J Surg Med. 2026;10(8):e8501.
https://doi.org/10.28982/josam.8501

Research Article
https://jsurgmed.com/

JOSAM
Journal of Surgery and Medicine
e-ISSN: 2602-2079

A multicenter cost-effectiveness analysis of endovascular versus open surgical repair for abdominal aortic aneurysm

Derya Engin[1], İsmail Ağırbaş[2], Atilla Aral[3]

[1] Hacettepe University Hospitals, Cost Accounting Unit, Ankara, Türkiye
[2] Ankara University, Faculty of Health Sciences, Department of Healthcare Management, Ankara, Türkiye
[3] Ankara University, Faculty of Medicine, Department of Cardiovascular Surgery, Ankara, Türkiye

ORCID of the author(s)

DE: https://orcid.org/0000-0002-2837-7550
İA: https://orcid.org/0000-0002-1664-5159
AA: https://orcid.org/0000-0001-7924-2819

Abstract

Background/Aim: Abdominal aortic aneurysm carries substantial clinical and economic consequences, and the long-term economic value of the available repair strategies remains important for reimbursement decisions. This study evaluated the cost-effectiveness of endovascular aneurysm repair (EVAR) and open surgical repair (OSR) for abdominal aortic aneurysm using actual hospital invoice data.

Methods: This retrospective multicenter study included 509 patients treated with EVAR or OSR at Ankara University and Hacettepe University Hospitals between 2011 and 2020. Cost data were derived from actual hospital invoices. Quality of life was assessed using the EQ-5D-3L questionnaire, HeartQoL, and a visual analog scale. Cost-effectiveness was evaluated using a Markov model, and a budget impact analysis was performed.

Results: The 1-year total cost was 58,732.38 TL ($8,386.24) for EVAR and 15,638.25 TL ($2,232.95) for OSR, while the corresponding lifetime costs were 132,726.00 TL ($18,951.65) and 21,906.23 TL ($3,127.94), respectively. The cost per quality-adjusted life-year (QALY) was 52,460.87 TL ($7,490.77) for EVAR and 13,777.50 TL ($1,967.26) for OSR. The incremental cost-effectiveness ratio was 118,892 TL ($16,976.33) per QALY gained, below the threshold of 181,611.00 TL ($25,931.83).

Conclusion: EVAR was a cost-effective alternative to OSR within the threshold used in this analysis.

Keywords: abdominal aortic aneurysm, cost-effectiveness analysis, health economics, quality of life

Corresponding Author
Derya Engin
Hacettepe University Hospitals, Cost Accounting Unit, Ankara, Türkiye
E-mail: deren79@gmail.com

Ethics Committee Approval
The study was approved by the Hacettepe University Non-Interventional Clinical Research Ethics Committee on September 7, 2021 (GO 21/899).
All research procedures were conducted in accordance with the Declaration of Helsinki.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2026 August 5

How to cite: Engin D, Ağırbaş İ, Aral A. A multicenter cost-effectiveness analysis of endovascular versus open surgical repair for abdominal aortic aneurysm. J Surg Med. 2026;10(8):e8501.

Introduction

Cardiovascular diseases, including coronary heart disease and stroke, are leading causes of noncommunicable mortality worldwide and impose a substantial clinical and economic burden on patients and society [1, 2]. Within this spectrum, aortic aneurysms, defined as permanent localized arterial dilatation of 50% or more and usually exceeding 30 mm, carry a high risk of mortality if left untreated [3]. Abdominal aortic aneurysm (AAA), the most common aortic pathology, becomes more frequent with advancing age and remains asymptomatic in approximately 75% of cases until complications such as rupture or embolization occur [4].

Although endovascular aneurysm repair (EVAR) and open surgical repair (OSR) are established treatment modalities, evidence regarding their relative long-term economic impact on reimbursement agencies remains limited in the context of current healthcare expenditures. This study aimed to address this gap by evaluating the cost-effectiveness of EVAR and OSR from the perspective of the reimbursement agency and to provide evidence that may inform healthcare decision-makers.

Materials and methods

Study design and cost data

A comparative cost-effectiveness analysis was performed to determine the relative cost-effectiveness of EVAR and OSR for the treatment of AAA. A budget impact analysis was also conducted to estimate the burden of these treatment methods on the national budget.

