in an outpatient or hospital emergency department. Based on the mechanism of injury, direct physical trauma can be classified into blunt force trauma, sharp force (penetration), and deceleration (Dumovich, 2022). In clinical practice, trauma cases are categorized as minor or major based on a series of treatment triage criteria. Therefore, in forensics, medical practitioners need to classify trauma in a way that is appropriate, can be understood by the justice system, and can provide clues to the cause (Hoffman, 2014).

Sharp trauma is a type of trauma that is a division of mechanical trauma. A sharp trauma is an abnormality in the body caused by the contact of an object with a surface that is capable of cutting or penetrating so that tissue continuity is lost. Usually caused

by swords, scissors, razors, axes, and others. Injuries resulting from sharp trauma can include cuts, slash wounds, and stab wounds (Yudianto, 2020).

A stab wound is a penetrating wound that is deeper than it is wide. Objects that cause this type of injury have sharp and pointed edges, usually in the form of daggers, ordinary knives, scissors, screwdrivers, bayonets, ice picks, etc. (Hakkenbrak et al., 2022). The common denominator of these tools is the presence of a sharp, pointed tip that can penetrate tissue with varying degrees of force. Even the slightest force can cause severe puncture injuries and damage to vital structures in the body (Carabellese et al., 2018).

In this case, the open wound on the patient was the result of a sharp weapon in the form of a stab wound because the wound was larger than the length of the wound (Yudianto, 2020). The stab wound to the chest, which is a vital area, shows that the perpetrator aimed to fatally injure the victim. The stab wound was single and on the right side, which means the perpetrator was facing the victim and used his right hand, so this matches the victim's statement that when the victim was about to get up, the victim was stabbed by the perpetrator (Sauko and Knight, 2016). The angle of the wound in this case is sharp on one side and blunt on the other, or a sharp, single-edged

weapon, which is generally a knife. The depth of the stab wound was not determined, while the length of the stab wound was 3 cm and the width of the wound was 0.5 cm. This indicates that the dimensions of the weapon used were a knife with a maximum width of 3 cm (Sitepu, 2022) (Figure 3). As a result of this wound, the patient had to undergo 10 days of treatment, including receiving a WSD for hemothorax, treating and suturing the wound, and administering medication. The wound does not cause a life-threatening condition, but it creates obstacles to carrying out work or daily activities for a while.



Figure 3. The perpetrator's weapon

To determine injury qualifications, we conduct an assessment based on three assessments: the applicable Indonesian criminal law, the injury scoring system, and the Barthel index. In the law-based assessment, we consider the role of daily activities. Although considered, the system remains subjective in nature. The injury scoring system solely assesses location,

without considering function. On the other hand, the Barthel index serves as an assessment tool, measuring functional independence in terms of self-care and mobility, using a scoring system based on a person's ability to carry out life activities independently. Combining these three, we can determine the qualifications of the injuries in this case.

According to Criminal Code Chapter XX, Article 351 Paragraph 2, and Article 353 Paragraph 1, the perpetrator had a pre-existing problem or grudge and planned to abuse the victim by preparing a sharp weapon, which he carried in his jacket pocket. The punishment is a maximum imprisonment of two years and eight months, or a maximum fine of four thousand five hundred rupiah. This injury qualifies as a moderate injury due to its ability to induce illness or temporarily impede the victim's work (Moeljatno, 2006).

Based on the scoring carried out with the Injury Severity Score (ISS), there are six locations assessed, namely: head and neck, face, chest, abdomen, extremities, and skin. From these locations, the three with the highest values were selected, then each value was squared and then added up. The ISS interpretation is as follows: 1–8 = mild injury; 9–15 = moderate injury; 16–24 = severe injury; >24 = very severe injury

(Garcia et al., 2024). The patient received an ISS result of 9, indicating a moderate injury. Based on the scoring carried out with the Revised Trauma Score (RTS), there are two parameters assessed, namely consciousness, respiratory rate, and systolic blood pressure. The RTS interpretation indicates a value below the established threshold of 4, necessitating immediate treatment at a trauma center. The higher the RTS, the higher the chance of survival (Mohammed et al., 2022). The patient obtained an RTS result of 7.5500 or greater than 4, so he did not require treatment at a trauma center. Based on the scoring carried out by the Trauma and Injury Severity Score (TRISS), a combination of assessments from the ISS and RTS and age are used as calculations in the formula (Indurkar et al., 2023). In this patient, the TRISS score was obtained with penetrating trauma, with a recovery rate of 98.76%. Based on the Barthel index scoring, there are three points assessed: activity, hygiene, and mobility (Knauf et al., 2019). In this patient, a Barthel score of 65 was obtained, which states that the patient is still minimally dependent on carrying out daily activities due to the injury. Of all the scoring carried out on this patient, it excluded minor injuries and supported the assessment of the degree of injury

determined based on the Criminal Code, namely moderate injuries.

Conclusion

A forensic report prepared by a doctor must be able to assist law enforcement by providing conclusions that are in line with medical science and law enforcement requirements.

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The Role of ChatGPT and Artificial Intelligence in Physical Therapy and How It Would Impact Employment in This Field: A Conversation with ChatGPT

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ABSTRACT

Introduction: ChatGPT is a generative language model tool launched by OpenAI on November 30, 2022, enabling the public to converse with a machine on various topics. In January 2023, ChatGPT reached over one hundred million users, making it the fastest-growing consumer application.

Objective: This interview with ChatGPT provides an idea of the current capabilities of ChatGPT and AI to play their role in the physical therapy field and how it can impact the employment rate in the physical therapy field. It also hints at current problems and limitations it will face in providing services in physical therapy. In this conversation with ChatGPT, this study will make ideas on how AI can become more helpful for Physical Therapists, how the quality of treatment cannot be compromised even by means of ChatGPT and AI, and how it impacts employment in the field of physical therapy.

Methods: OpenAI provided ChatGPT-3.5 was used in the paper to make content about its application in the field of physical therapy and how it would impact employment in this field. This is done through self-centered questions about the current capabilities of ChatGPT and AI to play their role in the physical therapy field.

Results: ChatGPT and AI can be supportive tools for physical therapists, but they cannot completely replace physical therapists. Physical therapists are likely to accomplish better treatment outcomes compared to AI.

Conclusions: AI offers considerable advantages for physical therapists, improving efficiency and accuracy in documentation writing and other things and it is time saving for them. Currently, as per need physical therapists should integrate training of AI in their education and practice. Ethical considerations like privacy of patient's data, informed consent and liability must remain essential. AI counters human expertise, it should be assessed as a supportive tool rather than a replacement. AI is unlikely to affect employment of physical therapists, as this field requires human empathy, hands on techniques and personalized care that technology cannot replicate.

Introduction

The 1st and 2nd Generative Pre-trained Transformer (GPT) built on Natural Language Processing (NLP) technology, involved with the relations between

computers and human language, were presented in 2018 and 2019. However, the paper related to the current Chatbot, the 3rd GPT (ChatGPT-3), was published in 2020, followed by its issue on November 30,

2022, by the OpenAI researchers, which is an autoregressive language model that customizes deep learning to create human-like speech and text. The NLP is gradually becoming more important in medicine and healthcare, which assists analyze text and notes in the electronic health records (Iftikhar et al., 2023).

