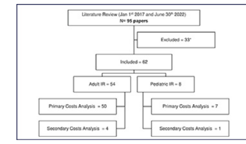
Research Consensus Panel Follow-Up: A Systematic Review and Update on Cost Research in IR



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ABSTRACT

Purpose: To systematically review cost research in interventional radiology (IR) published since the Society of Interventional Radiology Research Consensus Panel on Cost in December 2016.

Materials and Methods: A retrospective assessment of cost research in adult and pediatric IR since December 2016 to July 2022 was conducted. All cost methodologies, service lines, and IR modalities were screened. Analyses were reported in a standardized fashion to include service lines, comparators, cost variables, analytical processes, and databases used.

Results: There were 62 studies published, with most from the United States (58%). Incremental cost-effectiveness ratio, quality-adjusted life-years, and time-driven activity-based costing (TDABC) analyses were performed in 50%, 48%, and 10%, respectively. The most frequently reported service line was interventional oncology (21%). No studies on venous thromboembolism, biliary, or IR endocrine therapies were found. Cost reporting was heterogeneous owing to varying cost variables, databases, time horizons, and willingness-to-pay (WTP) thresholds. IR therapies were more cost-effective than their non-IR counterparts for treating hepatocellular carcinoma ($55,925 vs $211,286), renal tumors ($12,435 vs $19,399), benign prostatic hyperplasia ($6,464 vs $9,221), uterine fibroids ($3,772 vs $6,318), subarachnoid hemorrhage ($1,923 vs $4,343), and stroke ($551,159 vs $577,181). TDABC identified disposable costs contributing most to total IR costs: thoracic duct embolization (68%), ablation (42%), chemoembolization (30%), radioembolization (80%), and venous malformations (75%).

Conclusions: Although much of the contemporary cost-based research in IR aligned with the recommendations by the Research Consensus Panel, gaps remained in service lines, standardization of methodology, and addressing high disposable costs. Future steps include tailoring WTP thresholds to nation and health systems, cost-effective pricing for disposables, and standardizing cost sourcing methodology.

ABBREVIATIONS

DCB = drug-coated balloon, HCC = hepatocellular carcinoma, ICER = incremental cost-effectiveness ratio, IO = interventional oncology, IR = interventional radiology, LVP = large-volume paracentesis, MR = magnetic resonance, PAD = peripheral arterial disease, PTA = percutaneous transluminal angioplasty, QALY = quality-adjusted life-year, RCP = Research Consensus Panel, TARE = transarterial radioembolization, TDABC = time-driven activity-based costing, UAE = uterine artery embolization, US = ultrasound, VTE = venous thromboembolic, WTP = willingness-to-pay

Physicians are faced with the dual challenge of ensuring provision of high-quality care to patients and making cost-conscious decisions on resource use to make spending justifiable (1). A formal assessment of trade-offs involving the health benefits, harms, and costs associated with health care choices helps health care systems maximize the welfare of their population using available resources. Cost research compares interventions, assesses population-level health effects, and, ultimately, supports decisions of disinvesting in less cost-effective options (2). The First (1996) and Second Panel (2016) on Cost Effectiveness in Health and Medicine define cost-effective analysis as “a framework for comparing the relative value of different interventions, along with information that can help decision makers sort through alternatives and decide which ones best serve their programmatic and financial needs” (2,3).

For this reason, health care costs continue to be an area of scrutiny and ongoing reform to improve the quality and

Tables E1–E9 can be found by accessing the online version of this article on *www.jvir.org* and selecting the Supplemental Material tab.

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RESEARCH HIGHLIGHTS

- Since the 2016 SIR Foundation Research Consensus Panel, much of the contemporary cost-based research in interventional radiology has aligned with its recommendations.
- While there has been an increase in robust cost-based research in IR, gaps remain in addressing certain service lines, standardization of cost-based research methodology, and addressing the high costs of consumable IR equipment.
- Future steps for conducting cost-based research include standardization of cost sourcing methodology, tailoring willing-to-pay thresholds to nation and health systems, multi-institution cost-reporting, and cost effective pricing of disposables.

value of health care delivery. Alternative payment models continue to increase, with >30 proposals currently and many models already implemented for inflammatory bowel disease, end-stage renal disease, oncology, asthma, emergency services, and primary care. These models aim to provide high-quality care while also lowering the costs of health care. Outside of alternative payment models, payers also consider costs when determining coverage, as shown in a recent national survey of medical directors of 228 commercial insurance plans, in which 90% reported considering costs in coverage determination (4). Although many policy-making bodies in Canada, Europe, and Australia have included cost-effective analysis as a vital component in health technology assessments, Medicare in the United States does not consider cost research when reimbursing new therapies (5–7).

Cost research is challenging to conduct and can vary on the basis of the perspective it is being viewed from (eg, provider, patient, payer societal, and health care), as mentioned by the Second Panel on Cost Effectiveness in Health and Medicine (2). In December 2016, the Society of Interventional Radiology (SIR) Foundation assembled a Research Consensus Panel (RCP) that evaluated the existing environment of economic research in interventional radiology (IR), conceptualized a framework for understanding cost-based research in the field, and made a list of recommendations for research, clinical, and organizational priorities for the future (8). The goal of this consensus panel was to generate more high-quality and robust evidence-based cost research to demonstrate the effectiveness of IR and its effect on patient care processes, health-related outcomes, and key stakeholders. At that time, particular areas lacking robust research included interventional oncology (IO), peripheral arterial disease (PAD) and critical limb ischemia, dialysis access, venous thromboembolic (VTE) disease, gastrointestinal hemorrhage, and pain.

The purpose of this systematic review was to evaluate the current state of cost-based research in IR since the 2016 SIR Foundation RCP and delineate steps for a future prospective cost-based analysis.

MATERIALS AND METHODS

This systematic review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. Institutional review board approval was waived by Beth Israel Deaconess Medical Center, Harvard Medical School because no human subjects were recruited during the designing, conducting, or analyzing stage of this document, nor were there plans to involve human subjects in the dissemination of this report's findings.

Search

A comprehensive search strategy was developed to capture the maximum number of relevant articles. A retrospective assessment of data from 2017 until July 2022 was conducted. This systematic review was registered with The International Prospective Register of Systematic Reviews (PROSPERO) on September 17, 2022 (ID: CRD42022357582). Embase (Excerpta Medica Database), Center for the Evaluation of Value and Risk in Health, and PubMed were searched. Screening was performed using search terms that were synonymous with the following themes: (*a*) economic, (*b*) IR, and (*c*) organ systems. Within the economic themes, all possible formulations of the following keywords were used: cost effectiveness, incremental cost-effectiveness ratio (ICER), quality-adjusted life-year (QALY), and time-driven activity-based costing (TDABC). The IR and organ systems themes were used in concert with each other. Within organ systems, the following keywords were included: gastrointestinal, hepatobiliary, liver, breast, neurology, genital system, cardiovascular, urinary tract, lung, pain palliation, bone, and arterial, venous, and lymphatics. Within IR, keywords included IO, ablation, embolization, radioembolization, endovascular, stenting, coiling, catheters, and biopsy.

Eligibility Criteria and Study Selection

Duplicate records were removed. Study journals, authors, or institutes were not blinded during the review. The initial search was broad and included all studies within the scope of adult and pediatric IR. Results were excluded if they were ongoing trials, were abstracts, were systematic reviews, comprised general educational content, did not concern economic evaluation or cost analysis, were non-English, or were based on nonhuman data (**Figs 1**, **2**).

Data Extraction and Analysis

Initial data extraction included extracting preliminary list key domains: country of origin, comparison between IR devices, comparison between IR and non-IR devices, use of sophisticated cost-analytical processes (ICER and QALY), and use of TDABC. Studies were further classified by clinical specialty councils defined by SIR. In the

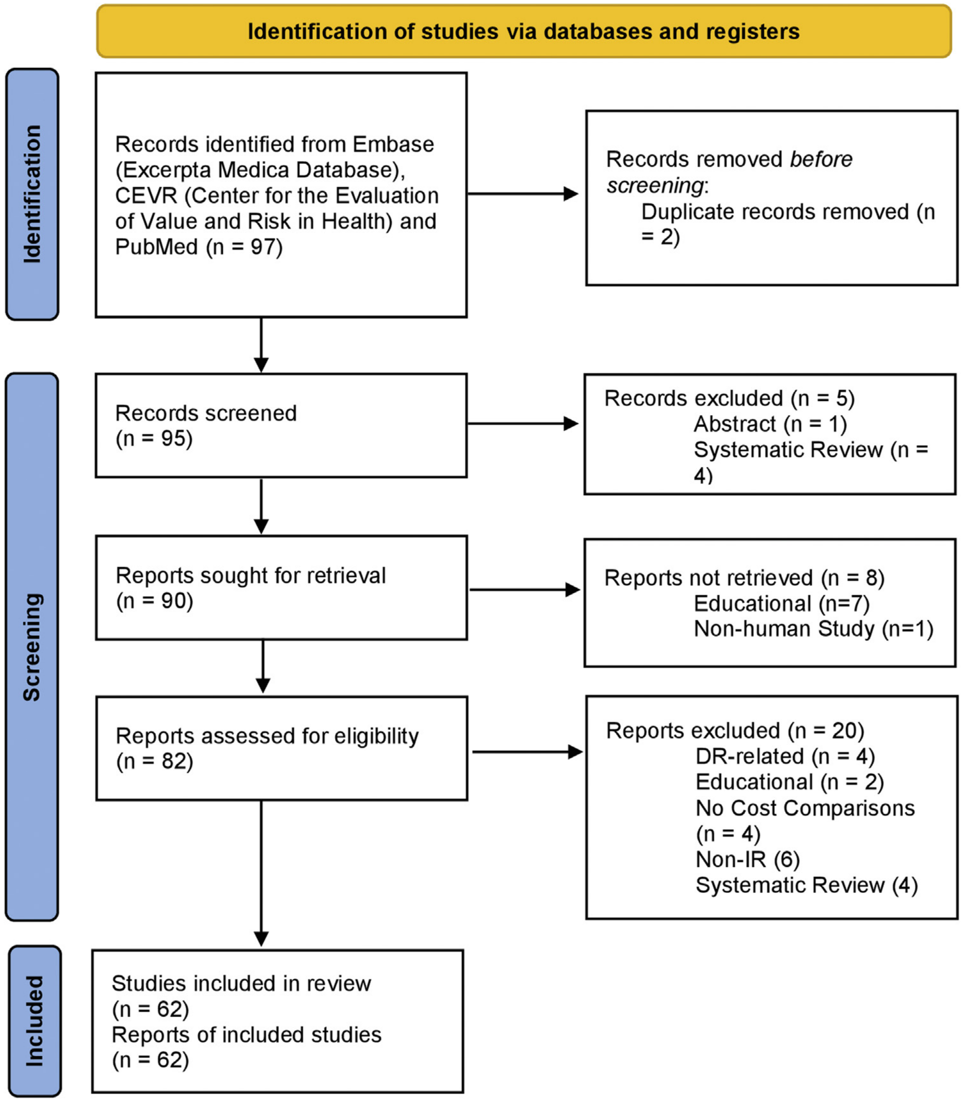

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram. CEVR = Center for the Evaluation of Value and Risk in Health; DR = diagnostic radiology; IR = interventional radiology.

