Journal homepage: https://pcijournal.org/index.php/jmscowa

Journal of Mathematics and Scientific Computing with Applications

Published: Pena Cendekia Insani

APPLICATION OF ANALYTICAL HIERARCHY PROCESS (AHP) IN SELECTING OPTIMAL THERAPY FOR OVARIAN CYST DISEASE

Gita Sakinah[1]

[1]Department of Mathematics, Universitas Islam Negeri Sumatera Utara, Medan, Indonesia

Article Info

Article history:

Received 07 15, 2022
Revised 09 20, 2022
Accepted 12 25, 2022

Keywords:

Ovarian Cyst; Analytic Hierarchy Process; Therapy Selection; Multi-Criteria Decision Making

ABSTRACT

Ovarian cysts are one of the common health disorders in women that require proper diagnosis and treatment. Unfortunately, ovarian cyst patients face challenges in determining the optimal therapy for treating ovarian cysts. So, the aim of this research is to develop a decision model using the Analytic Hierarchy Process (AHP) to select the optimal therapy for ovarian cyst treatment. By analyzing 4 criteria, this model identifies the most optimal factors influencing therapy selection, including hormonal treatment, laparoscopic surgery, laparotomy surgery, and alternative medicine. The findings indicate that alternative therapy has the highest priority in terms of recovery time, while hormone therapy excels in cost criteria. The consistency ratio (CR) in the analysis is below the established threshold (≤ 0.1), indicating the reliability of the calculation results. The AHP method has proven effective as a decision-making tool in the selection of ovarian cyst therapy. This research provides insights for healthcare practitioners in selecting the appropriate treatment method and suggests further studies to explore additional factors influencing medical decisions.

Corresponding Author:

Gita Sakinah,
Department Of Mathematic,
Universitas Islam Negeri Sumatera Utara Medan
Email: sakinahgita42@gmail.com

1. INTRODUCTION

One of the most common clinical obstetric-gynecological cases is asnexal messes or adnexal masses which include masses on the ovaries, fallopian tubes and surrounding tissue. The complaint that can be felt by patients is pain. However, adnexal masses are more often detected after physical examination. Adnexal masses have a number of differential diagnoses including several non-gynecological conditions such as gastrointestinal cancer, bladder diverticulum, ovarian cyst, and so on. Therefore, appropriate examinations to diagnose adnexal masses need to be carried out by each relevant doctor. Apart from that, a doctor needs to determine the level of malignancy, whether benign or malignant, of the adnexal mass. In women with malignant masses or masses that have not yet been confirmed, surgical procedures such as laparotomy need to be performed [1].

Cysts are growths in the form of sacs that grow in certain parts of the body. One example of a cyst that will be discussed in this article is an ovarian cyst. An ovarian cyst is a sac filled with fluid or semisolid material that grows in the ovary. Ovarian cysts produce hormones in the form of progesterone and estrogen and participate in regulating menstruation. Ovarian tissue is very dynamic, influenced by hormonal stimulation from puberty to menopause. This is the reason why many cysts or benign tumors appear on the ovaries [2].

Ovarian cysts were discovered when the patient underwent an ultrasound examination (USG) both abdominal and transvaginal and transrectal. Ovarian cysts occur in around 18% of postmenopausal women. Most of the cysts found are benign cysts. And the remaining 10% are cysts that lead to malignancy. Functional ovarian cysts are common occurs in women of reproductive age and is relatively rare in postmenopausal women. In general, there is no specific age distribution regarding the age at which ovarian cysts occur [3].

Decision Support Systems (DSS) are used as a way for decision makers to produce more accurate decisions. In this study, SPK plays a role in choosing the optimal therapy for ovarian cysts, this choice is obtained based on the results of calculations using a decision support method. Choosing optimal therapy is not a simple matter, because it must consider various clinical and non-clinical aspects. One method that can be used in decision making is using a method Analytical Hierarchy Process (AHP)[4]. AHP is an effective method for selecting the optimal therapy in the treatment of ovarian cysts. To build a comprehensive decision-making model, correlated factor weights are needed. If the correct weights of these elements for such an AHP model can be estimated, the effect size of each can be determined [5]. However, determining the appropriate weight for these elements can be a challenge. One of the approaches used is to involve obstetrician-gynecologist specialists in providing subjective assessments of these factors. Thus, the AHP model can provide more accurate and relevant results in the selection of optimal therapy [6].