The unit prices of health resources used in the model were obtained from the Ministry of Health Drug Price List and the Social Security Institution Health Implementation Communiqué. Cost data for both treatment methods were derived from patient invoices obtained from the hospital databases. Treatment costs were classified as surgery, anesthesia, blood products, medications, examinations, laboratory services, supplies, medical imaging, hospital beds, and other services. Costs were analyzed from the reimbursement agency perspective using actual hospital invoice data.

One-year follow-up costs after discharge were determined by analyzing invoice amounts from outpatient visits to the relevant departments. The unit costs of drugs used after discharge were calculated from the current price list of the Turkish Medicines and Medical Devices Agency. Public discount rates were applied, and 1 euro was accepted as 3,815.5 TL [5].

Quality-of-life assessment

Two scales were used to determine the health-related quality of life of treated patients. The first was the EQ-5D-3L scale developed by the EuroQol Group [6]. The Turkish version of the scale was administered by telephone interview, and German EQ-5D-3L utility weights were used in the base-case analysis. The second was the HeartQoL scale, which was developed for cardiac disorders and consists of 14 questions. A visual analog scale was also administered by telephone to assess the patients' health status.

Because comparative cost-effectiveness analyses require balanced baseline disease severity, the Charlson Comorbidity Index was used to evaluate pretreatment comorbidity burden. The Charlson Comorbidity Index, developed by Charlson et al. [7], is a widely used clinical scoring system that estimates prognosis according to patients' comorbidities.

Modeling and budget impact analysis

A Markov model was developed to calculate the cost-effectiveness ratio using the cost and effectiveness data obtained. For modeling purposes, study data were used as inputs for a hypothetical cohort of 1,000 patients, and lifetime health-state transitions were derived from a literature review. The health states specified in the model and the transitions between these states were simulated separately for EVAR- and OSR-treated patients in 1-month cycles over a lifetime horizon. A 3% discount rate was applied after the first year. The incremental cost-effectiveness ratio (ICER) was calculated and compared with a threshold of three times gross domestic product (GDP) per capita. One-way sensitivity analyses were then performed, and the impact of both treatment modalities on the national budget was analyzed.

The AAA patient population in Türkiye was used as the basis for the budget impact analysis. The prevalence of AAA in the general population was obtained from the study by Sampson et al. [8]. In 2010, the global age-specific prevalence per 100,000 individuals was reported as 9,506.84 among people aged 25 years or older, whereas the incidence was reported as 850.70. According to the Turkish Statistical Institute (TurkStat), the population of Türkiye in 2020 was 83,614,362, including 53,614,362 individuals aged 25 years or older [9]. Based on these data, the target population was calculated as 5,097,031.61 individuals according to prevalence and 456,097.38 individuals according to incidence.

Treatment for AAA is recommended only for individuals with an aortic diameter of 5.5 cm or greater. To estimate the proportion of the target population eligible for treatment, the probability of an aortic diameter of 5.5 cm or greater (8.11%), as reported by Lederle et al. [10], was used. Accordingly, the budget impact analysis assumed that 8.11% of the target population would undergo treatment.

Statistical analysis

SPSS Version 22.0 was used for all statistical analyses. Descriptive data are presented as number (%), mean (SD), or median, as appropriate. Independent samples t-test and Mann-Whitney U test were used for continuous variables, while the Chi-square test was used for categorical variables. All statistical tests were two-sided, and the significance threshold was set at $P < 0.05$. Patients with missing data were excluded from the analysis due to the high volume of incomplete records.

Cost-effectiveness outcomes were estimated using the Markov model described above, with 1-month cycles over a lifetime horizon. Costs and outcomes beyond the first year were discounted at 3%. The ICER was compared with a threshold of three times GDP per capita, and one-way sensitivity analyses were performed to evaluate model robustness.

Ethics

Ethical approval was obtained from the Hacettepe University Non-Interventional Clinical Research Ethics Committee on September 7, 2021 (GO 21/899). The study was conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from all participants before direct patient contact for the questionnaire assessment.

Results

Of the 509 patients included in the study, 89.2% were male and 10.8% were female. Patients younger than 65 years accounted for 15.1% of the cohort, while 84.9% were aged 65 years or older. Regarding length of hospitalization, 62.9% of patients were hospitalized for fewer than 10 days and 37.1% for 10 days or longer. Patients treated with EVAR constituted 87.2% of the study group (n = 444), whereas those treated with OSR constituted 12.8% (n = 65). In this two-center study, 70.3% of patients were treated at Ankara University Hospital and 29.7% at Hacettepe University Hospital. The descriptive findings are presented in Table 1.