second phase of extraction, textual data were analyzed to identify study rationales, strengths, and weaknesses and outline any future steps advocated. The selected studies were further cross-checked independently by 2 fellowship trained interventional radiologists (A.S., J.C.B.), and the changes proposed were applied in the updated versions of the consort diagram and tables. Finally, studies were categorized as primary or secondary, with the latter including studies that reported on costs as either part of additional analysis or general overhead cost of care without the use of cost-analytical processes (ICER and QALY).

Outcomes

The primary outcomes of this study included the study of the cost effectiveness of IR therapies on the basis of stakeholder perspectives. Cost effectiveness in IR was further dichotomized as those comparing costs within groups of IR therapies and those comparing IR and non-IR therapies. Owing to the heterogeneity in reporting, costs measurements were categorized into broad domains. Direct medical costs captured expenditures associated with patient care processes, including but not limited to costs of faculty, staff, the procedure, resources, and consumables the during index procedure/hospitalization. Where appropriate, costs also included expenditures associated with patient health outcomes, such as readmissions, procedural event rates, length of hospital stay, rates of recurrence, and further treatment of complications.

Synthesis Methods

Studies chosen to be tabulated were based on the principle of comparing IR therapies with other IR and non-IR therapies to demonstrate the effect on costs. Selected records were visually displayed using a standardized format that included author and publication details, disease conditions,

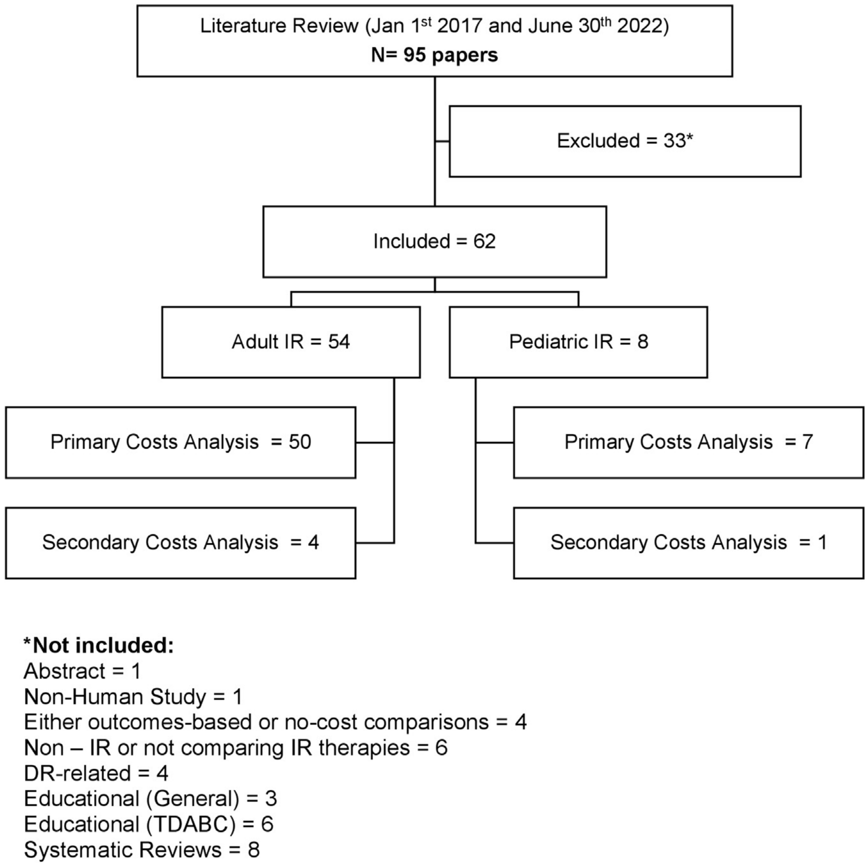

Figure 2. Diagram detailing the included and excluded studies. DR = diagnostic radiology; IR = interventional radiology; TDABC = time-driven activity-based costing.

comparators, type of cost analysis, databases used, cost variables considered, results, and general comments.

Statistical Analysis

Descriptive statistics were used to evaluate the number of studies for each service line and the specific features of each study. Results were tabulated in a descending order with the most common to least common variables.

RESULTS

This search produced 95 studies, of which 33 studies were excluded (Fig 1). Most of the studies were from the United States (36 of 62, 58%), followed by the United Kingdom and Europe (20 of 62, 32%), with only 4 studies from Asia (6%), 1 study from South America (2%), 1 study from Canada (2%), and 0 studies from Africa or Australia. Within service lines, most of the studies were in IO (13 of 62, 21%). No studies were performed in VTE disease, biliary disease, or endocrine therapies. Most of the studies (57 of 62, 92%) were primary cost analyses, with 38 (61%) of 62 comparing costs between IR treatments and non-IR treatments and 21 (34%) of 62 comparing costs between IR treatments. Cost research was performed using ICER in 31 (50%) of 62 studies and QALY in 30 (48%) of 62 studies. TDABC was used in 6 (10%) of 62 studies. **Table 1** outlines study specifics by service line and disease state, and **Table 2** describes the study characteristics of all the included studies.

IO Studies

There were 13 IO studies (**Table E1**, available online on the article's Supplemental Material page at *www.jvir.org*), with most of the research in hepatocellular carcinoma (HCC) (77%), followed by colorectal hepatic metastases (15%) and renal cell carcinoma (7%). In HCC and colorectal hepatic metastases studies, locoregional therapies (ablation, transarterial chemoembolization, and transarterial radioembolization [TARE]) were more cost-effective than their surgical counterparts (surgery and transplant) (9–13). In addition, 4 studies (14–17) compared TARE with sorafenib for HCC. In renal tumors, percutaneous cryoablation was found to be more cost-effective than surgery (nephrectomy) (18).

Renal Insufficiency and Genitourinary

Four dialysis access intervention studies were performed in the United States (**Table E2**, available online at *www.jvir.org*). Two studies (19,20) compared endovascular and

Table 1. Description of Types of Cost Research Studies since 2017

Disease state	No. of studies	Countries	Features
Interventional oncology (13 studies)			
Primary and secondary liver cancer	11 (P), 1 (S)	United States, Europe, China, Canada	Costs within IR devices/techniques; costs between IR and non-IR, ICER and QALY, TDABC
Renal tumors	1 (P)	Brazil	Costs between IR and non-IR, ICER
Renal insufficiency and GU (7 studies)			
Hemodialysis	4 (P)	United States	Costs within IR devices/techniques; costs between IR and non-IR
Benign prostatic hyperplasia	2 (P)	United States	Costs between IR and non-IR, ICER and QALY
Varicocele	1 (S)	China	Costs between IR and non-IR
Women's health (5 studies)			
Uterine fibroids	5 (P)	United States, Europe	Costs within IR devices/techniques; costs between IR and non-IR, ICER and QALY
Neurointerventional radiology (5 studies)			
Intracranial aneurysms	1 (P)	United States	Costs between IR and non-IR, ICER and QALY
Stroke	3 (P)	United States	Costs between IR and non-IR, ICER and QALY
Subarachnoid hemorrhage	1 (P)	Thailand	Costs between IR and non-IR, ICER and QALY
Pain management/MSK (3 studies)			
Cancer-induced bone pain	2 (P)	United States, Europe	Costs between IR and non-IR, ICER and QALY, TDABC
Osteoarthritis	1 (P)	United States	Costs between IR and non-IR, ICER and QALY
Pediatric IR (8 studies)			
Bone tumors	1 (P)	Europe	Costs between IR and non-IR
Enteral access	2 (P), 1 (S)	United States, Europe	Costs within IR devices/techniques
Central venous catheters	3 (P)	United States, Europe	TDABC, cost of complications
Plastic bronchitis	1 (P)	United States	Costs between IR and non-IR, ICER and QALY
Peripheral arterial disease (8 studies)			
Peripheral arterial disease	8 (P)	United States, Europe, Singapore	Costs within IR devices/techniques; costs between IR and non-IR, ICER and QALY
Venous (3 studies)			
Varicose veins	1 (P)	Europe	Costs within IR devices/techniques, costs between IR and non-IR, ICER and QALY
Vascular malformations (venous and arteriovenous malformations)	1 (P)	Europe	TDABC
Peripherally inserted central catheters	1 (P)	United States	Costs between IR and non-IR
Other (10 studies)			
Abdominal aortic aneurysm	2 (P)	Europe	Costs between IR and non-IR, ICER and QALY
Chyle leaks	1 (P)	United States	TDABC
Enteral access	1 (S)	United States	Cost between 2 types of IR techniques
Splenic trauma	2 (P)	United States, Europe	Costs between IR and non-IR, ICER and QALY
Ascites	3 (P), 1 (S)	United States	Costs between IR and non-IR, ICER and QALY

GU = genitourinary; ICER = incremental cost-effectiveness ratio; IR = interventional radiology; MSK = musculoskeletal; P = primary; QALY = quality-adjusted life-year; S = secondary; TDABC = time-driven activity-based costing.

surgical arteriovenous fistula creation and found an endovascular approach to be more cost-effective than a surgical one. Two studies (21,22) evaluated dysfunctional access, with one comparing drug-coated balloons (DCBs) with percutaneous transluminal angioplasty (PTA) for dysfunctional arteriovenous fistulae and the other comparing the use of stent grafts with PTA for thrombosed and dysfunctional arteriovenous grafts.