According to a study done in Saudi Arabia in 2023, the findings of the study suggested that ChatGPT could support healthcare teleconsultants in their work by offering informational and decisional support, helping communication, growing work efficiency, and improving patient engagement. By leveraging the chat platforms that use machine learning algorithms and natural language processing, healthcare teleconsultants could offer high-quality care to patients via telemedicine by improving cooperation between healthcare providers. However, due to its new nature, there is a require to explore its effect in different areas of healthcare for well understanding of its effect. Specifically, the ethical challenges concerned relate to liability and accountability, security, and data privacy, which are the major issues that may restrict the use of ChatGPT in teleconsultations (Alanzi, 2023). Likewise in the field of physical therapy AI tools like ChatGPT face important restrictions in teleconsultations due to uncertainties over medical accuracy, privacy of patient, lack of

real time checking, accountability and ethical guidelines. AI cannot provide exact diagnosis, treatment or store patient sensitive data, so all these things make it a supportive tool for physical therapists rather than a replacement.

ChatGPT identifies the general setting of a question or discussion, and it generates detailed replies linked to the subject. ChatGPT can be used in healthcare for numerous objectives, from improving the experiences of patients and supporting personnel in the medical field to improving healthcare techniques and showing significant information. It can be capable of offering a better solution in healthcare which is useful for patients' communication and medical caregivers and providers.

Generative Pretrained Transformers (GPT) describes a system that can be able to understand and generate long strings of complex ideas. ChatGPT is a natural language processing (NLP) model built by OpenAI that allows real-time conversations with an AI chatbot similar to that of a person. It is created on GPT design, a language model that practices to create writing that looks like a human's. ChatGPT collects round data from every informant it can obtain, feeds it into the transformer model, plots the associations between the numerous pieces of data, and prepares educated estimations about what content

had better be worked in which settings. ChatGPT and the analogous technologies may be skilled in organizational data to alter the industry as the technology progresses. They moreover deliver exceptional starting points for generating software and content, supervising understanding, improving consumer collaborations, and refining the experiences of employees. Tutors, event planners, and virtual personal aides are all probably coming advancements.

Though many aspects of healthcare need a relationship with patients, it is only sometimes required for ideal treatment. By improving adherence to routines of treatment and presenting more real and friendly care, ChatGPT may improve the care given by human healthcare providers and enhance patient consequences.

ChatGPT support for the healthcare division comprises descriptions like medical translations, remembering features, expectation support, etc. Distant from these unusual descriptions and capabilities, several limits have been studied, such as the occasional production of incorrect info that can occur with biased content, etc.

ChatGPT presents support for the healthcare suppliers, which can help to lower wait times and enhance the satisfaction level of patients. This can consist of patient questions about appointments, insurance, and billing to

offer them with required information. Healthcare specialists requiring help in doing informed patient care options could use ChatGPT as a clinical decision-support means but with caution. Healthcare workers can utilize this tool or technology to understand treatments, diagnostic techniques, and drugs and get assistance on what to do afterward. This technology or tool can computerize certain processes, expand effectiveness in the healthcare industry, and even substitute various jobs. Recalling that AI can increase human abilities in healthcare activity and can open additional career projections is furthermore important. By using AI in healthcare systems, professionals may spend less time on normal tasks and more on more valuable and challenging responsibilities like care of patients, counseling, and collaboration with other healthcare specialists. ChatGPT can help increase the safety of patients, decrease errors, and improve the quality of treatment. Because of ChatGPT's extraordinary fluency and resourcefulness, it can be a game-changer.

To assist in medical coding and medical billing, ChatGPT can give suggestions for improved patient treatment as per the symptoms of patient and his medical history. It powers the clinical meeting information, medical reports, and discharge summaries, storing patient care time. This is effective for real-time, evidence-based

clinical decision support for all medical practitioners.

Critical thinking and the problem-solving expertise humans have are absent in ChatGPT. ChatGPT can approach considerable information, but ChatGPT can only approach some of the information that doctors have. It cannot be capable of answering queries involving very specified or focused fields, and it may not be up to date on existing developments or alterations in certain disciplines.

However, AI tools cannot switch a doctor. There are many limitations relating to responsibilities, ethics in medicine, interpretation of data, legal framework, and modifications in human responses and anatomy (Javaid et al., 2023).

AI technologies, including ChatGPT, have shown promise in improving diagnostics, personalized medicine, and patient care. ChatGPT can be used to create conversational agents that assist patients with medical inquiries, manage appointments, and provide health advice. AI-powered image analysis and machine learning algorithms can aid in early detection and diagnosis of diseases.

ChatGPT and AI have considerably affected the healthcare sector, leading to displacement, transformation, and creation of jobs. The challenge is to make certain that medical professionals have the required skills to modify the evolving healthcare

setting and tackle the potential of AI technologies to advance patient care and outcomes (George et al., 2023).

AI-based technology innovations in the workplace have increased fears that a rising number of jobs face the danger of being replaced by technology, which would produce widespread unemployment. The biggest risk of experience was found to be in positions that need repetitive tasks, regular decision-making, and some extent of data analysis. Of course, "information processing industries" that demand writing skills, calculation, and analysis in depth are more likely to utilize Logic Learning Machine-based AI. However, employment expecting critical thinking and science inside those sectors are contrariwise related to contact with AI. Certainly, physically commanding professions like agriculture, manufacturing, and mining were better secure, but information processing professions are even now in danger (Gondane, 2023).

There is limited literature found on the role of ChatGPT and artificial intelligence specifically in physical therapy and how it would impact employment in this field. A Conversation with ChatGPT is done in this study to meet the aim of the study. This study aims to find the best answers to some specific questions and fears regarding the physical therapy field and how ChatGPT and AI can impact employment in this field.

Methods

OpenAI provided ChatGPT-3.5 was used in the paper to make content about its application in the field of physical therapy and how it would impact employment in this field. This is done through self-centered questions about the current capabilities of ChatGPT and AI to play their role in the physical therapy field.

Results and Discussion

A Conversation with ChatGPT

Q.1 How ChatGPT and AI can help physical therapist in writing SOAP notes?

ChatGPT and AI can assist physical therapists in writing SOAP notes (Subjective, Objective, Assessment, and Plan) by automating certain aspects of the documentation process. Here's how AI can be helpful:

<p>1. Data Extraction and Summarization:</p> <ul style="list-style-type: none"> • Subjective Section: AI can help extract relevant information from patient conversations or electronic health records (EHRs), summarizing key details about the patient's history, symptoms, and concerns. • Objective Section: AI can assist in extracting and summarizing objective data, such as vital signs,
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measurements, and test results, making it easier for therapists to include accurate and pertinent information.

<p>2. Template Generation:</p> <ul style="list-style-type: none"> • AI can generate SOAP note templates based on standard formats or specific clinic requirements, saving time for physical therapists. The templates can include placeholders for essential information in each section.
<p>3. Documentation Assistance:</p> <ul style="list-style-type: none"> • AI can suggest language and content for each section of the SOAP note based on the information provided. It can offer recommendations for clear and concise language to improve the overall quality of documentation.
<p>4. Coding and Billing Assistance:</p> <ul style="list-style-type: none"> • AI can assist in coding and billing processes by suggesting appropriate codes based on the documented information. This helps ensure accurate reimbursement and compliance with healthcare coding standards.
<p>5. Alerts and Reminders:</p> <ul style="list-style-type: none"> • AI can provide reminders for follow-up assessments, treatment plan adjustments, or other

important considerations. This helps therapists stay organized and ensures continuity of care.

6. **Integration with EHR Systems:**

- AI tools can integrate seamlessly with existing Electronic Health Record (EHR) systems, allowing for a smoother flow of information and reducing the need for manual data entry.

7. **Natural Language Processing (NLP):**

- NLP capabilities can be employed to understand and interpret natural language input, making it easier for therapists to communicate with the AI system and receive relevant suggestions.

8. **Continual Learning:**

- AI models can continually learn and adapt to evolving medical knowledge and documentation practices, staying up to date with the latest guidelines and standards in physical therapy.

While AI can be a valuable tool in enhancing the efficiency and accuracy of SOAP note documentation, it's important to note that human judgment and expertise are still crucial in the interpretation of patient information and the formulation of appropriate treatment plans. The use of AI should complement, not replace, the skills

and knowledge of healthcare professionals. Additionally, adherence to privacy and security regulations is paramount when dealing with patient data.