Effectiveness of treatment methods

In this study, 112 patients treated with EVAR and 35 patients treated with OSR were contacted, and 147 patients completed the questionnaires. The visual analog scale and HeartQoL scale were also administered. Using German weights, the mean QALY value was 0.90 (0.20) in the EVAR group and 0.80 (0.34) in the OSR group. The visual analog scale score ranged from 10 to 100 in the EVAR group, with a mean of 70.49 (16.94), and from 20 to 100 in the OSR group, with a mean of 60.28 (19.92). The mean HeartQoL score was 30.75 (10.59) in the EVAR group and 27.62 (12.57) in the OSR group. Patients in the EVAR group had significantly higher QALY values than those in the OSR group ($P = 0.035$). The visual analog scale score was also significantly higher in the EVAR group ($P = 0.005$), whereas the difference in HeartQoL score was not statistically significant ($P = 0.236$). The quality-of-life findings are presented in Table 2.

Costs

Table 3 presents the cost distribution of EVAR and OSR by expense type. The mean invoice cost for EVAR was 57,891.48 TL ($8,266.20), with medical materials accounting for the largest share at 84.44% (48,884.83 TL/$6,980.16). Medical imaging (5.56%) and medications (3.73%) were the next largest expense categories. In contrast, the mean invoice cost for OSR was substantially lower at 15,253.34 TL ($2,177.99). Unlike EVAR, OSR costs were distributed more evenly among medical materials (26.53%), surgery (21.26%), medications (17.60%), and blood products (14.49%).

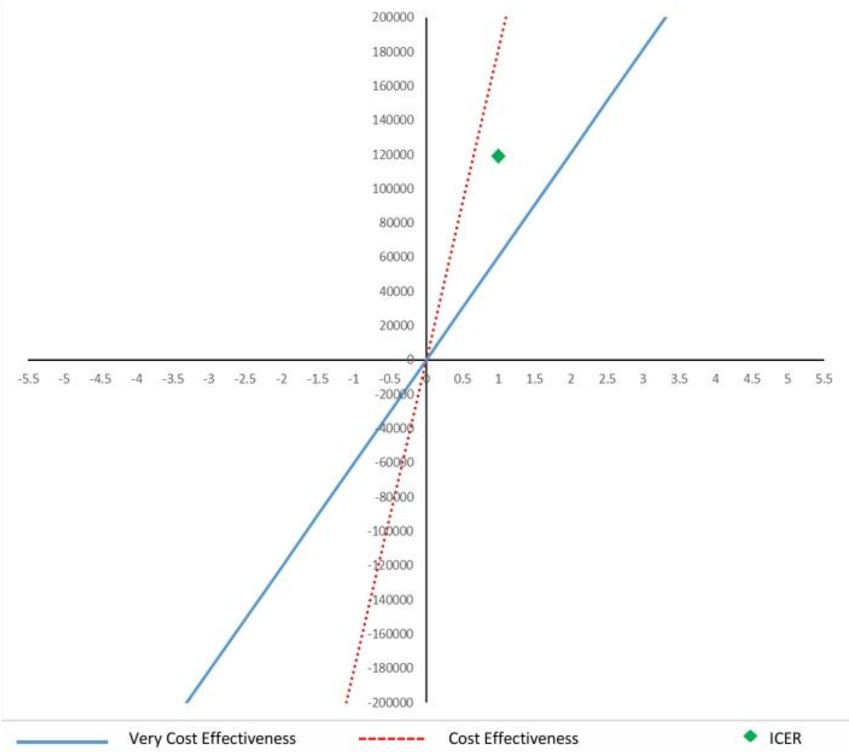
A marked difference was observed in blood-related expenses, which accounted for 0.74% of EVAR costs compared with 14.49% of OSR costs. Post-discharge outpatient expenses were 490.70 TL ($70.06) for EVAR and 189.45 TL ($27.05) for OSR. These findings indicate that the primary driver of the cost difference between the two methods was the high price of the stent-grafts used in EVAR.

