Costs and Cost-Effectiveness of Robotic-Assisted Surgery in Korea: A Systematic Review and Meta-Analysis

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OBJECTIVE

- In this study, we conducted a systematic review of cost and costeffectiveness studies on robotic-assisted surgery (RAS) in Korea, published over the two decades since RAS was introduced.
- Our objective is to provide relevant stakeholders with the most updated RAS economic evidence to highlight key knowledge gaps, and identify priority areas for future efforts, including real-world data collection methodological improvements, and policy engagements.

METHODS

1. Search Strategy

- We searched Pubmed, Embase and Scopus to identify cost or costeffectiveness literature of RAS in Korea. The search period spanned from January 1, 2007, to May 8, 2025.
- The search terms we applied for the three databases were: "cost* OR economic* OR financial* OR pric* OR charge* OR billing*) AND (Korea) AND ("robot surgery" OR "robot-assisted*" OR "robotic surgery" OR "robotic-assisted*")".

2. Study selection (PICOs)

- Participants: Patients who had benign or malignant tumors
- Intervention: Robotic-assisted surgery
- Comparators: Open surgery or laparoscopic surgery or endoscopic surgery or video-assisted thoracotomy (VATS)
- Outcomes: Economic outcomes (i.e. total hospitalization cost, operation cost or patient out-of-pocket payment);
- Study design: Observational, cohort or randomized trials