Q.2 Does SOAP note writing by physical therapist will be more accurate than by ChatGPT and AI?

As of my last knowledge update in January 2022, ChatGPT and AI, while capable of assisting in various aspects of SOAP note writing, may not surpass the accuracy and clinical judgment of a skilled and experienced physical therapist. Here are some reasons:

1. **Clinical Expertise:**

- Physical therapists possess clinical expertise and a deep understanding of their patients' conditions. They can interpret complex clinical information, assess patient responses, and make informed decisions based on their knowledge and experience.

2. **Patient Interaction:**

- The subjective component of SOAP notes involves information gathered directly from the patient. Physical therapists excel in patient communication, empathy, and the ability to extract nuanced

information that may be challenging for AI to capture accurately.

3. **Complexity of Assessment:**

- Physical therapy assessments often involve hands-on evaluation, observation of movement, and other physical examinations. These elements require a level of human judgment and sensory skills that AI currently does not possess.

4. **Individualized Treatment Plans:**

- Physical therapists develop individualized treatment plans based on the unique needs and responses of each patient. While AI can assist in suggesting general treatment options, the ability to tailor interventions to the specific characteristics of each patient is a strength of human therapists.

5. **Ethical and Legal Considerations:**

- Healthcare involves ethical and legal considerations that require human understanding and interpretation. Physical therapists navigate privacy issues, informed consent, and other ethical aspects in ways that go beyond the capabilities of AI.

6. **Continuous Adaptation:**

- Healthcare is a rapidly evolving field, and physical therapists continually update their knowledge and skills. While AI models can be trained on the latest data, they may not adapt as quickly as humans to new research findings and changes in clinical practice.

While AI can be a valuable tool for automating routine tasks, providing information, and assisting in documentation, it should be seen as a complement to, rather than a replacement for, the expertise of healthcare professionals. Collaboration between physical therapists and AI tools can lead to improved efficiency and accuracy in SOAP note writing, but the human touch, critical thinking, and clinical judgment remain essential in healthcare. Always refer to the most recent developments and guidelines in the field, as technology and AI capabilities continue to advance.

Q.3 I think ChatGPT and AI cannot replace physical therapist in future, what do you say?

I agree with your assessment. As of my last knowledge update in January 2022, while AI, including models like ChatGPT, can offer valuable assistance and automation in certain aspects of healthcare, it is unlikely to replace the role of a physical

therapist entirely. Here are some reasons for this perspective:

1. **Human Interaction and Empathy:**

- Physical therapy often involves a significant level of human interaction, empathy, and understanding. Physical therapists build rapport with their patients, motivate them, and provide emotional support, aspects that are challenging for AI to replicate.

2. **Clinical Judgment and Decision-Making:**

- Physical therapists rely on their clinical judgment, experience, and critical thinking skills to assess patients, interpret complex information, and make informed decisions. AI lacks the intuitive and contextual understanding that human therapists bring to their practice.

3. **Hands-On Assessment and Treatment:**

- Physical therapy often requires hands-on assessment and treatment techniques that involve a deep understanding of anatomy, physiology, and biomechanics. AI currently does not have the physical presence or tactile

capabilities to perform these tasks.

4. **Individualized Care:**

- Each patient is unique, and physical therapists tailor their interventions to the specific needs and responses of individual patients. This level of personalization goes beyond the capabilities of AI, which tends to provide more generalized recommendations.

5. **Complexity of Rehabilitation:**

- Rehabilitation involves addressing a variety of physical and functional challenges. Physical therapists work with patients to create comprehensive, multifaceted treatment plans that go beyond what AI can currently offer.

6. **Ethical and Emotional Considerations:**

- Healthcare involves ethical considerations, and physical therapists navigate these issues along with the emotional aspects of patient care. AI lacks the ethical understanding and emotional intelligence required in certain healthcare scenarios.

While AI and technology can play a supportive role in healthcare, the

collaboration between technology and human expertise is likely to be the most effective approach. Physical therapists can leverage AI for assistance in documentation, data analysis, and information retrieval, but the human touch, empathy, and complex decision-making remain crucial components of quality patient care.

It's important to note that advancements in AI and technology are ongoing, and the landscape may evolve. However, the unique skills and qualities of healthcare professionals, including physical therapists, are likely to remain essential in providing holistic and patient-centered care. Always consider the most recent developments in the field for the latest insights.

Q.4 Is physical therapist being only professional who cannot be replaced by AI?

The question of whether a profession can be entirely replaced by AI is complex and depends on the nature of the work involved. While AI has the potential to automate certain tasks and provide valuable support in various fields, complete replacement of human professionals, including physical therapists, is unlikely for several reasons:

1. **Human Interaction and Empathy:**

- Professions that involve significant human interaction, empathy, and emotional support, such as healthcare, counseling,

and certain customer service roles, are less likely to be fully replaced by AI. The ability to understand and respond to human emotions is a unique aspect of human expertise.

2. **Complex Decision-Making and Critical Thinking:**

- Professions that require complex decision-making, critical thinking, and adaptability in unpredictable situations are less susceptible to automation. Humans can navigate uncertain and dynamic environments, drawing on experience and intuition.

3. **Creativity and Innovation:**

- Jobs that involve creativity, innovation, and the ability to think outside the box are less likely to be automated. Humans have a unique capacity for creativity, problem-solving, and generating novel ideas.

4. **Physical and Tactile Skills:**

- Professions that involve physical skills, especially those requiring hands-on work, such as surgery, craftsmanship, and certain aspects of physical therapy, are less likely to be replaced by AI. AI lacks the physical presence

and dexterity required for these tasks.

5. **Ethical Decision-Making:**

- Professions that involve complex ethical decision-making and a deep understanding of moral and societal values, such as law, ethics, and certain healthcare roles, are less likely to be completely automated. Ethical considerations often require a nuanced understanding of human values and cultural context.

6. **Unique Human Qualities:**

- Certain professions leverage uniquely human qualities, such as intuition, intuition, and the ability to establish trust. These qualities are challenging for AI to replicate fully.

It's important to note that while AI may not replace entire professions, it can complement and augment human capabilities in various ways. Many professions will likely undergo transformations, with AI handling routine and repetitive tasks, allowing professionals to focus on higher-level decision-making, creativity, and interpersonal aspects of their work.

The impact of AI on the job market is an ongoing topic of discussion and research. As technology advances, it is crucial for

professionals to stay adaptable, acquire new skills, and be prepared for changes in the job landscape.

Q.5 What are the specific characteristics of a physical therapist that cannot be replaced by AI?

Physical therapists possess a combination of skills, qualities, and attributes that are challenging for artificial intelligence (AI) to fully replicate. While AI can assist in certain aspects of healthcare, the following specific characteristics of physical therapists make their role unique and less likely to be replaced by AI:

1. **Human Interaction and Empathy:**

- Physical therapists build strong relationships with patients, demonstrating empathy and understanding. They provide emotional support and encouragement, helping patients cope with the challenges of rehabilitation. The ability to connect with patients on an emotional level is a distinct human quality that AI struggles to replicate.

2. **Individualized Assessment and Treatment:**

- Physical therapists conduct thorough assessments that take into account a patient's unique

medical history, physical condition, and personal goals. The ability to perform nuanced and individualized assessments, considering both physical and psychosocial factors, is a complex skill that goes beyond the capabilities of current AI.

3. **Hands-On Techniques:**

- Physical therapy often involves hands-on techniques for assessment and treatment. Physical therapists use manual skills, such as joint mobilization, soft tissue mobilization, and therapeutic exercises, requiring a level of dexterity and sensitivity that AI lacks.