Two primary cost analyses (23,24) compared prostatic artery embolization with transurethral resection of the prostate for the treatment of benign prostatic hyperplasia and found prostatic artery embolization to be less expensive and more cost-effective despite a slightly higher QALY for transurethral resection of the prostate. One study (25) compared spermatic vein embolization with laparoscopic ligation for varicocele (**Table 3**).

PAD Studies

Eight cost-based research studies evaluated PAD (**Table E3**, available online at *www.jvir.org*). Endovascular treatment with angioplasty was more cost-effective than femoropopliteal bypass surgery but more costly than supervised exercise therapy despite higher QALYs for endovascular treatments (30,31). Four studies (32–35) compared stent types (drug-eluting vs bare-metal stents), whereas one study (36) compared types of angioplasties (DCB vs PTA) and another study (37) compared types of hospitalization (outpatient vs inpatient).

Pediatric IR

In the pediatric population, 3 studies investigated vascular access, 3 studies investigated enteral access, 1 study

Table 2. Characteristics of Cost Research Studies since 2017

Variables	Count (%)
Studies	
Primary	57 (92)
Secondary	5 (8)
Countries	
United States	36 (58)
Europe	20 (32)
China	2 (3)
Brazil	1 (2)
Canada	1 (2)
Singapore	1 (2)
Thailand	1 (2)
Service lines	
Interventional oncology	13 (21)
Peripheral arterial disease	8 (13)
Pediatric interventional radiology	8 (13)
Renal insufficiency and genitourinary	7 (11)
Neurointerventional radiology	5 (8)
Women's health	5 (8)
Pain management/musculoskeletal	3 (5)
Venous	3 (5)
Other	10 (16)
Ascites	4
Abdominal aortic interventions	2
Splenic trauma	2
Enteral access	1
Lymphatics	1
Features	
Costs between IR vs non-IR	38 (61)
ICER	31 (50)
QALY	30 (48)
Costs between IR devices	21 (34)
TDABC	6 (10)

ICER = incremental cost-effectiveness ratio; IR = interventional radiology; QALY = quality-adjusted life-year; TDABC = time-driven activity-based costing.

investigated lymphatic embolization for plastic bronchitis, and 1 study compared percutaneous with open biopsy for malignant bone tumors (**Table E4**, available online at *www.jvir.org*) (38–45).

Pain Management and Musculoskeletal

There were 3 studies (46–48) that evaluated bone pain (**Table E5**, available online at *www.jvir.org*). Bone pain intervention studies included two cost comparative analyses between magnetic resonance (MR)-guided focused ultrasound (US) ablation and medication for painful bone metastases and radiofrequency ablation and intra-articular steroids for osteoarthritis; along with a TDABC analysis of MR-guided high-intensity frequency US for painful bone metastases. TDABC found that equipment and disposables accounted for the greatest percentage (41%) of costs for MR-guided high-intensity frequency US, followed by personnel and overhead costs (32% and 16%, respectively) (46).

Neurointerventional Radiology

Five studies (49–53) evaluated costs of neurointerventional procedures (**Table E6**, available online at *www.jvir.org*), with 3 studies comparing endovascular thrombectomy with medical management for stroke, 1 comparing endovascular coil embolization with neurosurgical clipping for aneurysmal subarachnoid hemorrhage, and 1 comparing endovascular flow diverter stent with endovascular coil embolization for intracranial aneurysms. For stroke, endovascular thrombectomy was cost-effective in the long term for all patients in the 55-year, 65-year, and 75-year age groups (53).

Women's Health

There were 5 studies (54–58) in women's health: 4 comparing uterine artery embolization (UAE) with hysterectomy or uterine-sparing treatments and 1 comparing transcervical fibroid ablation with surgery (myomectomy) (**Table E7**, available online at *www.jvir.org*). The cost effectiveness of UAE varied depending on the definition of an episode of care in each study. UAE was generally more costly than its surgical comparators over time and in both rural and urban settings. Evaluation of encounter costs, such as hospital stays, showed lower mean initial costs for UAE than for myomectomy or hysterectomy in 2 studies and higher costs for UAE than for hysterectomy in 1 study. A within-trial cost-utility analysis of the Treating Fibroids with Either Embolization or Myomectomy to Measure the Effect on Quality of Life trial showed lower immediate costs and shorter hospital stays with UAE; however, owing to reinterventions, follow-up costs were higher than those for myomectomy (54).

Venous

Three cost-based analyses (59–61) studied the venous system, with 1 assessing treatment modalities for varicose veins, 1 comparing peripherally inserted central catheter placements (guided vs external), and 1 TDABC study evaluating the treatment of vascular malformations (**Table E8**, available online at *www.jvir.org*). For varicose veins, laser ablation was more cost-effective than foam sclerotherapy and surgery (59). For peripherally inserted central catheter placement, a guided approach (US and cardiac electrocardiography) was more cost-effective than an external approach. Finally, TDABC was used to restructure care of vascular malformations, resulting in reduced resource use and cost reduction. Evaluation of vascular malformation treatment revealed the major cost contributor to be disposables.

Other

Two studies evaluated endovascular versus open surgical repair of abdominal aortic aneurysms, and 2 studies evaluating the treatment of splenic trauma with endovascular approach versus surgical approaches found the

Table 3. Studies That Investigated Costs as a Secondary Analysis

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Interventional oncology							
Dhir et al (26), 2018, United States, USD ($)	Unresectable colorectal liver metastases	HAI TARE (^{90}Y)	Single hospital–level database; 34 patients	Hospital cost informational system	Procedural costs, clinical equipment and resources, laboratory tests, personnel/staffing costs	The median cost of HAI was lower than that of TARE ($29,479 vs $39,092). The median cost of HAI performed concomitantly with resection was higher than that of HAI performed alone ($30,578 vs $23,144)	Costs analysis considered actual costs, rather than hospital or reimbursement charges
Renal insufficiency and genitourinary							
Jing et al (25), 2020, China, Chinese yuan (¥)	Varicocele	Spermatic vein embolization Laparoscopic high ligation	Single hospital–level database; 69 patients	Hospital costs	Procedural costs	The mean cost of sorafenib was higher than that of SIRT in the pooled ($78,859 vs $58,397), and independent (SARAH [$72,899 vs $66,800] and SIRveNIB [$89,806 vs $46,15]) analysis, respectively.	Compared with those of the laparoscopic group, the mean operative time (31 vs 50 min) and mean hospitalization time (1.2 vs 4 d) were significantly shorter in the sclerotherapy group
Other							
Ma et al (27), 2020, United States, USD ($)	Enteral access	Single-step method for pull-type gastrostomy tube Push-type gastrostomy tube	Dual hospital–level database; 102 patients	Hospital costs	Procedural costs	The single-step pull-type method was less costly than the push-type method ($186.67 vs $465.43)	—
Rowley et al (28), 2019, United States, USD ($)	Ascites	Real-time ultrasound-guided paracentesis	Single hospital–level database (2-y horizon); 3,116 patients	Hospital costs	Transfusion-related cost savings	Ultrasound-guided paracentesis led to avoidance of 1,125 units of FFP (savings of $450,000) and 366 single-donor platelet transfusions (savings of $366,000)	—
Pediatric interventional radiology							
Kumar et al (29), 2020, United States, USD ($)	Nutritional support	Endoscopic gastrostomy tube placement Fluoroscopic gastrostomy tube placement Surgical gastrostomy tube placement	Multiple institution hospital–level database; 11,712 gastrostomy tube placements	Medicare and Medicaid Services wage/price index (PHIS database)	Admission costs, total costs, mortality, 30-d readmission, LOS	The median cost of admission was $10,434 (IQR, $6,949–$18,303). Overall, there was no significant difference in the total cost between endoscopic and nonendoscopic placements	Hematologic comorbidities were associated with increased costs. There was no difference in LOS or mortality between the endoscopic and nonendoscopic placement groups

^{90}Y = yttrium-90; FFP = fresh frozen plasma; HAI = hepatic artery infusion; IQR = interquartile range; LOS = length of stay; PHIS = pediatric health information system; TARE = transarterial radioembolization.

endovascular approach to be more cost-effective (62–65) (**Table E9**, available online at *www.jvir.org*).

Thoracic duct embolization was evaluated using TDABC and hospital costing data in adults with chyle leaks, and the evaluation revealed disposables to account for the highest portions of cost, particularly glue and coils (66). Finally, in the management of ascites, tunneled peritoneal drainage catheters were more cost-effective than repeated large-volume paracentesis (LVP) (67,68), whereas transjugular intrahepatic portosystemic shunt placement provided more QALYs and was slightly more cost-effective than LVP at a willingness-to-pay (WTP) threshold of $100,000/QALY (69).

Secondary Cost-Based Research Studies

Five studies either evaluated cost as a secondary measure or did not describe their methods of cost determination (**Table 3**).

DISCUSSION

Since the recommendations made by the SIR Foundation RCP on Cost in 2016, there has been continued research in cost analysis in many disease states treated by IR. Most research was performed in the areas of IO for HCC, dialysis access management, PAD, and pediatric IR. The 2016 RCP made recommendations for research priorities and uptake of novel methods of cost assessment, such as TDABC, and there has been subsequently increased publication of cost research in IR; however, no cost studies on venous thromboembolism, biliary, or IR endocrine therapies were found. Moreover, study methodology and outcomes continue to be variables in selection of cost-accounting levels, data sources, analyses, and stakeholder perspectives.