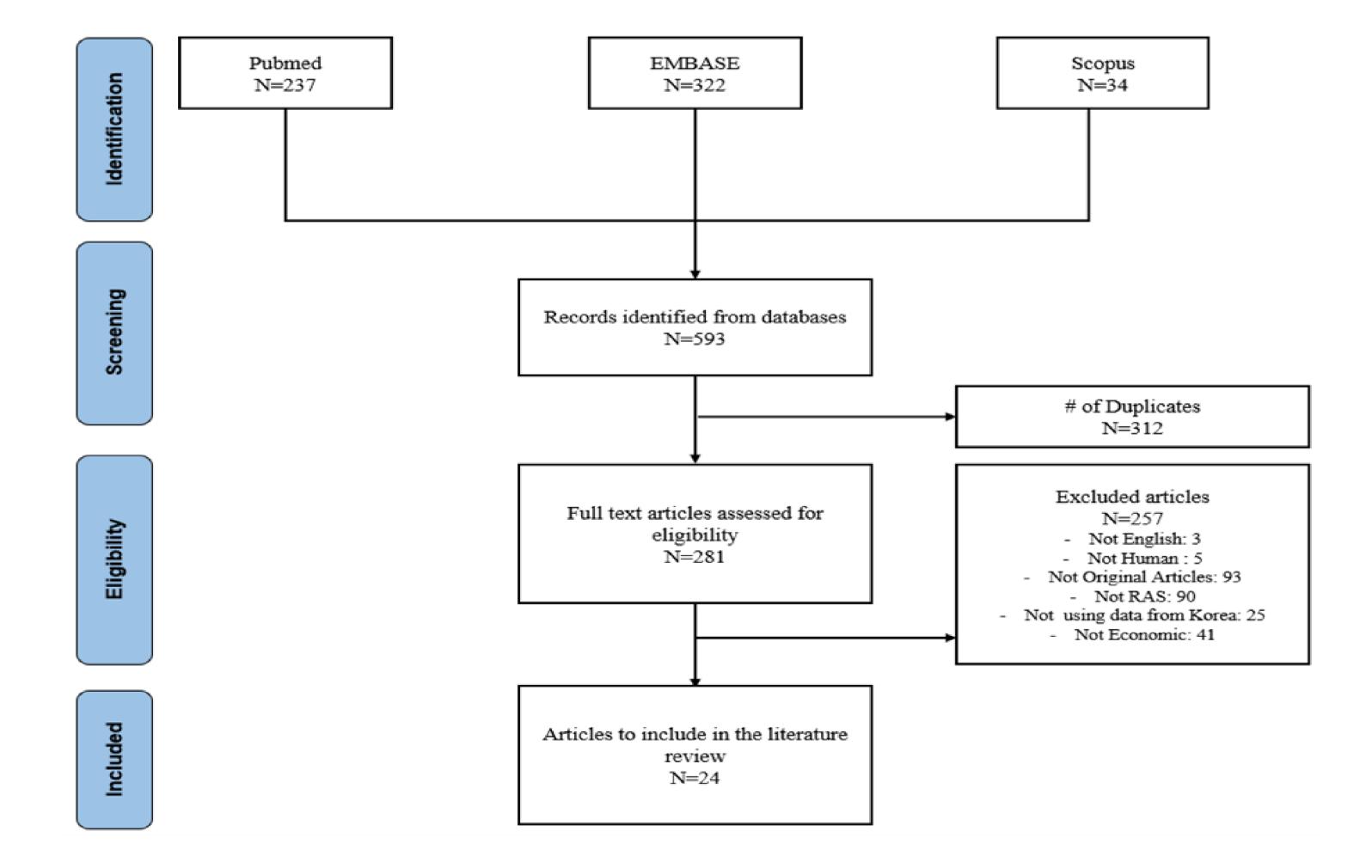
3. Statistical Analysis

• Meta analysis was conducted using Restricted Maximum-Likelihood (REML) random effect model. The analysis was performed with Review Manager (Revman). To assess potential publication bias, funnel plots were generated, and Egger's regression test was conducted.

RESULTS

• A total of 593 publications were identified in the initial search. After removing 312 duplicates and 257 articles that didn't meet PICO criteria, 24 publications were included in this review.

Figure 1. PRISMA Flow Chart



• A total of 7 different surgical specialties were covered. The most frequently represented specialty was colorectal surgery (N=6) followed by Hepato-Biliary Pancreatic (HBP) surgery (N=5), gynecology (N=4), endocrine surgery (N=3), urology (N=3), gastrointestinal surgery (N=2) and thoracic surgery (N=1)

- The pooled mean differences in total hospitalization cost and operation cost were \$3,279 [CI \$2,414-4,145], and \$3,359 [CI \$1,771-4,946], respectively, higher for RAS compared to other Minimally Invasive Surgeries (MIS).
- The pooled analysis shows that OOP for RAS was \$5,701[CI \$4,613-\$6,790] higher, while the government payment was \$2,671[CI \$2,083-\$3,259] lower compared to other MIS.

Figure 2. Forest plot

	RAS			Laparoscopic				Mean difference	Mean difference			
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Randor	n, 95% CI		
4.1.1 Patient Payment (Out of Pocket)												
Baek 2012	11540	2263	154	3956	1170	150	10.9%	7584.00 [7180.51 , 7987.49	9]	•		
Hyun 2025	7221	684	170	1170	492	197	11.1%	6051.00 [5927.34 , 6174.66	5]			
Kang 2016	8788	2013	20	4394	1634	43	9.9%	4394.00 [3385.62 , 5402.38	3]	-		
Kim 2015	12613.1	2002.7	234	5104	1903.3	234	11.0%	7509.10 [7155.10 , 7863.10	0]	•		
Kim 2016	11535.75	14910.41	223	3691.67	3756.55	211	7.3%	7844.08 [5822.53 , 9865.63	3]			
Park 2012a	8713.8	3341.9	35	5109.7	941.6	35	9.6%	3604.10 [2453.84 , 4754.36	5]	-		
Park 2012b	6003.91	47.31	20	475.26	411.2	20	11.1%	5528.65 [5347.25 , 5710.06	5]			
Park 2015	10029.4	2581.4	133	4285.2	1255.1	84	10.8%	5744.20 [5229.90 , 6258.50	0]	+		
Yoon 2021	6578	1081	16	2626	632	23	10.7%	3952.00 [3362.70 , 4541.30)	-		
Yoon 2024	10322.05	6589.12	95	5551.23	9720.79	174	7.5%	4770.82 [2810.77 , 6730.87	n l	-		
Subtotal (HKSJ ^a)			1100			1171	100.0%	5701.22 [4612.84, 6789.61	ij	•		
Test for overall effect:	T = 11.85, dt	f = 9 (P < 0.	00001)							_		
Heterogeneity: Tau ^a (F	REMLb) = 20	48142.35; (Chi² = 234	1.06, df = 9	9 (P < 0.00	0001); l² =	98%					
Total (HKSJa)			1100			1171	100.0%	5701.22 [4612.84 , 6789.61	1	•		
Test for overall effect:	T = 11.85, df	f = 9 (P < 0.	00001)						-10000 -5000 0	5000 10000		
Test for subgroup differences: Not applicable								Favours [RAS]	Favours [Laparosco			
Heterogeneity: Tau ² (F	REMLb) = 20	48142.35: 0	chi² = 234	.06. df = 9	9 (P < 0.00	0001): I² =	98%			•		