4. **Adaptability and Dynamic Decision-Making:**

- Physical therapists frequently make dynamic decisions based on real-time patient responses, adapting treatment plans as needed. The ability to adjust interventions in response to subtle cues and changes in a patient's condition requires a level of adaptability and clinical judgment that is currently challenging for AI.

5. **Motivational and Educational Skills:**

- Physical therapists play a motivational role, encouraging patients to adhere to their treatment plans and make lifestyle changes. They also educate patients about their conditions and empower them to take an active role in their recovery. Motivational and educational skills involve interpersonal communication and individualized strategies that go beyond AI capabilities.

6. **Ethical Decision-Making:**

- Physical therapists navigate ethical considerations, respecting patient autonomy, privacy, and confidentiality. Ethical decision-making involves a deep understanding of moral and ethical principles within a healthcare context, which may be challenging for AI to navigate independently.

7. **Collaboration with Interdisciplinary Teams:**

- Physical therapists often collaborate with other healthcare professionals, such as physicians, nurses, and occupational therapists, to provide comprehensive care. Effective collaboration involves

communication, teamwork, and a holistic approach to patient care.

8. Cultural Competence:

- Physical therapists need to be culturally competent and sensitive to diverse patient backgrounds. Understanding and respecting cultural differences in healthcare practices and beliefs requires a nuanced and human touch.

While AI can support physical therapists by automating routine tasks, providing information, and assisting in documentation, the unique combination of human qualities, interpersonal skills, and clinical judgment makes physical therapists essential in delivering holistic and patient-centered care. It's likely that future collaborations between human professionals and AI will focus on enhancing efficiency and effectiveness rather than complete replacement.

Q.6 Is it good for a physical therapist that he cannot be completely replaced by AI?

Yes, it can be considered positive for physical therapists that their role cannot be completely replaced by AI. Here are several reasons why this is beneficial:

1. Human Connection and Empathy:

- Physical therapists often build strong relationships with their

patients, providing emotional support and empathy during the rehabilitation process. These human qualities contribute significantly to the overall patient experience and can positively impact treatment outcomes.

2. Individualized Care:

- The ability of physical therapists to conduct thorough assessments and create individualized treatment plans based on a patient's unique needs is a key strength. This personalized approach contributes to better outcomes and patient satisfaction.

3. Hands-On Skills:

- Physical therapy often involves hands-on techniques for assessment and treatment. The tactile skills and manual dexterity required for these procedures are unique to human therapists and contribute to the effectiveness of certain interventions.

4. Adaptability and Clinical Judgment:

- Physical therapists make dynamic decisions based on real-time patient responses and adapt treatment plans accordingly. This level of adaptability and clinical

judgment is a complex skill that relies on experience, intuition, and a deep understanding of both medical and human factors.

5. **Motivational and Educational Role:**

- Physical therapists play a crucial role in motivating patients to adhere to treatment plans and make lifestyle changes. They also educate patients about their conditions and empower them to take an active role in their recovery. These motivational and educational aspects involve interpersonal skills that are challenging for AI to replicate.

6. **Ethical Decision-Making:**

- Physical therapists navigate complex ethical considerations, respecting patient autonomy, privacy, and confidentiality. The ability to make ethical decisions within a healthcare context is a skill that requires a nuanced understanding of human values and principles.

7. **Cultural Competence and Communication:**

- Physical therapists need to be culturally competent and skilled in effective communication. Understanding and respecting diverse cultural backgrounds

contribute to better patient interactions and treatment outcomes.

8. **Job Security and Professional Satisfaction:**

- The fact that certain aspects of the physical therapist's role cannot be automated by AI provides job security for professionals in the field. This can contribute to higher job satisfaction and a sense of fulfillment in their roles.

While AI can be a valuable tool to enhance efficiency, automate routine tasks, and support decision-making, the unique human qualities of physical therapists remain essential in providing holistic and patient-centered care. The collaboration between human expertise and AI can lead to a synergistic approach that benefits both healthcare professionals and the patients they serve.

Q.7 In what ways ChatGPT and AI can help physical therapist in his work?

ChatGPT and AI can assist physical therapists in various ways, providing support and enhancing certain aspects of their work. Here are several ways in which AI can be helpful for physical therapists:

1. **Documentation Assistance:**

- AI can assist in the documentation process by providing suggestions and templates for SOAP notes (Subjective, Objective, Assessment, and Plan), saving time for physical therapists and ensuring comprehensive and organized documentation.

2. **Data Analysis and Insights:**

- AI can analyze large sets of patient data, helping physical therapists identify patterns, trends, and correlations that may inform treatment plans and interventions. This data-driven approach can contribute to more effective decision-making.

3. **Patient Communication and Education:**

- AI-powered chatbots or virtual assistants can be used to engage with patients, answer frequently asked questions, and provide educational materials. This can enhance patient understanding of their conditions and treatment plans.

4. **Remote Monitoring:**

- AI can facilitate remote monitoring of patients, collecting data on their progress and adherence to treatment plans.

This can enable physical therapists to track outcomes and intervene when necessary, even in telehealth settings.

5. **Rehabilitation Exercise Guidance:**

- AI can provide visual or textual guidance on rehabilitation exercises, ensuring that patients perform exercises correctly at home. Virtual assistants can offer real-time feedback and monitor adherence to prescribed routines.

6. **Decision Support Systems:**

- AI models can offer decision support by providing information on the latest research, treatment guidelines, and relevant case studies. This helps physical therapists stay informed and make evidence-based decisions.

7. **Speech-to-Text Transcription:**

- AI-powered transcription tools can convert spoken notes or instructions into text, facilitating faster and more accurate documentation for physical therapists. This can be particularly useful during patient interactions.

8. **Appointment Scheduling and Administrative Tasks:**

- AI can assist in managing administrative tasks, such as

scheduling appointments, sending reminders, and handling routine inquiries. This allows physical therapists to focus more on direct patient care.

9. **Biomechanical Analysis:**

- AI algorithms can assist in analyzing biomechanical data, such as gait analysis or movement patterns. This information can aid in the assessment of a patient's condition and guide the development of targeted treatment plans.

10. **Language Translation Services:**

- AI-powered translation tools can assist in overcoming language barriers, enabling effective communication between physical therapists and patients from diverse linguistic backgrounds.

It's important to note that while AI can offer valuable support, it should complement the skills and expertise of physical therapists rather than replace them entirely. The collaborative use of AI tools can lead to more efficient workflows, improved patient outcomes, and enhanced overall quality of care. Additionally, considerations regarding patient privacy, data security, and ethical use of AI should be prioritized in healthcare settings.

Q.8 Do you think AI can do better for patients than a physical therapist?

No, AI is not expected to fully replace physical therapists. The unique human qualities of empathy, adaptability, hands-on skills, and individualized care that physical therapists provide are challenging for AI to replicate completely. While AI can be a valuable tool in supporting certain aspects of healthcare, the collaborative approach, combining human expertise with AI assistance, is considered more likely and beneficial for the future of patient care.

Q.9 Is AI able to do mobilization on patients like physical therapist?

As of my last knowledge update in January 2022, AI does not possess the physical capabilities to perform hands-on mobilization on patients like a physical therapist. Physical therapists use manual techniques, including joint mobilization and soft tissue mobilization, which involve touch, pressure, and specific movements to improve joint mobility and alleviate pain.

While AI can provide valuable support in healthcare through data analysis, decision support, and other applications, it does not have a physical presence or the ability to perform hands-on interventions. The hands-on aspect of physical therapy remains a unique skill that requires the expertise,

training, and physical dexterity of a human professional.

It's important to note that advancements in technology and robotics may introduce new possibilities in the future, but as of now, hands-on mobilization is a skill performed by human physical therapists. Always refer to the latest developments in the field for the most up-to-date information.