The drug cost per patient after EVAR was 350.20 TL ($50.00), compared with 195.46 TL ($27.91) after OSR. When drug costs were added to outpatient clinic costs, the 1-year follow-up cost was 840.90 TL ($120.07) for EVAR and 384.91 TL ($54.96) for OSR. When these follow-up costs were added to the initial treatment costs, the 1-year total cost was 58,732.38 TL ($8,386.24) for EVAR and 15,638.25 TL ($2,232.95) for OSR. In the Markov model, the median costs used as inputs for patients in the good-health state were 49,760.48 TL ($7,105.18) for EVAR and 11,580.56 TL ($1,653.56) for OSR.

Cost-effectiveness analysis

In the cost-effectiveness analysis, the Markov model showed that the EVAR group remained in the model longer than the OSR group (279 vs 192 months), primarily because of lower mortality. Consequently, EVAR provided greater clinical effectiveness in terms of both life-years (2.84 vs 1.98) and QALYs (2.53 vs 1.59). Although EVAR provided better quality of life, its substantial lifetime cost resulted in a higher cost per QALY than OSR. The ICER was 118,892 TL per QALY gained, as detailed in Table 4.

Figure 1. Representation of the ICER on the cost-effectiveness plane.



ICER: Incremental cost-effectiveness ratio.

Table 1. Descriptive findings of the study group

Category	Variable	Number	Percentage
Gender	Male	454	89.2
	Female	55	10.8
Age	<65 years	77	15.1
	≥65 years	432	84.9
Hospitalization duration	<10 days	320	62.9
	≥10 days	189	37.1
Treatment type	Endovascular aneurysm repair	444	87.2
	Open surgical repair	65	12.8
Hospital	Ankara University Hospital	358	70.3
	Hacettepe University Hospital	151	29.7

Table 2. Quality of life of patients undergoing EVAR and OSR

Outcome	EVAR min	EVAR max	EVAR mean (SD)	OSR min	OSR max	OSR mean (SD)	*P* value
EQ-5D-3L Utility Score (Germany)	-0.21	1	0.90 (0.20)	-0.21	1	0.80 (0.34)	0.035
VAS score	10	100	70.49 (16.94)	20	100	60.28 (19.92)	0.005
HeartQoL	1	42	30.75 (10.59)	4	42	27.62 (12.57)	0.236

EVAR: Endovascular aneurysm repair, OSR: Open surgical repair, QALY: Quality-adjusted life-year, VAS: Visual analog scale. *P < 0.05 was considered statistically significant.

Table 3. Mean costs of EVAR and OSR methods

Expense type	EVAR (TL)	EVAR ($)	EVAR share (%)	OSR (TL)	OSR ($)	OSR share (%)
Operation	393.34	56.16	0.68	3,243.41	463.12	21.26
Anesthesia	529.96	75.67	0.92	874.98	124.94	5.74
Medicine	2,160.23	308.45	3.73	2,684.00	383.24	17.60
Blood	426.62	60.92	0.74	2,210.58	315.64	14.49
Laboratory	1,238.45	176.84	2.14	565.31	80.72	3.71
Material	48,884.83	6,980.16	84.44	4,046.94	577.85	26.53
Examination	31.58	4.51	0.05	42.34	6.05	0.28
Medical imaging	3,216.05	459.21	5.56	247.48	35.34	1.62
Bed	495.70	70.78	0.86	825.50	117.87	5.41
Other	514.72	73.50	0.89	512.77	73.22	3.36
Total	57,891.48	8,266.20	100	15,253.34	2,177.99	100

Table 4. Cost-effectiveness analysis results

Treatment	Total cost (TL)	Life-years	Clinical effectiveness (QALY)	Additional cost (TL)	Additional effectiveness (life-years)	Additional effectiveness (QALYs)	ICER per life-year	ICER per QALY
EVAR	132,726.00	2.84	2.53	110,819.76	0.86	0.93	129,180	118,892
OSR	21,906.23	1.98	1.59	-	-	-	-	-

EVAR: Endovascular aneurysm repair, OSR: Open surgical repair, QALY: Quality-adjusted life-year, ICER: Incremental cost-effectiveness ratio.