(a) Total Hospitalization Cost

		RAS		Laparoscopic				Mean difference	Mean difference	
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Rand	iom, 95% CI
3.1.1 Operation Cost										
Baek 2012	8849	1583	154	5620	942.7	150	14.4%	3229.00 [2936.99 , 3521.01	1	
Choi 2021	7330.54	462.84	502	854.15	361.04	531	14.5%	6476.39 [6425.57, 6527.21]	
Choi 2022	5288.5	0	24	441.5	136.8	32		Not estimable	e	
Kang 2011	5752.6	380.5	20	2222.1	627.5	25	14.4%	3530.50 [3233.33 , 3827.67	7	
Kim 2015	10375.4	916.2	234	6796.3	1347.9	234	14.4%	3579.10 [3370.28 , 3787.92	2]	
Park 2012	8970	0	30	3912	0	120		Not estimable	e	
Park 2012b	6032.7	151.71	20	2370.73	154.68	20	14.5%	3661.97 [3567.02 , 3756.92	2]	*
Park 2019	12235	1907.9	35	10319	1607.7	35	13.7%	1916.00 [1089.44 , 2742.56	5]	-
Yoon 2021	5781	845	16	4810	954	23	14.1%	971.00 [402.28 , 1539.72	2]	•
Subtotal (HKSJa)			1035			1170	100.0%	3358.93 [1771.63 , 4946.24	1	•
Test for overall effect: Heterogeneity: Tau ³ (R		,		3872.63, d	f = 6 (P <	0.00001)	; l² = 1009	6		
Total (HKSJe)			1035			1170	100.0%	3358.93 [1771.63 , 4946.24	1	•
Test for overall effect:	T = 5.18, df	= 6 (P =	0.002)						-10000 -5000	0 5000 10000
Test for subgroup diffe	rences: No	t applicab	le						Favours [RAS]	Favours [Laparoscop
Hatanaan and Tarre						0.000041				

(b) Operation Cost Mean difference Laparoscopic IV. Random, 95% CI IV. Random, 95% CI 5.1.1 Government payment (covered by NHI) Baek 2012 150 10.7% -2915.00 [-3836.82 , -1993.18] Kang 2016 211 9.9% -2117.16 [-3137.95 , -1096.37] 234 14.4% -3477.00 [-3961.18 , -2992.82] Kim 2015 3352 2167.9 234 6829 223 6151.57 211 9.9% -2117.16 [-3137.95 , -1096.37] Kim 2016 4034.41 5809.5 3159.2 1674.1 35 5208.8 35 13.0% -2049.60 [-2705.50 , -1393.70] Park 2012a 20 2562.47 600.03 758.4 272.71 20 15.8% -1804.07 [-2092.93 , -1515.21] Park 2012b 133 5816.1 3072.8 Park 2015 2713.1 4356.9 84 10.1% -3103.00 [-4092.99 , -2113.01] 3942 Yoon 2021 753 1298.8 23 11.6% -3189.00 [-3998.44 , -2379.56] 173 4.6% -4413.89 [-6392.56 , -2435.22] 2299.28 4734.26 Yoon 2024 95 6713.17 11640.57 Subtotal (HKSJa) 1141 100.0% -2671.08 [-3259.27 , -2082.89] Test for overall effect: T = 10.47, df = 8 (P < 0.00001) Heterogeneity: Tau² (REML^b) = 391570.07; Chi² = 47.69, df = 8 (P < 0.00001); I² = 77% 1133 1141 100.0% -2671.08 [-3259.27 , -2082.89] Total (HKSJa) Test for overall effect: T = 10.47, df = 8 (P < 0.00001) Test for subgroup differences: Not applicable Favours [RAS] Favours [Laparoscopic]

Heterogeneity: Tau ^a (i	REMLb) = 39	1570.07; C	hi² = 47.6	9, df = 8 (P < 0.000	01); I ² = 7	7%		, , , ,	
(c) Govern	ment	Paym	<u>ent</u>							
(c) Government Payment			La	paroscop	ic		Mean difference	Mean difference		
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Rando	m, 95% CI
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Heterogeneity: Tau ² (F	REML ^b) = 20	48142.35;	Chi² = 234	1.06, df =	9 (P < 0.00	0001); l² =	98%			
Total (HKSJa)	1100				1171	100.0%	5701.22 [4612.84 , 6789.61]	1	•	
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Heterogeneity: Tau ² (F	REML ^b) = 20	48142.35; (Chi² = 234	1.06, df = 9	9 (P < 0.00	0001); l² =	98%		-	
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CONCLUSIONS

- This is the first systematic review and meta-analysis to evaluate the economic implications of RAS in Korea.
- Our findings indicate that RAS is associated with higher costs compared with other surgical approaches, yet robust evidence of its long-term cost-effectiveness remains limited.
- As the adoption of RAS continues to expand, generating high-quality real-world data will be essential to inform equitable and evidence-based reimbursement decisions.



(d) Patient Out of Pocket Payment