2. RESEARCH METHODE

2.1 Data Collection

This research method involves literature study and interviews to support the development of a decision support system for optimal therapy in cases of ovarian cysts. Literature research is carried out by reviewing relevant literature, such as scientific journals, conference proceedings, and books that discuss methods Analytical Hierarchy Process (AHP) and its application in medical decision making. Apart from that, interviews were conducted with specialist obstetricians and gynecologists (obgyn) and radiology specialists at the Royal Prima Hospital in Medan to get in-depth information regarding the therapies that are often applied. Based on interviews, it is known that this is the most commonly used therapy for ovarian cysts are hormone treatment and laparoscopic surgery. This information became the basis for developing an AHP-based decision support system in this research.

2.2 Criteria Development

This study uses the Analytic Hierarchy Process (AHP), a widely used decision-making tool for selecting optimal therapy criteria for ovarian cyst treatment. The criteria were identified from 4 factors sourced from the Royal Prima Hospital in Medan City. Several types of therapies in the treatment of ovarian cysts, such as hormonal therapy, laparoscopy, laparotomy, and alternative medicine, have been used in the treatment of ovarian cysts. By establishing transparent criteria based on these types of therapies, researchers can ensure that their work meets the standards expected by many doctors, especially obstetrician-gynecologists who handle ovarian cyst cases.

The criteria and subcriteria in this research can be seen in Table 1.

Table 1. Criteria and sub-criteria for optimal therapy in ovarian cyst cases

Criteria	sub-criteria
Effectiveness	Hormone Treatment
Side Effects	Laparoscopic Surgery
Recovery Time	Laparotomy Surgery
Cost	Alternative Therapy

2.3 AHP Implementation

The Analytical Hierarchy Process (AHP) method is an approach developed by Thomas L. Saaty in the 1970s which is used to overcome multi-criteria decision making problems. AHP is one of the most well-known decision analysis methods and is frequently used in various contexts, including management, engineering, economics, and social sciences. AHP theory is based on the principle that effective decision making involves a comparison between criteria and alternatives that can be evaluated in a structured manner [7].

In order to determine the relative weight of each criterion, the researchers first compare these criteria pairwise when implementing AHP [8], [9]. The criteria and sub-criteria listed in Table 1 serve as the foundation for the checklist's construction. The Saaty scale technique, which rates responses on a scale of 1 to 9, was utilized in the evaluation of this questionnaire and interview [10]. Second, each criterion's priority weight can be computed using mathematical formulas or by entering values from the comparison matrix. This method increases the research's reputation in the scientific community and guarantees that it is carried out with a high degree of scientific rigor. Third, rank the criteria according to how they affect the overall worth and dependability of the study. This method increases the research's reputation in the scientific community and guarantees that it is carried out with a high degree of scientific rigor.

3. RESULT AND ANALYSIS

The research findings have produced calculations to determine the most optimal therapy in cases of ovarian cysts using the Analytic Hierarchy Process (AHP) model. The calculations are as follows:
This process results in the creation of matrices in Table 2a, Table 2b, Table 2c, Table 2d, and Table 2e.

Table 2a. Pairwise Comparison Matrix

Criteria	Effectiveness	Side effects	Recovery Time	Cost
Effectiveness	1	5	7	9
Side effects	0,2	1	3	5
Recovery Time	0,142857143	0,333333333	1	3
Cost	0,111111111	0,2	0,333333333	1
AMOUNT	1,453968254	6,533333333	11,33333333	18

The number 1 in the effectiveness column of the effectiveness row describes the same level of importance, while the number 5 in the effectiveness row of the side effects column describes effectiveness as being slightly more important than side effects. The number 0.2 in the side effects row in the effectiveness column is the result of calculating 1/ the value in the effectiveness row in the side effects column. And other numbers are also obtained in that way.