Table 5. One-way sensitivity analysis results

Variable	Exchange	ICER (TL/QALY)
EVAR treatment cost	When it decreases by 10%	105,231.64
EVAR treatment cost	When it decreases by 20%	91,571.65
EVAR treatment cost	When it decreases by 30%	77,911.66
EVAR treatment cost	When it decreases by 40%	64,251.67
Cost calculations	When calculated based on averages	136,458.82
Discount rate	When 0% is used	114,530.88
Discount rate	When 6% is used	122,979.19
Efficacy data	When the Netherlands weights are used	116,998.07
Efficacy data	When the United States weights are used	114,209.25

EVAR: Endovascular aneurysm repair, QALY: Quality-adjusted life-year, ICER: Incremental cost-effectiveness ratio.

Table 6. Budget impact analysis findings

Variable	Endovascular aneurysm repair	Open surgical repair
Number of patients	413,369.26	413,369.26
Average cost (TL)	57,891.48 TL	15,253.34 TL
Average cost ($)	8,266.20 $	2,177.99 $
Total cost (TL)	23,930,558,454.64 TL	6,305,261,922.80 TL
Total cost ($)	3,416,993,006.53 $	900,314,122.37 $
Spending difference between methods (2020)	17,625,296,531.84 TL ($2,516,677,292.72)	17,625,296,531.84 TL ($2,516,677,292.72)

TL: Turkish lira.

To determine whether EVAR was cost-effective, the ICER was compared with the prespecified threshold of three times GDP per capita. According to TurkStat, GDP per capita in 2020 was 60,537.00 TL ($8,643.94) [11]. Therefore, three times GDP per capita, 181,611.00 TL ($25,931.83), was used as the cost-effectiveness threshold. Because the ICER remained below this threshold, EVAR was considered cost-effective. The results are presented on the cost-effectiveness plane in Figure 1.

One-way sensitivity analysis

One-way sensitivity analyses were performed to examine the robustness of the EVAR findings under changes in treatment cost, the use of mean rather than median costs, different discount rates, and the use of country-specific quality-of-life weights from the United States and the Netherlands instead of German weights.

As the cost of EVAR decreased, the ICER also decreased and approached the very cost-effective threshold of 60,537.00 TL ($8,643.94). When mean costs were used instead of median values, the ICER increased but remained below the cost-effectiveness threshold of 181,611.00 TL ($25,931.83). Across all one-way sensitivity analyses, the ICER ranged from 64,251.67 TL ($9,174.35) to 136,458.82 TL ($19,484.65), remaining below the threshold in every scenario. These findings are presented in Table 5.

Budget impact analysis

In 2020, the target population for AAA was calculated as 5,097,031.61 individuals according to prevalence. Assuming that 8.11% of the target population would undergo treatment, treating all patients with EVAR would cost 23,930,558,454.64 TL ($3,416,993,006.53), whereas treating all patients with OSR would cost 6,305,261,922.80 TL ($900,314,797.73). The difference in expenditure between the two methods was 17,625,296,531.84 TL ($2,516,678,208.81). These data are presented in Table 6.

Discussion

Until 1991, open conventional surgery was the only available method for aortic aneurysm repair. In 1991, Parodi et al. [12] first performed endovascular repair in high-risk patients. With advances in interventional radiology, the number of open surgical procedures performed for AAA has decreased, whereas the use of endovascular procedures has increased in Türkiye, as in the rest of the world. In the present study, 87% of 509 patients were treated with EVAR and 13% with OSR.

The mean initial hospital invoice cost was 57,891.48 TL ($8,266.20) for EVAR and 15,253.34 TL ($2,177.99) for OSR. After 1-year follow-up costs were included, the corresponding total costs were 58,732.38 TL ($8,386.24) and 15,638.25 TL ($2,232.95). The lifetime costs were 132,726.00 TL ($18,951.65) for EVAR and 21,906.23 TL ($3,127.94) for OSR. Material costs accounted for the largest share of total EVAR expenditure, reaching 48,884.83 TL ($6,980.16).

Patients treated with EVAR had a shorter hospital stay than those treated with OSR. This finding is clinically plausible because EVAR requires a smaller incision and causes less tissue trauma than conventional open surgery. In addition, the EVAR group had better QALY and visual analog scale results, whereas HeartQoL scores were only modestly higher and did not differ significantly.

The Charlson Comorbidity Index indicated that the pretreatment comorbidity burden was similar between the two groups. This supports the comparability of the groups in terms of baseline disease severity and strengthens the interpretation of the observed differences in quality-of-life and cost outcomes.

The international literature includes several studies evaluating the cost-effectiveness of EVAR and OSR. Early analyses by Patel et al. and Bosch et al. supported EVAR as a clinically effective and cost-effective alternative to OSR, emphasizing its less invasive nature and favorable quality-adjusted survival [13, 14]. However, later long-term economic evaluations produced more complex findings.