Q.10 According to your knowledge how much AI would be helpful for physical therapist?

As of my last knowledge update in January 2022, AI has the potential to be highly beneficial for physical therapists in several ways, although the extent of its usefulness may depend on factors such as technological advancements, integration strategies, and the specific needs of healthcare settings. Here are ways in which AI can be helpful for physical therapists:

1. **Documentation Assistance:** AI can assist in automating and streamlining the documentation process, helping physical therapists create comprehensive and accurate patient records.
2. **Data Analysis and Insights:** AI can analyze large datasets to identify patterns, trends, and correlations, providing valuable insights for

treatment planning and outcomes assessment.

3. **Patient Education:** AI-powered tools can enhance patient education by providing tailored information, answering questions, and supporting ongoing communication between physical therapists and their patients.
4. **Rehabilitation Exercise Guidance:** AI can offer guidance on proper form and technique for rehabilitation exercises, ensuring patients perform them correctly, even in remote settings.
5. **Decision Support:** AI can provide decision support by offering information on the latest research, treatment guidelines, and relevant case studies to assist physical therapists in making informed decisions.
6. **Appointment Scheduling and Administrative Tasks:** AI can automate administrative tasks, such as appointment scheduling, sending reminders, and handling routine inquiries, allowing physical therapists to focus more on patient care.
7. **Telehealth and Remote Monitoring:** AI can support telehealth initiatives by facilitating remote monitoring of patients and assisting in virtual consultations.

8. Language Translation Services:

AI-powered translation tools can help overcome language barriers, ensuring effective communication between physical therapists and patients from diverse linguistic backgrounds.

9. Biomechanical Analysis:

AI algorithms can assist in analyzing biomechanical data, providing valuable information for assessing movement patterns and tailoring treatment plans.

It's important to note that while AI can enhance efficiency and support certain aspects of physical therapy, it is not a replacement for the unique human qualities that physical therapists bring to patient care, including empathy, adaptability, and hands-on skills. The collaborative use of AI, where technology supports and augments the capabilities of healthcare professionals, is likely to be a more effective approach. The field of healthcare and technology is dynamic, so ongoing monitoring of advancements and evolving best practices is recommended.

Q.11 Do you think physical therapists are the professionals who will get the least benefits from AI in their job settings?

No, physical therapists can benefit significantly from AI in various aspects of their job, including administrative tasks, data analysis, telehealth support, exercise

guidance, decision support, and patient education. The impact of AI depends on effective integration and the specific needs of healthcare settings.

Q.12 Does AI would be able to observe and examine patient's sign and symptoms?

The capability of AI to observe and examine patient signs and symptoms is evolving, and there are ongoing efforts to integrate AI into medical imaging and diagnostics. AI can be trained to analyze medical images, such as X-rays, MRIs, and CT scans, to assist in identifying patterns, abnormalities, and potential signs of various medical conditions. In this context, AI can contribute to the interpretation of visual data and aid healthcare professionals in diagnostics.

Additionally, AI systems can process and analyze large datasets, including electronic health records and physiological data, to identify correlations and trends that may be indicative of certain symptoms or conditions.

However, it's important to note that AI, as of now, does not replace the comprehensive and nuanced observational skills of human healthcare professionals. The ability to assess a patient's symptoms involves not only visual cues but also a holistic understanding of the patient's history, context, and non-verbal

communication – aspects that currently require human judgment and expertise.

As technology continues to advance, the role of AI in healthcare is likely to expand, but the collaboration between AI and human healthcare professionals is expected to be the most effective approach, combining the strengths of both to enhance patient care. Always consider the latest developments and research in the field for the most accurate and up-to-date information.

Q.13 Do you not think physical therapist will always do better to patients than solely done by AI?

As of now, physical therapists are likely to provide a level of care and expertise that is challenging for AI to replicate fully. The human touch, empathy, adaptability, and hands-on skills of physical therapists contribute significantly to the effectiveness of patient care. While AI can assist in certain aspects, the unique qualities and personalized approach of human therapists are likely to be valued in healthcare settings.

The collaboration between physical therapists and AI is a more promising approach, where technology supports and enhances the capabilities of healthcare professionals rather than replacing them entirely. AI can play a valuable role in automating routine tasks, analyzing data, and providing decision support, allowing

physical therapists to focus on the more nuanced and personalized aspects of patient care.

It's important to recognize that healthcare is a multidimensional field, and while AI continues to advance, the role of human healthcare professionals remains crucial, particularly in areas that require emotional intelligence, complex decision-making, and hands-on interventions. Ongoing advancements in technology and research will continue to shape the landscape, and the optimal approach is likely to involve a thoughtful integration of AI with the expertise of human professionals.

Q.14 Are physical therapists relatively safe from job loss due to the complete replacement by AI in the future?

While it's challenging to predict the future with certainty, physical therapists are generally considered to be in a profession that is less susceptible to complete replacement by AI in the foreseeable future. The unique skills and qualities that physical therapists bring to their work, including empathy, hands-on care, and personalized treatment plans, are challenging for AI to replicate entirely.

However, it's essential for healthcare professionals, including physical therapists, to stay informed about advancements in technology and how they may impact their field. While AI is unlikely to replace

physical therapists entirely, it can play a supportive role by automating certain tasks, providing data insights, and enhancing aspects of patient care.

Professionals in all fields are encouraged to adapt to evolving technologies, engage in continuous learning, and embrace the opportunities presented by advancements in healthcare and AI. The collaborative use of technology alongside human expertise is often the most effective approach to improving patient outcomes and the efficiency of healthcare delivery.

Q.15 How it is a great challenge for AI to replace physical therapists?

Replacing physical therapists with AI presents a significant challenge due to several key factors:

1. **Human Interaction and Empathy:**

- Physical therapists build strong relationships with patients, providing emotional support and empathy. The ability to connect with patients on a personal level is a nuanced and complex aspect that is challenging for AI to replicate.

2. **Hands-On Assessment and Treatment:**

- Physical therapy often involves hands-on assessments and interventions, requiring a level of

physical dexterity and tactile sensitivity that current AI lacks.

3. **Individualized Care:**

- Physical therapists tailor treatment plans based on the unique needs, preferences, and responses of each patient. The ability to provide individualized and personalized care is a strength of human therapists.

4. **Adaptability and Dynamic Decision-Making:**

- Physical therapists make real-time decisions based on patient responses, adapting treatment plans as needed. The dynamic and adaptive nature of physical therapy requires a level of clinical judgment that is challenging for AI.

5. **Complexity of Human Movement:**

- Evaluating and addressing human movement patterns, biomechanics, and functional limitations require a deep understanding of human anatomy and physiology, posing a challenge for AI systems.

6. **Motivational Support:**

- Physical therapists play a motivational role in encouraging patients to adhere to treatment plans and make lifestyle changes.

Motivating individuals involves interpersonal skills and understanding that go beyond the capabilities of AI.

7. Multifaceted Care:

- Physical therapy often involves a multifaceted approach, addressing not only physical symptoms but also considering psychological, social, and environmental factors. This holistic approach is complex and requires a comprehensive understanding of the patient.

8. Ethical and Emotional Considerations:

- Physical therapists navigate ethical considerations and emotional aspects of patient care, requiring a level of ethical judgment and emotional intelligence that AI currently lacks.

While AI can assist in certain tasks, enhance efficiency, and provide valuable support, the complexity of the physical therapist's role involves a combination of skills that are deeply rooted in human qualities. The collaborative use of AI alongside human expertise is seen as a more realistic and effective approach in healthcare.

Q.16 Does AI not have the capability to replace physical therapists in the future?