Table 2b. Criterion Value Matrix

Criteria	Effectiveness	Effect Side	Time Restoration	Cost	Amount	Priority
Effectiveness	0,68777293	0,76531	0,61765	0,5	2,5707261	0,642681527
Effect Side	0,13755459	0,15306	0,26471	0,27778	0,8330995	0,208274867
Time Restoration	0,09825328	0,05102	0,08824	0,16667	0,4041756	0,101043911
Cost	0,07641921	0,03061	0,02941	0,05556	0,1919988	0,047999695

New column row value = old column row value/sum of each old column. Mark 0.68777293 in the effectiveness row of the effectiveness column of Table 2b is obtained from the value of the effectiveness row of the effectiveness column of Table 2a. divided by the number of effectiveness columns in Table 2a. Column sum = the sum of the values from each row. The value 2.5707261 in the effectiveness row of the total is obtained from the addition of 0.68777293 + 0.76531 + 0.61765 + 0.5. For priority = number of values/number of criteria. The value 0.642681527 in the effectiveness row of the priority column is obtained from the value 2.5707261 in the number of effectiveness row column divided by the number of criteria, in this case 4 criteria.

Table 2c. Addition Matrix for Each Row

Criteria	Effectiveness	Side effects	Time Restoration	Cost	Amount
Effectiveness	0,642681527	1,041374337	0,707307377	0,431997253	2,823360494
Side effects	0,128536305	0,208274867	0,303131733	0,239998474	0,87994138
Time Restoration	0,091811647	0,069424956	0,101043911	0,143999084	0,406279598
Cost	0,071409059	0,041654973	0,033681304	0,047999695	0,19474503

New matrix = priority value multiplied by the pairwise comparison matrix. Mark 0.642681527 in the effectiveness row of the effectiveness column of Table 2c is obtained from the effectiveness row of the priority column of Table 2b multiplied by the effectiveness row of the effectiveness column of Table 2a. The total column = the number of values in each row. The effectiveness line is obtained from the sum of 0.642681527 + 1.041374337 + 0.707307377 + 0.431997253.

Table 2d. Calculation Results of the Number of Each Criteria Times the Priority of Each Criteria

Criteria	Amount	Priority	Results
Effectiveness	1,453968254	0,642681527	0,934438537
Side effects	6,533333333	0,208274867	1,360729134
Recovery Time	11,33333333	0,101043911	1,145164325
Cost	18	0,047999695	0,863994506

Consistency ratio (CR) value ≤ 0.1. If the CR value exceeds 0.1 then the pairwise comparison matrix must be corrected.

Table 2e. Calculating the Consistency Ratio

λ *Max*	4,304326502
CI=	0,101442167
CR=CI/IR	0,112713519

Value λ Max obtained from the sum of all the results of Table 2d. The CI value is obtained from (λ Max − many criteria) / (many criteria – 1) in this case (4.304326502 – 4) / (4-1). Then the CR value is obtained from the CI/IR value where IR is the Ratio Index, this ratio index value has been determined. Because there are 4 criteria, the ratio index value is 0.9. In this case 0.101442167 / 0,9.

Determining alternative priorities is stated in Table 3a, Table 3b, Table 3c, Table 3d, and Table 3e respectively.

Table 3a. Pairwise Comparison Matrix

Effectiveness	Hormone Treatment	Laparoscopic Surgery	Laparotomy Surgery	Alternative Therapy
Hormone Treatment	1	0,333333333	0,2	7
Laparoscopic Surgery	3	1	0,333333333	5
Laparotomy Surgery	5	3	1	7
Alternative Therapy	0,142857143	0,2	0,142857143	1
AMOUNT	9,142857143	4,533333333	1,676190476	20

Table 3b. Criteria Value Matrix

Effectiveness	Treatment Hormone	Operation Laparoscopy	Operation Laparotomy	Therapy Alternative	Amount	Priority
Treatment Hormone	0,109375	0,07353	0,11932	0,35	0,6522226	0,163055648
Operation Laparoscopy	0,328125	0,22059	0,19886	0,25	0,9975769	0,249394218
Laparotomy Surgery	0,546875	0,66176	0,59659	0,35	2,1552306	0,538807654
Alternative Therapy	0,015625	0,04412	0,08523	0,05	0,1949699	0,04874248