QALYs in cost studies compare treatment options to determine cost effectiveness. However, WTP thresholds set by regional standards are arbitrary. WTP ratios of <$50,000/QALY are arbitrarily considered to be cost-effective in the United States, whereas ratios of >$100,000/QALY are not. However, criticism persists that these values are outdated and artificially low, particularly in light of the price inflation that has occurred since the 1970s (70). The World Health Organization recommends a threshold of 2–3 times the per capita annual income, which would imply a US threshold of $110,000–160,000/QALY (71). However, using this WHO threshold, IR procedures would not be cost-effective compared with surgical procedures in countries with a lower per capita annual income. Thus, no single threshold for ICER should exist, and the wealth and cultural norms of a nation or health system will determine what type of thresholds might be acceptable. Despite IR now being a primary specialty, it is not available globally, which can be because of not only, in part, a lack of trained personnel but also, ultimately, high disposable costs compared with those of surgery even if personnel become available.

In addition to variability in thresholds to determine cost effectiveness, time horizons vary between the studies and can range from a 1-year horizon to a lifetime horizon. Longer time frames can capture additional elements of costs, such as reintervention, follow-ups, and rehabilitation. Because there is no standard time horizon when capturing costs, cost studies can provide varying results depending on the timeline of cost assessment. In trial-based analysis, cost-comparisons are based on upfront expenditures, but most benefits are achieved beyond the time frame of the study, thereby underestimating the aggregated incremental benefits associated with a chosen strategy (70).

In 2016, the RCP found no published evidence of the utility of TDABC in cost-based research in IR and recommended more use of this novel method for true cost measurement. Since then, 6 studies used TDABC in their methodology. Of the 6 studies using TDABC included in this review, 5 were from the United States and 1 was from Europe. The RCP highlighted the need for practice leaders to define reasonable intraprocedural expendable equipment costs and episodes of care for cost accounting. TDABC showed disposables and material costs (eg, coils, cyanoacrylate glue, and ablation probe) to be the major drivers in overall costs (9,39,43,46,60,66). Although TDABC uses an "episode of care" and looks at the cost of a procedure and not the outcome, it helps detect primary drivers of cost and drive process improvement, which increases operational efficiency and reduces wasted resources. Masthoff et al (60) used TDABC to inform cost reductions and negotiations that led to improved margins. TDABCs also serve as building blocks for future longitudinal analyses and alternative payment models, which supports the goals outlined the 2016 RCP.

The RCP also established IO as a research priority, particularly defining an episode of care for patients with HCC, which has since been performed by Ljuboja et al (9), through the use of TDABC in assessing TARE, transarterial chemoembolization, and ablation as locoregional therapies for HCC. Similarly, Garcia et al (18) compared percutaneous cryoablation with nephrectomy of renal tumors, a need highlighted by the RCP. However, given the recent results of the IMbrave150 trial, cost-effectiveness studies comparing IR HCC treatments with immunotherapy are yet to be completed (72). Another specific area of interest outlined by the RCP, owing to a lack of available literature then, was comparing IR therapies with non-IR therapies; since 2016, most of the published cost studies (61%) have made this comparison.

The RCP recommended that more research is needed at institutional and health-system levels to allow IR to better understand cost research and demonstrate its value. Wu et al (67,68) showed in 2 studies that tunneled peritoneal catheters and tunneled dialysis catheters were more cost-effective with a higher health benefit in patients with recurrent ascites than LVP. However, unless this evidence is advertised at a health-system level, practice patterns may remain unchanged, as can be seen through surveys of physicians in Germany, Austria, and Japan who continue to prefer LVP for recurrent ascites (73,74). Once favorable cost-based data are obtained, it is important for the IR community to harness them for system-wide impact, including advocacy at the health-system level to modify coverage policies and improve patient and provider education.

Other areas for improvement included using accurate cost information. In the hemodialysis access literature, for example, 1 study demonstrated cost effectiveness of DCBs in the dialysis circuit for stenosis. However, in the PAD literature, DCBs were not found to be cost-effective. When evaluating the methodology of each of these studies, the cost of the DCB, arguably the most expensive component of this procedure, was not included in the cost of the procedure for the dialysis access study (21,36). Because a DCB reduces the amount of reintervention needed, it is a high-value tool in IR; however, the high cost of this disposable may undermine its utilization in the United States and globally.

Another area where high costs can affect utilization was UAE. Two of the 4 studies that evaluated UAE used the Healthcare Cost and Utilization Project databases from the Agency for Healthcare Research and Quality, with Glass Lewis et al (58) evaluating data from 2004 to 2008 nationally and Wang et al (57) evaluating data from 2005 to 2014 in Florida and 2005 to 2011 in California. Glass Lewis et al (58) found that the costs of UAE were higher than those of hysterectomy in the urban setting but were unable to determine the drivers of this increased cost. Contrarily, Wang et al (57) found UAE to have the least expensive cost for the index procedure compared with the costs of both myomectomy and hysterectomy and found no difference in the length of stay for patients who underwent either UAE or myomectomy. The study by Rana et al (54) was the only study to include 2-year postprocedural data and found that reinterventions and readmissions after UAE were higher than those after myomectomy (18 vs 8, respectively), which contributed to a higher total mean cost over 2 years (£7,958 in UAE vs £7,314 in myomectomy). Cronan et al (56) also found in claims data that procedural payments for UAE were higher than those for myomectomy and hysterectomy; however, the entire episode of care (defined as 7 days after the procedure) was cheapest for UAE. Although uterine-sparing therapies have increased in frequency from 14% of total interventions in 2008 to 23.5% currently, Cronan et al (56) found that hysterectomy is still more common than uterine-sparing treatments in rural areas. However, assuming that insurance companies will prefer more cost-effective treatments, the cost effectiveness of UAE compared with that of surgery needs improvement either by techniques to reduce reinterventions or by decreasing the cost of the procedure itself.

Despite recommendations made by the RCP, this review found no published evidence of cost research in IR patients with VTE disease, cost benefit of embolization procedures by reducing length of stay for patients with gastrointestinal hemorrhage, comparing costs and outcomes of extended opioid use versus local percutaneous pain interventions, or assessing the use of routine surveillance and preventive measures in reducing vascular access thrombosis rates among patients with end-stage renal disease. Similarly, there was no cost-based research for service lines such as endocrine therapies, biliary interventions, and renal calculi or cholelithiasis management. In addition, the need for more research on indirect costs as an outcome measure (patient time, unpaid caregiver time, lost labor market earnings, or lost productivity) is yet to be addressed.

In summary, contemporary cost-based research in IR has mostly aligned with the recommendations of the RCP; however, gaps remain in research in certain service lines. Future research must contain robust methodology, with clear sources of cost data, and go beyond single-institution reporting to assess IR's effect on the health care system as a whole, societally, and, potentially, globally as IR becomes more available worldwide.

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Table E1. Studies on Interventional Oncology Council

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Froelich et al (1), 2021, Germany, USD ($)	Liver metastases (CRC)	Surgery Ablative treatment (MWA/RF ablation)	Base-case scenario; Markov model	Costs derived from Medicare (2018)	Lifetime costs	MWA was the preferred strategy with a higher effectiveness than RF ablation and lower overall costs than surgery	Lifetime costs were the lowest for MWA ($35,234) compared with those of RF ablation ($36,937) and transplant ($41,848). Cost effectiveness of MWA was seen for all age ranges
Jin et al (2), 2021, United Kingdom, UK pounds sterling (£)	Metastatic liver cancer and HCC	SABR Surgery RF ablation	Base-case scenario; Markov model; comparative data from preexisting literature and SABR CtE scheme; 189 patients	NHS Reference Costs (2015–2016), Unit Costs of Health and Social Care (2016)	Procedural, retreatment, hospitalization, follow-up, AE, and palliative care costs	In HCC, RF ablation was less costly than surgery but more costly than SABR	SABR dominated all interventions in liver oligometastases. In HCC, SABR was less effective and less expensive than RF ablation but RF ablation ICER exceeded NICE's WTP (£20,000/QALY) threshold, rendering SABR most cost-effective. SABR was 57% and 50% more cost-effective for liver oligometastases and HCC at the WTP threshold, respectively
Ljuboja et al (3), 2021, United States, USD ($)	HCC	TARE TACE Ablation	Single hospital–level database; prospective (4 TACE, ablation, and TARE procedures). Retrospective (117 ablations, 61 TACE, and 61 TARE); TDABC	Hospital costs	Process maps, time stamps, clinical equipment and resources, personnel/staffing costs	Overall costs were the lowest for ablation, followed by TACE and TARE ($3,744, $5,089, and $20,818, respectively). Consumables accounted for a substantial portion of total costs (30% of TACE, 42% of ablation, and 80% of TARE)	Ablation (74 min) had the shortest phase duration, followed by TARE (105 min) and TACE (138 min). This study showed that there was a negligible interobserver variability in calculating TDABC costs, and EMR time stamps served as accurate assessment tools. TDABCs did not consider the effect of procedure complexity on personnel effort, so cost for every minute was standardized. There was a significant difference between costs measured from TDABC when compared with cost measured by claims, with claims data showing much higher costs
Muszbek et al (4), 2021, United Kingdom, UK pounds sterling (£)	HCC	TARE Sorafenib	Base-case scenario; post hoc analysis of the SARAH trial	Costs from NICE appraisals, NHS reference costs, National Schedule of Reference Costs 2017–2018, Personal Social Services Research Unit report	Procedural costs, clinical equipment and resources, AE costs, and postprogression disease management costs	TARE was more cost saving and resulted in slightly less QALYs than sorafenib at an ICER of £58,298/QALY	TARE had a 95% probability of being cost-effective at a threshold of £20,000/QALY. TARE resulted in savings in treatment, AE, and postprogression disease management costs
Thein et al (5), 2017, Canada, Canadian dollar ($ CA)`	HCC	TACE RF ablation Surgery LT	Data obtained from the Ontario Cancer Registry; 2,222 patients	Claims data	Procedural costs, outpatient costs, hospitalization costs, pharmaceutical costs, and follow-up costs	Treatments with LT resulted in higher QALYs but were more costly than non–LT-related treatments	Lowest costs for those who underwent TACE + RF ablation and RF ablation monotherapy, and the highest costs were among those who underwent surgery + LT or RF ablation + surgery + LT. At a WTP threshold of $50,000/QALY, RF ablation monotherapy and TACE plus RF ablation would have a cost-effectiveness probability of 99%–100%
Jiao et al (6), 2022, China, renminbi (RMB)	HCC	Surgery RF ablation LT	Single hospital–level database; 719 patients	Hospital costs	Procedural, tumor-free survival, and postoperative recurrence costs	RF ablation was preferred with the WTP of <25,000 RMB/QALY, LT was preferred with a WTP of >75,000 RMB/QALY, and HR was preferred when WTP was between the 2	QALYs obtained by resection, RF ablation, and transplant were 10.024, 9.370, and 31.860, respectively. ICER obtained were 42,058.03, 40,558.13, and 61,914.53 RMB/QALY, respectively