As of now, AI is not fully capable of replacing physical therapists. The unique combination of skills, including human interaction, empathy, adaptability, hands-on assessment, and personalized care, poses challenges for AI to replicate entirely. While AI can assist in certain aspects, the comprehensive and nuanced nature of physical therapy makes complete replacement by AI unlikely in the foreseeable future. The collaborative use of AI alongside human expertise is seen as a more realistic and effective approach in healthcare.

Q.17 What are the most challenging professions for AI to replace completely in future?

The most challenging professions for AI to replace completely in the future are those that involve complex human interactions, emotional intelligence, creativity, and nuanced decision-making. Some of these professions include:

1. Healthcare Professions:

- Roles such as physicians, nurses, and therapists involve intricate patient interactions, empathy, and complex decision-making based on a combination of medical knowledge and

<p>understanding of individual patient needs.</p>	<p>challenging for AI to fully replicate.</p>
<p>2. Mental Health Professions:</p> <ul style="list-style-type: none"> Jobs in counseling, psychotherapy, and psychiatry require a deep understanding of human emotions, empathy, and the ability to navigate complex and individualized mental health challenges. 	<p>6. Leadership and Human Resources Management:</p> <ul style="list-style-type: none"> Roles that involve leadership, human resources management, and organizational development require emotional intelligence, understanding of interpersonal dynamics, and complex decision-making in varied situations.
<p>3. Creative Arts:</p> <ul style="list-style-type: none"> Professions in the creative arts, including writing, visual arts, and music composition, demand a level of creativity, intuition, and emotional expression that is currently beyond the capabilities of AI. 	<p>7. Therapeutic and Holistic Wellness Professions:</p> <ul style="list-style-type: none"> Professions focusing on holistic wellness, such as yoga instructors, holistic healers, and alternative medicine practitioners, often involve a deep understanding of individual needs and a holistic approach to well-being.
<p>4. Teaching and Education:</p> <ul style="list-style-type: none"> Effective teaching involves not only imparting knowledge but also understanding individual learning styles, adapting to diverse student needs, and providing mentorship and support. 	<p>8. Research and Development:</p> <ul style="list-style-type: none"> Professions that involve groundbreaking research, innovation, and scientific discovery often require creative thinking, hypothesis generation, and problem-solving that go beyond the current capabilities of AI.
<p>5. Social Work:</p> <ul style="list-style-type: none"> Social workers engage with individuals and communities, addressing complex social issues and providing support. The empathetic and context-specific nature of their work is 	<p>9. Emergency Response and Crisis Management:</p>

- Jobs in emergency response and crisis management demand quick decision-making, adaptability to dynamic situations, and a deep understanding of human behavior in high-stress scenarios.

10. **Ethical and Legal Professions:**

- Professions involving ethical decision-making, legal interpretation, and complex problem-solving in areas such as law and ethics pose challenges for AI due to the nuanced nature of human morality and legal reasoning.

While AI can augment and assist professionals in these fields, the multidimensional, context-dependent, and emotionally nuanced aspects of these professions make them particularly challenging to fully automate. Human qualities such as empathy, creativity, and adaptability remain essential in these roles (OpenAI, 2024).

Discussion

ChatGPT is a model artificial intelligence chatbot, which was developed by OpenAI in November 2022, with a focus on serviceability and chat. The ChatGPT was trained through reinforcement learning based on GPT-3.5 architecture, a big language model. GPT-3.5 is an improved language model following the GPT-3 that

can create sentences very similar to those written by humans. Tasks that GPT-3 can do include solving several language-related problems, simple arithmetic operations, translation, writing casual texts, and simple web coding corresponding to given sentences. Even, the GPT-3 wrote a seven-page article in accordance with format, such as citing references, in response to an input message to write an article about itself, and this article was published in preprint with the GPT-3 as a first author.

GPT-3 is envisioned to have many influences in the medical field. First, the computerization of tedious and simple computer tasks performed in clinical settings can productively enhance clinical workers' job contentment and reduce the amount of time given to computers. It can also route complex electronic health record (EHR) systems and can easily automate documentation for human medical decision-making, order preparation, and other everyday tasks. In addition to this, ChatGPT will likely be able to work as a personalized therapist. When GPT-3 was applied to answer the medical examination questions and medical research-related questions, it was noticed that overall GPT-3 performed at a high level and that the GPT-3 was knowledgeable and able to reason about the medical questions. GPT-3 showed reasoning patterns similar to human-like medical problem-solving, though it often

presented biased predictions when asked unanswerable questions and sometimes did not match with human performance. However, extending the model and data, increasing prompt sorting, and allowing a better contextualization of conclusions would be enough to reach human-level performance in the tasks on medical questions. As such, language models based on GPT-3 appear to be able to do medical tasks instead or give answers based on the reasoning about medical terminology.

It is still challenging for artificial intelligence chatbots to offer accurate medical information or offer correct treatment options to individuals on behalf of humans. Earlier natural language processing artificial intelligence was at the point of performing simple and basic tasks on behalf of humans, but at the current point, it could offer basic and general level medical information and treatment options on behalf of humans. In the future, if all technological advances in natural language processing models are yielded together with the medical field, more detailed medical information and treatment options can probably be provided instead of humans (Kim, 2022).

According to my study, the details that I got from ChatGPT while having a conversation with it, show that the integration in physical therapy has

introduced numerous benefits, primarily in improving efficiency and accuracy in several tasks. AI assists physical therapists in tasks such as data extraction, documentation, and coding, letting them gather central patient information promptly and maintain thorough and organized records. For instance, AI extracts and summarizes patient information from all conversations or electronic records, providing therapists with key details swiftly. Moreover, AI-generated SOAP note templates decrease formatting time and confirm reliability across documentation, while also implying language and content for SOAP note sections, increasing clarity, and retaining accuracy.

Regardless of these technological advancements, the role of physical therapists remains essential due to their exceptional qualities and skills. Physical therapists have innate qualities such as empathy, adaptability, and hands-on skills, which are critical for effective patient care. These professionals build deep relationships with patients, supplying emotional support and motivation during the rehabilitation process. Additionally, they modify treatment plans in real time based on their patient responses, confirming personalized and tailored care. While AI can assist in certain aspects of patient care, it does not have the human touch and innate

understanding that physical therapists provide.

The integration of AI in physical therapy also develops past administrative tasks, with AI expanding valuable understandings and support in processes of decision-making. AI can explore huge datasets to recognize patterns and trends, supporting therapists with significant insights for treatment planning and assessment of outcomes. Additionally, AI impeccably combines with Electronic Health Record (EHR) systems, easing manual data entry and enhancing organizational efficiency. The abilities of its natural language processing (NLP) also let AI recognize natural language input, improving communication between physical therapists and AI systems.

Though, regardless of these advancements, AI cannot totally replace the expertise and the human touch that a physical therapist has. The compassionate and adaptive values that a physical therapist has are needed in recognizing the emotional and physical needs of patients and offering them holistic care. While AI can help in reform processes and provide considerable understanding, it cannot copy the expert decision-making and concerned care provided by human professionals.

Also, in other professions involving complex human interactions and emotional intelligence, AI meets challenges in the

complete replacement. The multidimensional quality of human interactions, creativity, and experienced decision-making mounts obstructions for AI in fully replacing the human professionals. Therefore, while AI remains to play an important role in improving efficiency and usefulness in various fields, the combined use of AI with human expertise is critical for getting optimum outcomes in patient care and other professional territories.

The addition of AI in physical therapy offers valuable support in tasks such as documentation, analysis of data, and patient communication, but the exceptional human qualities and services of the physical therapists are doubtful to be entirely replaced by AI, highlighting the importance of collective application of both AI and the human expertise in the field of physical therapy.

AI in physical therapy provides strength like analysis of data, tracking of motion and gait, personalized rehab tools, and automating tasks of admin. However, it lacks human empathy, struggles with complex individualization, cannot perform physical assessments and have privacy concerns.