Epstein et al. highlighted considerable uncertainty regarding the long-term cost-effectiveness of EVAR, whereas Stroupe et al. reported better early survival despite initial cost differences [15, 16]. Burgers et al. further suggested that the high graft cost of EVAR could be partly offset by shorter hospital stays [17]. In the present study, however, EVAR treatment costs remained clearly higher than OSR costs, and nearly 85% of total EVAR expenditure was attributable to material costs. This difference likely reflects institutional cost structures and the reimbursement perspective used in the analysis.

Long-term evidence also suggests that the early survival and morbidity advantages of EVAR may diminish over time. Lederle et al. reported no significant difference in survival or quality of life after 9 years of follow-up, as costs often converged because of continued surveillance and secondary interventions in the EVAR group [18]. In younger patient populations, OSR has also been reported to be more cost-effective, underscoring the importance of patient age and long-term monitoring costs [19]. More recent evidence, including the systematic review by Nargesi et al. and the large-scale study by Yei et al., indicates that although EVAR provides important early benefits, late complications and reinterventions remain major barriers to long-term cost-effectiveness [20, 21].

Taken together, the available literature shows that the economic profile of EVAR depends strongly on perspective, follow-up duration, and local cost structure. In the present study, EVAR was cost-effective over a lifetime horizon using hospital-based evidence. Moreover, one-way sensitivity analyses consistently kept EVAR below the national threshold, supporting the robustness of the main finding.

However, the budget impact analysis revealed a substantial difference of more than 17.6 billion TL between universal EVAR adoption and universal OSR adoption. This gap was driven primarily by the high cost of stent-grafts, which represented nearly 85% of EVAR expenditure. Therefore, although EVAR appeared cost-effective for suitable candidates, strategic price negotiations for medical materials and careful patient selection remain essential for the long-term sustainability of the reimbursement system.

The ultimate goal of endovascular aneurysm treatment is to reduce mortality, morbidity, and hospital stay compared with standard surgical treatment. Although studies, including the present analysis, suggest that EVAR shortens hospitalization and reduces blood-related resource use, the cost of new-generation endovascular stent-grafts remains high. Because these costs vary substantially among countries and healthcare systems, direct one-to-one comparisons between settings should be interpreted cautiously.

Limitations

Although this study was based on multicenter data, the findings reflect hospital-level costs and may not be generalizable to all healthcare settings. In addition, quality-of-life data were obtained from a subset of patients. Nevertheless, the use of real-world data and a long-term modeling approach provides valuable insight into both clinical and economic outcomes.

References

1. Ferrari AJ, Santomauro DF, Aali A, Abate YH, Abbafati C, Abbastabar H, et al. Global incidence, prevalence, years lived with disability (YLDs), disability-adjusted life-years (DALYs), and healthy life expectancy (HALE) for 371 diseases and injuries in 204 countries and territories and 811 subnational locations, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. Lancet. 2024;403(10440):2133-61. doi: 10.1016/S0140-6736(24)00757-8.
2. Wiethoff I, Evers SMAA, Michels M, Hiligsmann M. An introduction to health technology assessment and health economic evaluation: an online self-learning course. Neth Heart J. 2023;31(6):219-25. doi: 10.1007/s12471-023-01777-0.
3. Zettervall SL, Schanzer A. ESVS 2024 clinical practice guidelines on the management of abdominal aorto-iliac artery aneurysms: a North American perspective. Eur J Vasc Endovasc Surg. 2024;67(2):187-9. doi: 10.1016/j.ejvs.2023.10.036.
4. Turkish Society of Cardiovascular Surgery. Diagnosis and treatment guide in aortic surgery. Ankara: Güneş Tıp Kitabevleri; 2008. Available from: tkdcd.org.
5. Turkish Medicines and Medical Devices Agency. Reference-based drug price list [Internet]. Ankara: TITCK; 2021 [cited 2024 May 20]. Available from: https://www.titck.gov.tr.
6. EuroQol Group. EQ-5D-3L valuation [Internet]. Rotterdam: EuroQol Office; 2023 [cited 2024 May 20]. Available from: https://euroqol.org.
7. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method for classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;40(5):373-83. doi: 10.1016/0021-9681(87)90171-8.
8. Sampson UK, Norman PE, Fowkes FGR, Aboyans V, Song Y, Harrell FE Jr, et al. Estimation of global and regional incidence and prevalence of abdominal aortic aneurysms, 1990 to 2010. Glob Heart. 2014;9(1):159-70. doi: 10.1016/j.gheart.2013.12.009.
9. Turkish Statistical Institute (TurkStat). Turkey statistics, 2020 [Internet]. Ankara: TurkStat; 2021 [cited 2024 May 20]. Available from: https://tuik.gov.tr.