continued

Table E1. Studies on Interventional Oncology Council *(continued)*

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Wu et al (7), 2021, United States, USD ($)	HCC	DEEs Conventional TACE	Base-case scenario; Markov model	Claims data	Procedural costs, clinical equipment and resources, complication costs	Conventional TACE was more cost-effective for all simulations than DEE TACE	Conventional TACE yielded a higher QALY than that yielded by DEE TACE (2.11 vs 1.71) at a lower cost ($125,324 vs $144,816). DEE TACE was more cost-effective when the disease progression risks were equal and remained so when the difference was within 0.4%. With an ICER of $48,730/QALY, conventional TACE was dominant over DEE
Pollock et al (8), 2020, international, euro and UK pound sterling (€, £)	HCC	TARE TKIs	Base-case scenario; Markov model	Country-specific national sources	Procedural, hospitalization, AE, follow-up care, costs, and end-of-life care costs	SIRT was more cost-effective than TKIs across 4 European Countries in patients with BCLC Stage B and C HCC	Cost savings were the highest in Spain (26.5%), followed by France (11.7%), United Kingdom (7.7%), and Italy (5.4%). Initial treatment with SIRT also increased patients eligible for curative intent (1.4%–4.6%)
Garcia et al (9), 2021, Brazil, USD ($)	Renal tumors	PCA Nephrectomy (RPN)	Single hospital–level database; 122 patients	Hospital costs	Procedural costs, clinical equipment and resources, laboratory tests, maintenance and overhead costs, complication costs	PCA was more cost-effective than RPN ($12,435 vs $19,399), with a lower complication rate	Compared with RPN, PCA had a lower mean procedural time (99 vs 129 min), a lower mean hospital time (2.2 vs 3.03 d), and a lower complication rate. The incremental effectiveness was 5% higher when comparing PCA with RPN, in PCA's favor
Marqueen et al (10), 2021, United States, USD ($)	HCC	TARE Sorafenib	Base-case scenario using patient-level data from the SARAH (n = 459) and SIRveNIB (n = 360) trial; Markov model; 5-y horizon	Costs data from Medicare reimbursement rates and Healthcare Cost and Utilization Project data	Cost of consumables, procedural costs, retreatment costs, hospitalization costs, follow-up costs, and AE costs	The mean cost of sorafenib was higher than that of SIRT in the pooled ($78,859 vs $58,397), and independent (SARAH [$72,899 vs $66,800] and SIRveNIB [$89,806 vs $46,15] analysis), respectively. Sorafenib had slightly higher QALYs than SIRT in the pooled (0.88 vs 0.87) and independent SIRveNIB (0.91 vs 0.86) analysis, whereas SIRT had higher QALYs in the independent SARAH analysis (0.84 vs 0.83)	SIRT had a 99%–100% likelihood of being more cost-effective than sorafenib across a wide range of WTP thresholds ($0–$500,000/QALYs). SIRT-dominated sorafenib in cost effectiveness ($59,918 vs $78,859), and QALYs gained (0.95 vs 0.88) when equal overall survival was assumed between the 2 treatments. In the pooled analysis, sorafenib had an ICER of $1,280,224/QALY compared with SIRT and only fell below the $200,000/QALY threshold if the monthly price reduced by 50% ($16,390 vs $7,000) and below $100,000/QALY if monthly price reduced to $6,600
Zarca et al (11), 2021, French, euro (€)	HCC	TARE Sorafenib	Patient-level data from the SARAH trial (n = 459). Partitioned survival model using trial outcomes (OS and PFS) and costs; 5-y horizon	Costs from hospital claims system and reference costs (2017). Device and drug unit costs from manufacturers and list prices. Cost of TARE procedure from TDABC	Cost of consumables; procedural, retreatment, hospitalization, follow-up, and AE costs	Compared with sorafenib, TARE was more costly when comparing total procedural and initial costs (€32,534 vs €19,441) and follow-up costs (€10,164 vs €5,966). This resulted in TARE being less cost-effective when comparing within-trial costs (€42,699 vs €25,407)	The TARE group had higher extrapolated 5-y costs (€44,345 vs €27,166) with slightly higher total QALYs (0.803 vs 0.7797; difference, 0.006), resulting in an ICER of €3,153,086/QALY. The main cost driver in the TARE group was the number of workups and radioembolization. Probability sampling revealed a 50% chance that sorafenib would dominate TARE over 5 y. Patients in TARE arm had on average a shorter hospital stay for AEs than those in the sorafenib arm (7.4 vs 9.6 d) and slightly lower average costs (€7,357 vs €7,948)

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Table E1. Studies on Interventional Oncology Council *(continued)*

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Manas et al (12), 2021, United Kingdom, UK pounds sterling (£)	HCC	TARE TAE cTACE DEE-TACE	Base-case scenario; Markov model; 20-y horizon	Costs data from NICE, NHS, and the Personal Social Services Research Unit	Cost of consumables, procedural costs, physician fees, retreatment costs, hospitalization costs, laboratory tests, follow-up costs, and AE costs	Therasphere (Boston Scientific Corp., Marlborough, MA) produced a higher QALY than all other comparators (2.24 vs 1.57). Total cost per person was the highest in Therasphere (£49,583), followed by TACE (£37,038), DEE-TACE (£33,206), and TAE (£37,015). At a WTP threshold of £20,000, Therasphere had a higher probability of being cost-effective than cTACE and TAE (76.8% and 75.4%, respectively) compared with DEE-TACE (15.9%)	TARE held the potential of lower costs owing to lesser number of procedures required per patient compared with TACE (1.2 vs 3). TARE had a low likelihood of being cost-effective compared with DEE-TACE because the latter had lower treatment costs. However, this analysis did not consider postembolization syndrome as an AE that is more common with TACE than with TARE

AE = adverse event; BCLC = Barcelona Clinic Liver Cancer; CRC = colorectal carcinoma; cTACE = conventional transarterial chemoembolization; CtE, Commissioning through Evaluation scheme; DEE = drug-eluting embolic; EMR = electronic medical records; HCC = hepatocellular carcinoma; HR = hepatic resection; ICER = incremental cost-effectiveness ratio; LT = liver transplant; MWA = microwave ablation; NHS = National Health Service; NICE = National Institute for Health and Care Excellence; OS = overall survival; PCA = percutaneous cryoablation; PFS = progression-free survival; QALY = quality-adjusted life-year; RF = radiofrequency; RMB = renminbi; RPN = robotic partial nephrectomy; SABR = stereotactic ablative body radiation; SARAH = Sorafenib versus Radioembolization in Advanced Hepatocellular Carcinoma; SIRT = selective internal radiation therapy; SIRveNIB = Selective Internal Radiation Therapy versus Sorafenib in Locally Advanced HCC; TACE = transarterial chemoembolization; TAE = transarterial embolization; TARE = transarterial radioembolization; TDABC = time-driven activity-based costing; TKI = tyrosine kinase inhibitor; WTP = willingness-to-pay.