Table 3c. Addition Matrix for Each Row

Effectiveness	Treatment Hormone	Operation Laparoscopy	Operation Laparotomy	Therapy Alternative	Amount
Treatment Hormone	0,163055648	0,083131406	0,107761531	0,34119736	0,695145945
Operation Laparoscopy	0,489166945	0,249394218	0,179602551	0,2437124	1,161876114
Operation Laparotomy	0,815278242	0,748182654	0,538807654	0,34119736	2,443465909
Alternative Therapy	0,023293664	0,049878844	0,076972522	0,04874248	0,19888751

Table 3d. Results of calculating the number of each criterion multiplied by the priority of each criterion

Criteria	Amount	Priority	Results
Hormone Treatment	9,142857143	0,163055648	1,4907945
Laparoscopic Surgery	4,533333333	0,249394218	1,130587121
Laparotomy Surgery	1,676190476	0,538807654	0,903144258
Alternative Therapy	20	0,04874248	0,974849599

Table 3e. Calculating the Consistency Ratio

λ *Max*	4,499375477
CI=	0,166458492
CR=CI/IR	0,184953881

The value of λ Max is obtained from the sum of all columns in Table 2d. The CI value is obtained from the value (λ Max – number of criteria) / (number of criteria – 1), in this case (4.499375477– 4) / (4-1). Then the CR value is obtained from the CI/IR value where IR is the Index Ratio, and the index ratio value has already been determined. Because there are 4 criteria, the index ratio value is 0.9. In this case, 0.166458492/0.9.

Determining the priority of alternatives based on side effect criteria is stated in Table 4a, Table 4b, Table 4c, Table 4d, and Table 4e respectively.

Table 4a. Pairwise Comparison Matrix

Side Effects	Hormone Treatment	Laparoscopic Surgery	Laparotomy Surgery	Alternative Therapy
Hormone Treatment	1	3	5	7
Laparoscopic Surgery	0,333333333	1	0,333333333	5
Laparotomy Surgery	0,2	3	1	7
Alternative Therapy	0,142857143	0,2	0,142857143	1
AMOUNT	1,676190476	7,2	6,476190476	20

Table 4b. Criteria Value Matrix

Effect Side	Treatment Hormone	Operation Laparoscopy	Operation Laparotomy	Therapy Alternative	Amount	Priority
Treatment Hormone	0,596590909	0,416666667	0,77206	0,35	2,1353164	0,5338291
Operation Laparoscopy	0,198863636	0,138888889	0,05147	0,25	0,6392231	0,159805778
Operation Laparotomy	0,119318182	0,416666667	0,15441	0,35	1,0403966	0,260099153
Therapy Alternative	0,085227273	0,027777778	0,02206	0,05	0,1850639	0,046265969

Table 4c. Addition Matrix for Each Row

Effect Side	Treatment Hormone	Operation Laparoscopy	Operation Laparotomy	Therapy Alternative	Amount
Treatment Hormone	0,5338291	0,479417335	1,300495766	0,32386178	2,637603981
Operation Laparoscopy	0,177943033	0,159805778	0,086699718	0,231329843	0,655778372
Operation Laparotomy	0,10676582	0,479417335	0,260099153	0,32386178	1,170144088
Alternative Therapy	0,0762613	0,031961156	0,006609424	0,046265969	0,161097848

Table 4d. Calculation Results of the Number of Each Criteria Times the Priority of Each Criteria

Criteria	Amount	Priority	Results
Hormone Treatment	1,676190476	0,5338291	0,894799253
Laparoscopic Surgery	7,2	0,159805778	1,150601604
Laparotomy Surgery	6,476190476	0,260099153	1,684451659
Alternative Therapy	20	0,046265969	0,92531937

Table 4e. Calculating the Consistency Ratio

λ *Max*	4,655171887
CI=	0,218390629
CR=CI/IR	0,242656254

The value of λ Max is obtained from the sum of all columns in Table 4d. The value of CI is obtained from the value (λ Max – number of criteria) / (number of criteria – 1), in this case (4.655171887 – 4) / (4-1). Then the CR value is obtained from the CI/IR value where IR is the Index Ratio, and this index ratio value has already been determined. Because there are 4 criteria, the index ratio value is 0.9. In this case, 0.218390629/0.9.