According to a study done by Javaid et al. (2023), ChatGPT can soon be extensively utilized in clinical practice, with several applications in nearly all medical

specialties, for example, communication with patients and clinical decision-making support.

In my study, the conversation with ChatGPT shows that, according to ChatGPT, it is very challenging for ChatGPT and AI to completely replace physical therapists due to their special innate characteristics as compared to other professionals, so physical therapists are on the safe side, as their employments can't be affected by AI as much as of other professionals.

To my knowledge, it is a pioneer study of its type and includes some questions specifically about the physical therapy field. One of the major limitations of this study is that it does not include many other important questions about the field of physical therapy. In the future major work can be done on many other concerns related to physical therapy and physical therapists. There is much more to do in highlighting present and future challenges that can come in the physical therapy field due to advanced technologies like ChatGPT and AI and how different advanced technologies can help physical therapists in their jobs and reduce their job workloads and how dependence on new technologies like AI, rehab apps can reduce physical therapists' hand on skills, and clinical reasoning and judgment. Depending too much on automated data can lead to less

personalized treatment and misunderstanding of patients' needs. This can compromise the precision of care, as machines may miss details that human observation and expertise provide.

Conclusion

AI offers considerable advantages for physical therapists, improving efficiency and accuracy in documentation writing and other things and it is time saving for them. Currently, as per need physical therapists should integrate training of AI in their education and practice. Ethical considerations like privacy of patient's data, informed consent and liability must remain essential. AI counters human expertise, it should be assessed as a supportive tool rather than a replacement. AI is unlikely to affect employment of physical therapists, as this field requires human empathy, hands on techniques and personalized care that technology can not replicate.

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Double infection by Multi-Drug Resistant *Escherichia coli* bacteria: A case report

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ABSTRACT

Introduction: Antimicrobial resistance (AMR) is a global issue causing multidrug-resistant bacterial infections, leading to higher morbidity and mortality rates. *Escherichia coli*, a Gram-negative Enterobacterales bacteria, is the predominant cause of common diseases. In 2018, *Escherichia coli* ESBL (beta-lactamase enzyme Extended-spectrum) bacterium had the highest antibiotic resistance in Surabaya, Indonesia. In 2022, 3rd generation cephalosporin-resistant *E. coli* and carbapenem-resistant *E. coli* were the top priority pathogens in Indonesia.

Case: A one-year-old girl was taken to the emergency room after vomiting seven times and vomiting. She had a fever for one week, and her nose was runny. The patient had kidney channels narrowed and had surgery to implant a DJ stent in her right kidney five months prior. Physical examination revealed anemia, jaundice, cyanosis, and dyspnea. Blood and urine cultures were conducted, and *Escherichia coli* bacteria were found in urine and blood samples. *Escherichia coli* ESBL was found to be sensitive to several drugs, while its blood showed it was carbapenem-resistant, only sensitive to Ceftazidim, Amikacin, Gentamicin, Tigecycline, and Cefoperazone Sulbactam.

Discussion: Pediatric patients often experience urinary infections from *Escherichia coli* (ESBL) and bloodstream infections from *Escherichia coli* (CRE). These bacteria colonize various sites in the human body, including the urinary tract, causing diarrhea and causing cystitis. ESBL, or Extended Spectrum b-lactamase, breaks down antibiotics, making them ineffective for treating infections. ESBL production is associated with a bacterium found in the bowel, and resistance genes are often transmitted through plasmids carrying other resistance genes. The emergence of carbapenem-resistant *Escherichia coli* isolates (CREC) has led to using polymyxin, tigecycline, fosfomycin, and aminoglycosides as effective antibiotics against CREC. CREC can lead to severe infections, including intra-abdominal infections, pneumonia, urinary tract infections, and device-associated infections.

Conclusions:

Escherichia coli, an MDRO bacteria, requires antibiotic sensitivity test results for effective treatment, with sensitive drugs often chosen in difficult cases, and requiring source control.

Introduction

The global issue of Antimicrobial resistance (AMR) is significant. (Huang et al., 2024; Leoni et al., 2023). Multi-drug-

resistant bacterial infections are linked to higher morbidity and mortality rates in real-world environments (Kasanga et al., 2023; Saliba et al., 2023). With the usage

of antimicrobial medications, AMR rises (Huang et al., 2024). Antibiotic resistance leads to fewer treatment options available, longer hospital stays, higher treatment costs, and higher death rates. The need for alternate treatment options is urgent due to the rise in antibiotic resistance and the ineffectiveness of antibiotic therapies (Nasrollahian et al., 2024). Multidrug-resistant organism (MDRO) infections are more common among elderly people confined to long-term care institutions (Rodríguez-Villodres et al., 2021).

Each continent has a different prevalence of MDROs in long-term care facilities (LTCF). Asia has the highest prevalence of extended-spectrum β -lactamase (ESBL) Enterobacterales (71.6%), carbapenem-resistant (CRE) Enterobacterales (6.9%), and methicillin-resistant *Staphylococcus aureus* (MRSA) (25.6%) (Rodríguez-Villodres et al., 2021)

Escherichia coli belongs to the family Enterobacteriaceae and order Enterobacterales. Gram-negative Enterobacterales bacteria *Escherichia coli* is a facultative anaerobe that is not sporogenous (Nasrollahian et al., 2024; Vázquez-López et al., 2023). *Escherichia coli* is the predominant cause of several common bacterial diseases, such as gastroenteritis, urinary tract infections (UTIs), bloodstream infections (BSIs), septicemia, and newborn meningitis, even

though it is a frequent member of the gut microbiota in both people and animals. It is also present in water, soil, and the vicinity of plants. Apart from the rising incidence of *Escherichia coli* infections, a significant problem is their ongoing drug resistance (Sora et al., 2021).

Escherichia coli can manufacture the beta-lactamase enzyme Extended-spectrum (ESBL) and is carbapenem-resistant. Broad-spectrum cephalosporins, monobactams, and penicillins can all be hydrolyzed by bacteria that produce enzyme-specific beta-lactamases (ESBLs). On the other hand, an isolate of *Escherichia coli* that is carbapenem-resistant is resistant to imipenem, meropenem, ertapenem, or any other carbapenem-containing antibiotic (Endraswari et al., 2022). Within six months, *Escherichia coli* was the third rank of Gram-negative bacteria responsible for a bloodstream infection at Dr. Soetomo Hospital in Surabaya in 2018. Regarding the most dangerous UTIs, *Escherichia coli* ESBL bacterium had the highest level of antibiotic resistance (Ariana et al., 2020; Endraswari et al., 2022). Distribution of WHO priority pathogens based on specimens in all hospitals in 2022 in Indonesia, 3rd generation cephalosporin-resistant E. coli, and carbapenem-resistant E. coli are in first and third place compared to other MDRO bacteria (PAMKI, 2023).

Case

The patient's mother took a one-year-old girl to the Emergency room. Since this morning, the patient has puked seven times and made quite a bit of vomit. She appeared thirsty and was still drinking. There was a fever for one week, reaching a temperature of 39.5°C. The temperature drops with paracetamol and then increases again. She hasn't had diarrhea or shortness of breath in the last four days but has been coughing up phlegm. Her nose is runny. Past medical background: The patient, who was eight months old, had both of his kidney channels narrowed. Five months prior, she had surgery to implant a DJ stent in his right kidney. Additionally, the catheter was withdrawn from the patient two months ago.