Table E2. Studies on Renal Insufficiency and Genitourinary Council

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Renal and dialysis							
Pietzsch et al (13), 2022, United States, USD ($)	Dysfunctional hemodialysis AVFs	DCB PTA	Multicenter randomized clinical trial (IN.PACT AV Access study)	Claims data	Procedural costs, clinical equipment and resources, and reintervention costs	Compared with PTA, DCB had lower 12 mo ($12,207 vs $14,359) and 30 mo ($24,722 vs $28,615) total costs	12-mo primary patency rates were higher for DCB than those for PTA (53.8% vs 32.4%). DCB also had a smaller number of reinterventions at 3 y (1.70 vs 2.76). The initial analysis without including the cost of device found DCB to be more cost saving than PTA. After including the cost of devices, DCB was more costly at 1 y and cost neutral at 2 y
Arnold et al (14), 2018, United States, USD ($)	ESRD–hemodialysis	SAVF endoAVF	Retrospective, observational study using USRDS data and clinical trial data (NEAT trial); propensity score–matched sample; 33 patients (prevalent), 27 patients (incident)	Claims data	Postprocedural event rate costs	The endoAVF group had a smaller number of event rates (overall and catheter-related infections) than the surgery group	Event rates were fewer in the endoAVF group than in the surgical group (0.74/patient-year vs 7.22/patient-year), resulting in a cost difference of $16,494, favoring endoAVF
Yang et al (15), 2017, United States, USD ($)	ESRD–hemodialysis	SAVF endoAVF	Retrospective, observational study using CMS data and clinical trial data (NEAT trial); propensity score–matched sample; 60 patients	Claims data and Medical Care component of the Consumer Price Index	Postprocedural event rate costs	There were fewer postcreation event rates and less costs in the endoAVF group than in the SAVF group	The postcreation event rate was shorter in the endoAVF group (0.78/PY vs 3.43/PY). The mean postprocedure-related cost of endoAVF was $11,240 lower than that in the SAVF group
Mohr et al (16), 2019, United States, USD ($)	Thrombosed and dysfunctional grafts	SG PTA	Economic analysis embedded within the REVISE trial (24-mo horizon); 269 patients	Claims data	Procedural, follow-up, and reintervention costs	The SG group had higher index costs in thrombosed and stenosed circuits. However, SGs reduced total 24-mo costs by 18% in thrombosed circuits and 14% in stenosed circuits	Index procedure costs were significantly higher for thrombosed circuits ($11,007 [SG] and $5,941 [PTA]) than for stenosed circuits ($9,034 [SG] and $3,643 [PTA]). Reduced 24-mo costs for the SG group were attributable to the reduced number of reinterventions
Men's reproductive health							
Rink et al (17), 2022, US, USD ($)	BPH	PAE TURP	Base-case scenario; Markov model (5-y horizon)	Hospital costs	Procedural costs, hospitalization costs, clinical equipment and resources, complication costs	Total costs for PAE were lower than those for TURP ($6,464 vs $9,221). The mean QALY for PAE was lower than that for TURP (4.566 vs 4.577), but TURP's ICER ($247,732) was higher than the WTP threshold of $50,000/QALY, making it less effective	At a WTP threshold of $50,000/QALY and $100,00/QALY, PAE was cost-effective in 96.44% and 85.95% of iterations, respectively

continued

Table E2. Studies on Renal Insufficiency and Genitourinary Council *(continued)*

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Bagla et al (18), 2017, US, USD ($)	BPH	PAE TURP	Single hospital–level database; 156 patients	Hospital costs	Procedural costs (operating room/IR suite), hospitalization costs, clinical equipment and resources	Procedural costs were lower for PAE than for TURP ($1,667 vs $2,153, respectively). Although the cost of intraprocedural supplies for PAE was greater than that for TURP, the mean cost of hospitalization was significantly greater for TURP than for PAE ($5,338 vs $1,678)	PAE was performed as an outpatient procedure, so there were no additional costs for anesthesia supplies or staffing. The mean LOS was lower for PAE than for TURP (0.125 d vs 1.38 d, respectively)

AVF = arteriovenous fistula; BPH = benign prostatic hyperplasia; CMS = Centers for Medicare and Medicaid Services; DCB = drug-coated balloon; endoAVF = endovascular arteriovenous fistula; ESRD = end-stage renal disease; ICER = incremental cost-effectiveness ratio; IN.PACT AV = IN.PACT AV Access Paclitaxel-Coated Percutaneous Transluminal Angioplasty (PTA) Balloon vs. Standard PTA for the Treatment of Obstructive Lesions in the Native Arteriovenous Dialysis Fistulae (AVF); IR = interventional radiology; LOS = length of stay; NEAT = Novel Endovascular Access Trial; PAE = prostatic artery embolization; PTA = percutaneous transluminal angioplasty; QALY = quality-adjusted life-year; REVISE = Endoprosthesis Versus Percutaneous Transluminal Angioplasty to Revise AV Grafts in Hemodialysis; SAVF = surgical arteriovenous fistula; SG = stent graft; TURP = transurethral resection of the prostate; USRDS = United States Renal Data System; WTP = willingness-to-pay.

Table E3. Studies on Peripheral Arterial Disease Council

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Vossen et al (19), 2019, the Netherlands, euro (€)	PAD	PTA/S FPB surgery	Single hospital–level database (3-y horizon); 226 patients	Hospital costing data based on Central Plan Bureau (20)	Diagnostic, procedural, hospitalization, and reintervention costs	PTA/S was more cost-effective than FPB for TASC B and C lesions as an initial treatment strategy	PTA/S vs FPB costs at 3 y: €29,058 vs €42,437. FPB costed $563,716 more per an extra patient, reaching 3-y primary patency rates comparable with those of PTA/S. The main contributor to PTA was the initial treatment cost
van Reijen et al (21), 2022, the Netherlands, euro (€)	PAD	ER SET	Multicenter RCT (SUPER study); 240 patients; societal perspective	Costs from the Dutch Cost Manual and Dutch Care Products Manual	Procedural, reintervention, and follow-up costs	ER resulted in a slightly better health outcome and higher QALYs but more costly than SET	Largest RCT comparing both treatments. ER was more costly than SET (€4,031 vs €2,179), mainly owing to higher number of concomitant days of admission to surgical ward for ER. VascuQOL sumscore was modestly higher in ER than in SET (5.76 vs 5.11). With an ICER of €20,805/QALY, ET was more cost-effective
Locham et al (22), 2019, United States, USD ($)	PAD	DESs BMSs	Multivariable generalized linear model to examine costs; 20,702 patients	All-payer US data (inpatient and outpatient)	Total in-hospital costs	The cost of a DES was $407 higher than that of a BMS	Overall cost of hospitalization was higher for both stents in patients with >3 comorbidities, smokers, inpatients, and those undergoing concomitant procedures. Endovascular stent placement was more costly in teaching hospitals and rural settings ($620 and $1,036, respectively)
Gray et al (23), 2022, United States, USD ($)	PAD	Paclitaxel-eluting stent (Eluvia, Boston Scientific, Marlborough, MA) Zilver PTX stent (Cook Medical, Bloomington, IN)	State-transition, decision-analytic (microsimulation) model (2-y horizon)	Medicare Administrative and Claims data (inpatient and outpatient)	Procedural costs; physician fees	Eluvia dominated Zilver PTX by being less costly and more effective 73.6% of 1,000 simulations	At a WTP threshold of $5,000/target lesion revascularization (TLR), $10,000/TLR, and $15,000/TLR, Eluvia was 84.1%, 87.8%, and 90.7% cost-effective respectively
Sivapragasam et al (24), 2022, Singapore, USD ($)	PAD	DCBA Conventional balloon angioplasty (PTA)	Economic analysis embedded within the SINGA-PACLI trial (12-mo horizon); 138 patients	Hospital costs and market price	Procedural, hospitalization, and health care utilization costs	DCBA had a mean gain of 0.012 QALYs, but no statistical difference was found in costs and effectiveness between the DCBA and PTA groups	Balloon costs in DCBA were 4 times higher than those in PTA owing to unit pricing and the number of balloons used. The DCBA group had higher number of inpatient admissions, leading to higher health care utilization costs
Wakkie et al (25), 2020, the Netherlands, euro (€)	PAD	DES BMS	Economic analysis embedded within the PADI Trial (1-, 2-, and 3-y horizons); 137 patients	Hospital costs and costs from a Dutch Health Insurance Company (VGZ)	Procedural costs, clinical equipment and resources, rehabilitation costs	DESs were more cost-effective than BMSs owing to lesser costs of amputation and rehabilitation	A difference of €1.679 and €2.694 at 1- and 3-y, respectively, was found in favor of the DES group
Gouëffic et al (26), 2021, France, euro (€)	PAD	Outpatient hospitalization Inpatient hospitalization	Economic analysis embedded within the AMBUVASC trial (1-mo horizon); 153 patients	Costs valued on the basis of the euro rate from the year 2017	Procedural costs, equipment and resources, rehabilitation, hospitalization costs, and follow-up costs	At an ICER of €67,741/QALY (a WTP of €50,000), outpatient procedures were not cost-effective from a societal perspective	The mean cost per patient was higher in the outpatient arm owing to higher intervention and rehospitalization costs. Outpatient was not cost-effective unless a relatively high WTP was accepted

continued

Table E3. Studies on Peripheral Arterial Disease Council *(continued)*

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Sridharan et al (27), 2018, United States, USD ($)	PAD	BMS Zilver PTX	Simulation base-case scenario; model based on Florida State ambulatory databases (5-y horizon)	Medicare and Medicaid reimbursement rates	Procedural and reintervention costs	The use of DES resulted in overall cost savings of $1,688,953 compared with that of BMS alone over 5 y	Despite high device costs for DES, overall costs at 5 y were less owing to significant decrease in reinterventions owing to improved patency rates

AMBUVASC = Cost-utility Analysis of the Outpatient versus Conventional Hospitalization in Treatment of Occlusive Arterial Disease; BMS = bare-metal stent; DCBA = drug-coated balloon angioplasty; DES = drug-eluting stent; ER = endovascular revascularization; FPB = femoropopliteal bypass; ICER = incremental cost-effectiveness ratio; PAD = peripheral arterial disease; PADI = Percutaneous Transluminal Angioplasty versus Drug-Eluting Stents for Infrapopliteal Lesions; PTA = percutaneous transluminal angioplasty; PTA/S = percutaneous transluminal angioplasty with optimal stent placement; QALY = quality-adjusted life-year; RCT = randomized controlled trial; SET = supervised exercise therapy; SINGA-PACLI = Singapore Infra-Genicular Angioplasty with Paclitaxel-Eluting Balloon for Critical Limb Ischaemia; SUPER = Supervised Exercise Therapy versus Endovascular Revascularisation; TASC = TransAtlantic Inter-Society Consensus; VascuQOL = vascular quality of life; WTP = willingness-to-pay.