Determining alternative priorities based on side effect criteria is stated in Table 5a, Table 5b, Table 5c, Table 5d, and Table 5e respectively.

Table 5a. Pairwise Comparison Matrix

Recovery Time	Hormone Treatment	Laparoscopic Surgery	Laparotomy Surgery	Alternative Therapy
Hormone Treatment	1	5	7	3
Laparoscopic Surgery	0,2	1	3	0,2
Laparotomy Surgery	0,142857143	0,333333333	1	0,142857143
Alternative Therapy	0,333333333	5	7	1
AMOUNT	1,676190476	11,33333333	18	4,342857143

Table 5b. Criteria Value Matrix

Time Recovery	Treatment Hormone	Operation Laparoscopy	Operation Laparotomy	Therapy Alternative	Amount	Priority
Treatment Hormone	0,596590909	0,441176471	0,38889	0,69079	2,1174457	0,529361436
Operation Laparoscopy	0,119318182	0,088235294	0,16667	0,04605	0,4202728	0,105068194
Operation Laparotomy	0,085227273	0,029411765	0,05556	0,03289	0,2030893	0,050772332
Alternative Therapy	0,198863636	0,441176471	0,38889	0,23026	1,2591922	0,314798038

Table 5c. Addition Matrix for Each Row

Time Recovery	Treatment Hormone	Operation Laparoscopy	Operation Laparotomy	Therapy Alternative	Amount
Treatment Hormone	0,529361436	0,525340968	0,355406327	0,944394115	2,354502846
Operation Laparoscopy	0,105872287	0,105068194	0,152316997	0,062959608	0,426217086
Operation Laparotomy	0,075623062	0,035022731	0,050772332	0,044971148	0,206389274
Alternative Therapy	0,176453812	0,525340968	2,203586269	0,314798038	3,220179087

Table 5d. Calculation Results of the Number of Each Criteria Times the Priority of Each Criteria

Criteria	Amount	Priority	Results
Hormone Treatment	1,676190476	0,529361436	0,887310597
Laparoscopic Surgery	11,33333333	0,105068194	1,19077286
Laparotomy Surgery	18	0,050772332	0,913901984
Alternative Therapy	4,342857143	0,314798038	1,36712291

Table 5e. Calculating the Consistency Ratio

λMax	4,359108351
CI=	0,119702784
CR=CI/IR	0,133003093

The value of λ Max is obtained from the sum of all columns in Table 5d. The CI value is obtained from the value (λ Max – number of criteria) / (number of criteria – 1), in this case (4.359108351– 4) / (4-1). Then the CR value is obtained from the CI/IR value where IR is the Index Ratio, and this index ratio value has already been determined. Because there are 4 criteria, the index ratio value is 0.9. In this case, 0.119702784/0.9.

Determining alternative priorities based on cost criteria is stated in Table 6a, Table 6b, Table 6c, Table 6d, and Table 6e respectively.

Table 6a. Pairwise Comparison Matrix

Cost	Hormone Treatment	Laparoscopic Surgery	Laparotomy Surgery	Alternative Therapy
Hormone Treatment	1	3	5	0,333333333
Laparoscopic Surgery	0,333333333	1	3	0,2
Laparotomy Surgery	0,2	0,333333333	1	0,142857143
Alternative Therapy	3	5	7	1
AMOUNT	4,533333333	9,333333333	16	1,676190476

Table 6b. Criteria Value Matrix

Cost	Treatment Hormone	Operation Laparoscopy	Operation Laparotomy	Therapy Alternative	Amount	Priority
Treatment Hormone	0,220588235	0,321428571	0,3125	0,19886	1,0533804	0,263345111
Operation Laparoscopy	0,073529412	0,107142857	0,1875	0,11932	0,4874905	0,121872613
Operation Laparotomy	0,044117647	0,035714286	0,0625	0,08523	0,2275592	0,056889801
Alternative Therapy	0,661764706	0,535714286	0,4375	0,59659	2,2315699	0,557892475