On physical examination, the Glasgow coma scale (GCS) was found to be 4/5, heart rate 140 times per minute, pulse strong, body temperature 36.6, SpO₂ 97% fa, respiratory rate 26 times per minute. Head and neck: Anemia (-), Jaundice (-), cyanosis (-), Dyspnea (-), droopy eyes, dry lips, abdomen: supple, flat, not distended, normal bowel sounds, extremities: pale warm acral, CRT < 2 seconds. Blood laboratory examination: Hb: 8.5, WBC: 21.92x10³, PCT: 5.82, Neut: 71.2%, BUN: 12.5, SK 0.4. Urinalysis: Clear yellow, Specific gravity 1.003, Ph 5.5, glucose -, ketones -,

Leukocytes 3+, Nitrites +, erythrocytes 2+, Protein 1+, bilirubin -, urobilinogen -, albumin 150, erythrocytes 1.16/hpf, leukocytes 57.15/hpf, non-squamous epithelium 14.21 per visual field, crystals -, bacteria 1982 per visual field.

Then, urine and blood cultures are carried out. From the results of culture in the media on urine samples, direct Gram staining was obtained: PMN -, Epithelium -, Bacteria -. Blood Agar Plate: Round, small, white colonies, non-hemolyzed, > 10⁵. McConkey Agar Plate: Pink colonies, lactose fermenter. The blood specimen showed a Gram Bactec result: Gram-Negative Rods. Blood Agar Plate: Round, small, white colonies, non-hemolyzed. Chocolate agar plate: Colonies are round, small, white, non-hemolyzed— McConkey Agar Plate: Pink colonies, lactose fermenters.

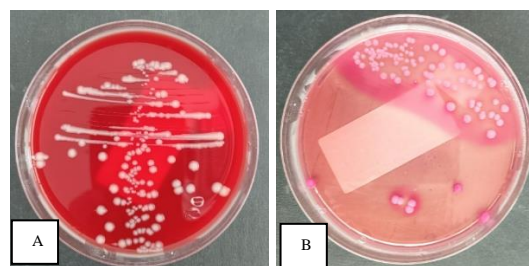


Figure 1. Colony growth in (A) Blood Agar, (B). McConkey Agar after incubation 1x24 hours, at temperature 37°C

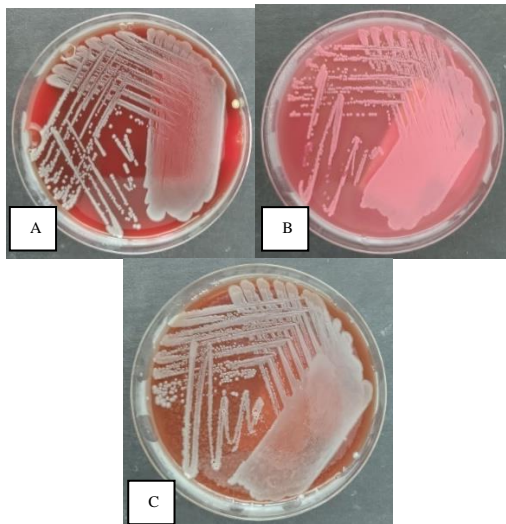


Figure 2. Colony growth in (A) Blood Agar, (B). McConkey Agar, (C) Chocolate Agar after incubation 1x24 hours, at temperature 37°C

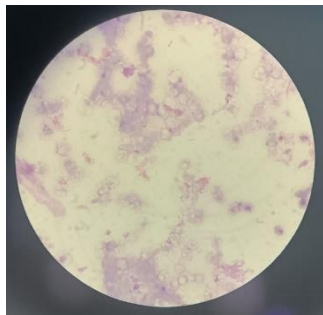


Figure 3. Direct gram stain from bacteria, Time to Positivity 1x24 hours, gram-negative rods in high power field

Table 1. Results of bacterial identification and antibiotic sensitivity testing

Specimens	Urine	Blood
Bacteria	<i>Escherichia coli ESBL</i>	<i>Escherichia coli CRE</i>
Antibiotic Sensitivity Test	Sensitive = Amikacin, Ceftazidime, Gentamicin, Imipenem, Meropenem, Tigecycline, Cefoperazone Sulbactam, Fosfomycin	Sensitive = Ceftazidime, Amikacin, Gentamicin, Tigecycline, Cefoperazone Sulbactam

Escherichia coli bacteria were found in urine and blood specimens with different bacterial sensitivity test results. In the urine specimen (*Escherichia coli ESBL*), some drugs were still sensitive, namely Amikacin, Ceftazidim, Gentamicin, Imipenem, Meropenem, Tigecycline, Cefoperazone Sulbactam, and Fosfomycin. Meanwhile, the blood specimen results showed that *Escherichia coli* was carbapenem-resistant, which was only sensitive to the drugs Ceftazidim, Amikacin, Gentamicin, Tigecycline, and Cefoperazone Sulbactam.

On the 3rd day of hospitalization, urine and blood cultures came out, and the patient was given the antibiotic Cefoperazone Sulbactam.

Discussion

From the results above, it was found that these pediatric patients experienced infections in two different places. *Escherichia coli ESBL* in patients is called a urinary infection, and *Escherichia coli CRE* obtained in the blood is called a bloodstream infection. The urinary tract is the most often colonized extra-intestinal location by these bacteria, and these bacteria frequently cause bloodstream infections. The site of infection (e.g., uropathogenic *Escherichia coli*, named for their impact on the urinary system, and

also extraintestinal pathogenic *Escherichia coli*, or ExPEC) are among the characteristics used to classify pathogenic *Escherichia coli* into "pathotypes" or "pathovars." (Foster-Nyarko & Pallen, 2022; Zhou et al., 2023)

In Gram-negative bacteria, β -lactamase enzymes that hydrolyze the amide bond of the four-membered β -lactam ring are the primary resistance mechanism, with multiple enzymes disseminating on mobile genetic elements across opportunistic pathogens such as Enterobacteriaceae (e.g., *Escherichia coli*) (Tooke et al., 2019). ESBL stands for Extended Spectrum β -Lactamase. β -lactamase enzymes break down and destroy some commonly used antibiotics, including penicillin and cephalosporins, and make these drugs ineffective for treating infections. ESBL production is associated with a bacterium usually found in the bowel. Particularly in Enterobacteriaceae, genes that produce ESBL and carbapenemase frequently have a high transmission rate through plasmids that carry other resistance genes. Both resistances in the same strain are often on different plasmids since ESBL and carbapenemases are connected with various plasmids. This has a significant impact on the use of antibiotics, the price of treatment, patient outcomes, and the range of available treatments. *Escherichia*

coli were treated by cephalosporin and carbapenem; nevertheless, following the emergence of carbapenem-resistant *Escherichia coli* isolates (CREC) and the global spread of these variants, polymyxin, tigecycline, fosfomycin, and aminoglycosides, either alone or in conjunction with other antibiotics, are the antibiotics that continue to be efficacious against CREC. CREC can lead to severe infections, including intra-abdominal infections, pneumonia, urinary tract infections, and device-associated infections (Huang et al., 2024; Nasrollahian et al., 2024). Various mechanisms of resistance are exhibited by *Escherichia coli* strains, including the production of different β -lactamase enzymes, lowered permeability of the membrane, formation of capsule and biofilm, employment of efflux pumps, and enzymatic modification (Nasrollahian et al., 2024). Through the release of antimicrobial compounds, food competition, maintenance of the integrity of the epithelial barrier, bacteriophage deployment, and immunological stimulation, the gut microbiota can offer resistance against colonization. Nevertheless, nothing is now known about the connection between MDRO colonization and the microbiome (Ducarmon et al., 2021)

Conclusion

Escherichia coli is an Enterobacteriaceae which is often listed as MDRO bacteria. Reporting of antibiotic sensitivity test results will be highly anticipated when treating patients. Treatment will choose culture results with still-sensitive drugs in difficult cases with *Escherichia coli* bacterial infections with different genotypes. However, source control management is still important to do while waiting for the drug to be administered.

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