Table E4. Studies on Pediatric Interventional Radiology Council

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Ceraulo et al (28), 2017, France, euro (€)	Primary malignant bone tumors	Percutaneous biopsy Open biopsy	Single hospital–level database; 117 patients	Hospital costs	Cost of consumables, clinical equipment and resources, laboratory tests, maintenance and overhead costs, and supplementary costs	Mean costs for the entire outpatient visit or inpatient stay were significantly lower with percutaneous biopsy (€1,937 vs €6,362 for open biopsy)	The percutaneous group was cost-effective even after considering supplementary costs generated from a failed percutaneous attempt. The mean LOS was shorter for the percutaneous group (2 d) than for the open group. The diagnostic yield was not significantly different
Hayatghaibi et al (29), 2020, United States, USD ($)	TFCL placement	Placement of a catheter at bedside Placement of a catheter in the IR suite	Single hospital–level database; TDABC; 19 patients	Hospital costs	Process maps, time stamps, clinical equipment and resources, and personnel/staffing costs	TFCLs placed in IR took less operative time but did not translate into cost savings. Costs were not significantly different between in-suite and portable procedures	The greatest contribution for both groups was from personnel costs (68%–75% for IR and 74%–80% for bedside). Anesthesia was a significant contributor to the cost of TFCL placement
Tan et al (30), 2021, United Kingdom, UK pounds sterling (£)	Nutritional support	Conversion of endoscopically placed gastrostomy (Enfit Connection System, Cardinal Health, Dublin, OH) to unibody balloon-retained gastrojejunostomy Balloon GJ (Vygon MIC-Key) tube Use of an Enfit connector jejunostomy (through disc-retained gastrostomy)	Single hospital–level database; 100 patients	NHS tariffs	Clinical equipment and resources; complication costs	The mean health care cost for Enfit connector jejunostomy was £547, and the cost for unibody gastrojejunostomy was £505, making unibody gastrojejunostomy more cost-effective	A Balloon GJ tube had higher tube costs (£325 vs £142) but lower complication costs (£9,925 vs £28,375) than PEGJ. Balloon GJ showed a significant survival advantage against all complications over PEGJ
Rose et al (31), 2021, United Kingdom, UK pounds sterling (£)	Nutritional support	Balloon-retained gastrojejunostomy tubes Disc-retained gastrojejunostomy tubes	Single hospital–level database; 187 patients	Hospital costs	Cost of consumables, personnel/staffing costs, and overhead costs	Disc-retained tubes cost significantly more per day than balloon-retained tubes (£6.9/d vs £5.2/d)	Despite disc-retained tubes having a longer length of time between tube changes than balloon tubes, costs were still higher in the disc-retained tube group. Timing of the tube changes directly affected tube costs per day
Dabrowiecki et al (32), 2020, United States, USD ($)	Long-term central venous access	Evaluation of hospital charges associated with central venous stenosis in patients with SBS or ESRD	Single hospital–level database; 9,617 patients	Medicare and Medicaid Services wage/price index (PHIS database)	Number of hospitalizations, LOS, number of procedures, laboratory tests, imaging	Higher charges were found (cumulative, imaging, and laboratory) for patients with central venous stenosis than those for patients without central venous stenosis	Patients with central venous stenosis experienced increased total number of admissions, hospital days, and count of procedures than those without
Reis et al (33), 2021, United States, USD ($)	Venous catheter placement (PICC and TCVC)	Placement of a catheter at bedside Placement of a catheter in the IR suite	Single hospital–level database; TDABC; 195 patients	Hospital costs	Process maps, time stamps, clinical equipment and resources, and personnel/staffing costs	Costs of catheter placement were lower at bedside than those for fluoroscopic procedures ($1,421 vs $2,256)	Bedside interventions had a similar technical success rate and lower bundled direct costs than fluoroscopic interventions, without a significant difference in complication costs. The major difference was costs owing to

continued

Table E4. Studies on Pediatric Interventional Radiology Council *(continued)*

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
							lower sedation, lack of IR room equipment, and room space
Benjamin et al (34), 2019, United States, USD ($)	Plastic bronchitis	Percutaneous lymphatic embolization Heart transplantation Medical management	Single hospital–level database; Markov model	HCUP-AHRQ database	Overhead treatment costs (medication costs included maintenance costs and procedure costs)	Lymphatic embolization was the least costly ($340,941) compared with transplant ($385,841) and medical management ($594,520)	Lymphatic embolization added a net benefit of 0.66 QALYs relative to transplant and generated an ICER of $68,030/QALY (compared with transplant) and $192,105/QALY (compared with medical management). At a WTP threshold of $150,000/QALY, lymphatic embolization is cost-effective

AHRQ = Agency for Healthcare Research and Quality; ESRD = end-stage renal disease; HCUP = Healthcare Cost and Utilization Project; ICER = incremental cost-effectiveness ratio; IR = interventional radiology; LOS = length of stay; NHS = National Health Service; PEGJ = percutaneous endoscopic transgastric jejunostomy system; PHIS = Public Health Information System; PICC = peripherally inserted central catheter; QALY = quality-adjusted life-year; SBS = short bowel syndrome; TCVC = tunneled central venous catheter; TDABC = time-driven activity-based costing; TFCL = tunneled femoral central line; WTP = willingness-to-pay.

Table E5. Studies on Pain Management and Musculoskeletal Council							
Author, year, country, currency	**Disease condition**	**Comparators**	**Cost analysis**	**Cost source**	**Costs measurements**	**Results**	**Comments**
Galendi et al (35), 2022, Germany, euro (€)	CIBP	TDABC of MR-guided high-intensity frequency US treatments for CIBP	Single hospital–level database; TDABC	Hospital data	Process maps, time stamps, clinical equipment and resources, and personnel/staffing costs	Total costs per patient with CIBP treated with MR-guided high-intensity frequency US were €5,147, with equipment costs being highest (41%, €2,112), followed by personnel costs (32%, €1,621) and overhead costs (16%, €842). TDABC provided a reproducible tool for cost accounting for MR-guided high-intensity frequency US	The developed pathway reflects care practices from several European centers. The cost per patient treated with MR-guided high-intensity frequency US dropped by €540 when an increased operational capacity was considered secondary to better capital asset utilization. Owing to a learning curve regarding evaluating costs of MR-guided high-intensity frequency US, it is possible that there may be overestimation of costs. A subgroup analysis on different types of bone tumors was not conducted owing to small individual sample size
Bucknor et al (36), 2020, United States, USD ($)	CIBP	MR-guided focused US ablation Medication only	Dual hospital–level database; Markov model	From hospital reimbursement data and Red Book Online (Pediatric Infectious Diseases from the American Academy of Pediatrics)	Procedural costs, cost of consumables, clinical equipment and resources, personnel/staffing costs	MR-guided focused US ablation accumulated additional 0.22 QALYs (0.50 vs 0.28) compared with medication only, with an ICER of $54,160/QALY	At a WTP threshold of $100,000/QALY, MR-guided focused US ablation was the preferred treatment strategy, which remained the preferred treatment throughout the range of plausible costs of pain medications
Desai et al (37), 2019, United Kingdom, USD ($)	Osteoarthritis	RF ablation IAS	Analysis based on randomized, crossover trial (38); 151 patients	Centers for Medicare and Medicaid Services fee schedules (reference year, 2017)	Procedural costs, physician fees	RF ablation was a highly cost-effective option compared with IAS	At an incremental cost of $1,711, RF ablation was associated with an incremental QALY gain of 0.091 and 0.229 at 6 and 12 mo, respectively, showing a sustained benefit over IAS. Using RF ablation translated into ICERs below $17,827/QALY (6 mo) and $7,308/QALY (12 mo). At a WTP threshold of $100,000/QALY, RF ablation had a 86% (6 mo) and 95% (12 mo) probability of being cost-effective

CIBP = cancer-induced bone pain; IAS = intra-articular steroid; ICER = incremental cost-effectiveness ratio; MR = magnetic resonance; QALY = quality-adjusted life-year; RF = radiofrequency; TDABC = time-driven activity-based costing; US = ultrasound; WTP = willingness-to-pay.

Table E6. Studies on Neurointerventional Radiology Council

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Duangthongphon et al (39), 2022, Thailand, USD ($)	SAH	Endovascular coil embolization Neurosurgical clipping	Base-case scenario; Markov model (lifetime horizon)	Costs from Standard Consumer Price Lists	Procedural costs, hospitalization costs, reintervention costs, personnel/staffing costs, equipment and resources	The use of coil was more cost-effective than clipping but incurred additional costs of $4,343 and $1,923 under health care and societal perspectives, respectively, resulting in an ICER of $3,321/QALY and $1,470/QALY, respectively	Coil embolization had a >65% chance of being cost-effective at the country's CE threshold (THB 160,000 or US $5,156/QALY). Coil embolization was more effective in reducing disability and, hence, incurred a lower caregiver cost
Khunte et al (40), 2021, United States, USD ($)	Stroke	EVT MM	Base-case scenario; Markov model (1-y horizon)	Costs from National Inpatient Sample	Procedural, hospitalization, and follow-up costs	EVT was not cost-effective in the short term (higher costs: $51,015 vs $36,542) but was cost-effective in the long term (lower costs: $551,159 vs $577,181)	EVT was cost-effective in 93.37% of all simulations and resulted in net benefit of 1.66 QALYs (606 d of perfect health) for the 65-y-old patient group. EVT had higher ICER for the 55-y-old group that for the 65-y-old group (–$27,320/QALY vs $15,647/QALY)
Wali et al (41), 2017, United States, USD ($)	Intracranial aneurysms	Endovascular coil embolization PED	Base-case scenario; Markov model (50-y horizon)	Hospital and manufacturer costs	Procedural cost, hospitalization costs, reintervention costs, personnel/staffing costs, and equipment and resources	PED was more cost-effective than endovascular coil embolization (lifetime costs: $59,837.52 vs $79,025.42) while yielding slightly lower QALYs (12.72 vs 12.89)	At a WTP threshold of 50,000/QALY, PED was more cost-effective than endovascular coil embolization (58.4% vs 41.4%). The cost-effectiveness model was most sensitive to costs and mortality risks for PED and coil embolization
Sarraj et al (42), 2021, United States, USD ($)	Stroke	EVT MM	Multicenter, prospective, observational (SELECT study); Markov model; 105 patients (lifetime horizon)	Costs from National Inpatient Sample	Procedural costs, hospitalization costs, personnel/staffing costs, equipment and resources, follow-up costs, and community care costs	EVT had an incremental cost of $33,094 and a gain of 1.34 QALYs, resulting in an ICER of $24,664/QALY. EVT had a higher net monetary benefit than MM at lower (–$42,747 vs –$76,740) and upper (155,041 vs 57,134) WTP thresholds	At a WTP of $50,000/QALY and $100,000/QALY, EVT had a 77% and 92% probability of being cost-effective, respectively. Sensitivity analysis using a Markov model and data from the pivotal trials HERMES, DAWN, and DEFUSE 3 showed EVT to be the dominant strategy, with societal cost savings of $37,901, $86,164, and $22,501 and gains of 1.62, 2.36, and 2.21 QALYs, respectively
Wu et al (43), 2021, United States, USD ($)	Stroke	EVT MM	Base-case scenario; Markov model (lifetime horizon)	Costs extracted from the IMS III trial	Procedural costs, hospitalization costs, personnel/staffing costs, equipment and resources, follow-up costs, community care costs	EVT was more cost-effective in the long term than in the short term for patients in the 55-, 65-, and 75-y age groups	In the short term, EVT had an ICER higher than the $100,000/QALY threshold ($412,411/QALY and $1,022,985/QALY for 55- and 65-y-old groups, respectively). In the long term, EVT had a higher health benefit of 2.21 QALYs and 0.79 QALYs in the 2 groups. Probability sampling revealed EVT to be more cost-effective 96.16% of times. EVT was more cost-effective when the good outcome was 1.6% higher in absolute value than that in MM