Table 6c. Addition Matrix for Each Row

Cost	Treatment Hormone	Operation Laparoscopy	Operation Laparotomy	Therapy Alternative	Amount
Treatment Hormone	0,263345111	0,365617838	0,284449007	0,185964158	1,099376114
Operation Laparoscopy	0,087781704	0,121872613	0,170669404	0,111578495	0,491902215
Operation Laparotomy	0,052669022	0,040624204	0,056889801	0,079698925	0,229881953
Alternative Therapy	0,790035332	0,609363063	3,905247326	0,557892475	5,862538197

Table 6d. Calculation Results of the Number of Each Criteria Times the Priority of Each Criteria

Criteria	Amount	Priority	Results
Hormone Treatment	4,533333333	0,263345111	1,193831169
Laparoscopic Surgery	9,333333333	0,121872613	1,137477718
Laparotomy Surgery	16	0,056889801	0,910236822
Alternative Therapy	1,676190476	0,557892475	0,935134054

Table 6e. Calculating the Consistency Ratio

λ*Max*	4,176679763
CI=	0,058893254
CR=CI/IR	0,065436949

The value of λ Max is obtained from the sum of all columns in Table 6d. The **CI** value is obtained from the value (λ Max − number of criteria) / (number of criteria – 1), in this case (4.176679763– 4) / (4-1). Then the **CR** value is obtained from the **CI/IR** value where **IR** is the Index Ratio, and the index ratio value has already been determined. Because there are 4 criteria, the index ratio value is 0.9. In this case, 0.058893254/0.9.

4. CONCLUSION

The conclusion of this article shows that the Analytic Hierarchy Process (AHP) method is effective in evaluating ovarian cyst treatment based on the criteria of recovery time and cost. The calculation results show that the consistency ratio (**CR**) for the pairwise comparison matrix is below the specified limit (≤ 0.1), with a **CR** value for recovery time of 0.133003093 and for costs of 0.065436949, which indicates consistency in assessment. Alternative therapies have the highest priority in terms of recovery time, while hormone treatments are superior in terms of cost. These findings provide insight for health practitioners in selecting appropriate treatment methods and recommend further research to explore other factors that influence treatment decisions. Overall, this article confirms the importance of a systematic approach in medical decision making and shows how AHP can improve the quality of decisions in the treatment of ovarian cysts.

5. REFERENCES

[1] A. Y. ,. A. R. Archana Singh. 2013. K-means with Three different Distance Metrics, International Journal of Computer Applications, vol. 67, no. 10.

[2] Badan Pusat Statistik Republik Indonesia. 2010. Sensus Penduduk 2010. Sumatera Utara: Badan Pusat Statsitik Provinsi Sumatera Utara

[3] D. A. K. G. Dibya Jyoti Bora. 2014. Effect of Different Distance Measures on the Performance of K-Means Algorithm: An Experimental Study in Matlab, International journal of computer science and 108 information technologies, vol. 5, no. 2, pp. 2501-2506.

[4] Ghozali, Imam. 2009. Aplikasi Analisis Multivariate dengan Program SPS. Semarang:UNDIP.

[5] Johnson, R.A., dan Wichern, D.W., 2007. Applied Multivariate Statistical Analysis. 6th edition. pearson Education Inc United States of America.

[6] Madhulatha, T.S. 2012. An Overview On Clustering Methods. IOSR Journal of Engineering, II(4), pp.719-25.

[7] Nugroho, S. 2008. Pengantar Statistika Matematika, Edisi Pertama. UNIB Press

[8] Rencher, Alvin C,. 2002. Method of Multivariate Analysis. Canada: Simultaneously.

[9] Rivani, E,. 2010. Aplikasi K-Means Cluster Untuk Pengelompokan Provinsi Berdasarkan Produksi Padi, Jagung, Kedelai, dan Kacang Hijau Tahun 2009. Jurnal Mat Stat.

[10] Supranto, Johanes. 2004. Analisis Multivariat Arti Dan Interpretasi. Rineka Cipta: Jakarta.