10. Lederle FA, Johnson GR, Wilson SE, Chute EP, Hye RJ, Makaroun MS, et al. The aneurysm detection and management study screening program: validation cohort and final results. Arch Intern Med. 2000;160(10):1425-30. doi: 10.1001/archinte.160.10.1425.
11. Turkish Statistical Institute (TurkStat). Quarterly gross domestic product, quarter I: January-March 2021 [Internet]. Ankara: TurkStat News Bulletin; 2021 [cited 2024 May 20]. Available from: https://tuik.gov.tr.
12. Parodi JC, Palmaz JC, Barone HD. Transfemoral intraluminal graft implantation for abdominal aortic aneurysms. Ann Vasc Surg. 1991;5(6):491-9. doi: 10.1007/BF02015271.
13. Patel ST, Haser PB, Bush HL Jr, Kent KC. The cost-effectiveness of endovascular repair versus open surgical repair of abdominal aortic aneurysms: a decision analysis model. J Vasc Surg. 1999;29(6):958-72. doi: 10.1016/S0741-5214(99)70237-5.
14. Bosch JL, Kaufman JA, Beinfeld MT, Adriaensen ME, Brewster DC, Gazelle GS. Abdominal aortic aneurysms: cost-effectiveness of elective endovascular and open surgical repair. Radiology. 2002;225(2):337-44. doi: 10.1148/radiol.2252011687.
15. Epstein DM, Sculpher MJ, Manca A, Michaels J, Thompson SG, Brown LC, et al. Modelling the long-term cost-effectiveness of endovascular or open repair for abdominal aortic aneurysm. Br J Surg. 2008;95(2):183-90. doi: 10.1002/bjs.5911.
16. Stroupe KT, Lederle FA, Matsumura JS, Kyriakides TC, Jonk YC, Ge L, et al. Cost-effectiveness of open versus endovascular repair of abdominal aortic aneurysm in the OVER trial. J Vasc Surg. 2012;56(4):901-9.e2. doi: 10.1016/j.jvs.2012.01.086.
17. Burgers LT, Vahl AC, Severens JL, Wiersema AM, Cuypers PWM, Verhagen HJM, et al. Cost-effectiveness of elective endovascular aneurysm repair versus open surgical repair of abdominal aortic aneurysms. Eur J Vasc Endovasc Surg. 2016;52(1):29-40. doi: 10.1016/j.ejvs.2016.03.001.
18. Lederle FA, Stroupe KT, Kyriakides TC, Ge L, Freischlag JA; Open vs Endovascular Repair (OVER) Veterans Affairs Cooperative Study Group. Long-term cost-effectiveness in the Veterans Affairs Open vs Endovascular Repair Study of aortic abdominal aneurysm: a randomized clinical trial. JAMA Surg. 2016;151(12):1139-44. doi: 10.1001/jamasurg.2016.2783.
19. Byun E, Kwon TW, Kim H, Cho YP, Han Y, Ko GY, et al. Quality-adjusted life year comparison at medium-term follow-up of endovascular versus open surgical repair for abdominal aortic aneurysm in young patients. PLoS One. 2021;16(12):e0260690. doi: 10.1371/journal.pone.0260690.
20. Nargesi S, Abutorabi A, Alipour V, Tajdini M, Salimi J. Cost-effectiveness of endovascular versus open repair of abdominal aortic aneurysm: a systematic review. Cardiovasc Drugs Ther. 2021;35(4):829-39. doi: 10.1007/s10557-020-07130-6.
21. Yei K, Mathlouthi A, Naazie I, Elsayed N, Clary B, Malas M. Long-term outcomes associated with open vs endovascular abdominal aortic aneurysm repair in a Medicare-matched database. JAMA Netw Open. 2022;5(5):e2212081. doi: 10.1001/jamanetworkopen.2022.12081.