CE = cost effectiveness; DAWN = Clinical Mismatch in the Triage of Wake Up and Late Presenting Strokes Undergoing Neurointervention With Trevo; DEFUSE 3 = Endovascular Therapy Following Imaging Evaluation for Ischemic Stroke 3; EVT = endovascular thrombectomy; HERMES = Highly Effective Reperfusion evaluated in Multiple Endovascular Stroke Trials; ICER = incremental cost-effectiveness ratio; IMS = interventional management of stroke; MM = medical management; PED = pipeline embolization device; QALY = quality-adjusted life-year; SAH = subarachnoid hemorrhage; SELECT = Optimizing Patient Selection for Endovascular Treatment in Acute Ischemic Stroke; THB = Thai baht; WTP = willingness-to-pay.

Table E7. Studies on Women's Reproductive Health Council

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Rana et al (44), 2021, United Kingdom, UK pounds sterling (£)	Uterine fibroids	UAE Myomectomy	A within-trial cost-utility analysis (FEMME trial); 254 patients	NHS reference costs, Personal Social Services Resource Unit, BNF	Clinical equipment and resources, follow-up, inpatient admission, and complication costs	UAE had a lower mean cost, higher posttreatment costs (2 and 4 y) and lower QALY (2 and 4 y) than myomectomy	The mean treatment cost for UAE was lower than that for myomectomy (£3,064 vs £3,862), but the follow-up cost was higher because women in the UAE group received more reinterventions at 2 y (£4,918 vs £3,431) and 4 y (£5,288 vs £4,151). A longer LOS was observed for myomectomy than for UAE (4 d vs 2 d)
Brooks et al (45), 2020, United States, USD ($)	Uterine fibroids	TFA Myomectomy	Comparative case-matched study using prospective (TFA arm) and retrospective (surgery arm) data; 88 patients	Hospital costs	Procedural costs, clinical equipment and resources, and hospitalization costs	The supply cost of TFA was higher than that for the surgery arm, but all nonsupply costs and total mean costs of TFA were lower than those for myomectomy (combined, abdominal, and laparoscopic variant)	TFA was more cost-effective, with reduced procedural time and being an outpatient procedure ($7,563 vs $18,373)
Cronan et al (46), 2020, United States, USD ($)	Uterine fibroids	Hysterectomy Endometrial ablation Myomectomy UFE	Claims data using CPT codes to identify treatment types; 229,897 patients	Claims data	Procedural costs, episode of care costs (within 7 d or admission)	Endometrial ablation was the least costly per procedure and per episode of care. Among all treatment groups, UFE was the most costly	The mean procedural cost of ablation ($2,781) was less than that of hysterectomy ($3,188) and UFE ($6,161). UFE and ablation had a shorter LOS than surgery (0.17 d and 0.02 d vs 1.24 d, respectively)
Wang et al (47), 2020, United States, USD ($)	Uterine fibroids	Hysterectomy Myomectomy UAE	Population-level analysis using administrative outpatient data (HCUP); 90,800 patients	Claims data	Mean encounter and hospitalization costs	UAE was associated with lower mean encounter costs and lower hospital charges than those of myomectomy and hysterectomy	There was a significant difference in hospital LOSs for UAE compared with those of hysterectomy. UAE ($3,772) was the least costly, whereas myomectomy was the most costly ($6,318)
Lewis et al (48), 2017, United States, USD ($)	Uterine fibroids	Hysterectomy UAE	Inpatient data from Agency for Health Care Research and Quality's HCUP; 133,813 patients	Hospital costs	Overhead treatment costs	UAE was generally more costly than hysterectomy	Cost of UAE was higher in both urban and rural settings

BNF = British National Formulary; CPT = Current Procedural Terminology; FEMME = Treating Fibroids with Either Embolization or Myomectomy to Measure the Effect on Quality of Life; HCUP = Healthcare Cost and Utilization Project; LOS = length of stay; NHS = National Health Service; QALY = quality-adjusted life-year; TFA = transcervical fibroid ablation; UAE = uterine artery embolization; UFE = uterine fibroid embolization.

Table E8. Studies on Venous Council

Author, Year, Country, Currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Brittenden et al (49), 2019, United Kingdom, UK pounds sterling (£)	Varicose veins	Laser ablation Foam sclerotherapy Surgery	Multicenter, randomized, controlled trial (5-y horizon); Markov model; 798 patients	Hospital costing data	Procedural, recurrence and reintervention costs	Laser ablation was the most cost-effective among all modalities	In a 3-way comparison, at a threshold WTP of £20,000/QALY ($28,433) per QALY, 77.2% of the probabilistic model iterations favored laser ablation. In a 2-way comparison between surgery and foam sclerotherapy, surgery was favored
Masthoff et al (50), 2021, Germany, euro (€)	VM	Treatments of VMs and AVMs	Single hospital–level database; TDABC	Hospital costing data	Process maps, time stamps, clinical equipment and resources, and personnel/staffing costs	Material costs contributed the most to costs (45% and 75% of total costs for VM and AVM, respectively). The mean cost of AVM materials was 5.1 times higher than that of VM treatment. TDABC-informed negotiations improved profit from –56% to +40% and from +41% to +69% for AVM and VM treatments, respectively. Treatment time was lower for VMs (19% of total) than for AVMs (46% of total)	Use of TDABC with process modification resulted in major reduction of personnel time and total costs. An interview-based approach was used for time reporting of steps, which might have resulted in an inherent bias. When interviewing for time estimates, there was a lesser variability in reporting for shorter and standardized process steps (compared with process steps that were extended and more complex). This analysis was based on a tertiary care institution, which may have included more complex ailments requiring more complex treatments, more time per patient, and more extensive overhead than another level of care
Keller et al (51), 2019, United States, USD ($)	PICC placement	Guided PICC placement External PICC placement	Single hospital–level database; propensity score–matched sample; base-case scenario	Medicare reimbursement rates	Procedural costs, personnel/staffing costs, equipment, and resources	Cost per guided PICC was lower than externally placed PICC ($318.54 vs $381.44)	Guided PICCs required less repositioning (1.5% vs 10.3%) and resulted in more PICCs placed overall (86.8% vs 67.6%)

AVM = arteriovenous malformation; PICC = peripherally inserted central catheter; QALY = quality-adjusted life-year; TDABC = time-driven activity-based costing; VM = vascular malformation; WTP = willingness-to-pay.

Table E9. Cost Studies on Unclassified Service Line Councils

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Abdominal aortic interventions							
IMPROVE Trial Investigators (52), 2017, United Kingdom, UK pounds sterling (£)	AAA	EVAR Open surgical repair	Multicenter, randomized controlled trial (IMPROVE); 613 patients; hospital and personal social services perspective	Hospital costing data based on the NICE guidelines	Procedural, admission and readmission, and reintervention costs	Endovascular strategy was more cost-effective with lower mean costs and higher mean QALYs at 3 y	Cost reduction (–£2,605) in the endovascular group was due to fewer hospital days than that in the surgery group (14.4 d vs 20.5 d). The incremental net monetary benefit of endovascular over open repair (QALY at £30,000/QALY) was £7,367
Canning et al (53), 2019, Ireland, euro (€)	AAA	EVAR Open surgical repair	Single hospital–level database (3-y horizon); 494 patients	Ireland Inpatient Hospital Data based on National Costing Figures from 2011 (Ready Reckoner Report) (54)	Procedural costs, follow-up care costs, clinical equipment and resources, laboratory tests	EVAR was more cost-effective than surgical repair (costs at 3 y were €5,776/QALY vs €7,101/QALY)	Total accommodation and operating room costs were lower for EVAR, but follow-up costs were higher than those for open repair
Lymphatics							
Lewis et al (55), 2020, United States, USD ($)	Chyle leaks	Thoracic duct embolization	Single hospital–level database; TDABC	Hospital costing data	Process maps, time stamps, clinical equipment and resources, and personnel/staffing costs	The base-case cost was $7,466.67, and after using local salary information and negotiated prices, the true cost per case was $8,038.94. Largest labor factor contribution came from the time spent by the anesthesiologist, interventional radiologist, and registered nurse anesthetist. Among materials, glue (quantity used) and coils were the largest drivers of cost	Procedural disposable devices and material expenses (glue) dominated the costs. Using alternative materials for glue resulted in significant cost savings of $2,947.5. Limitation on the quantity of materials used also resulted in cost savings
Splenic trauma							
Kanters et al (56), 2022, the Netherlands, euro (€)	Splenic trauma	SAE Splenectomy	Multicenter, prospective, observational (SPLENIQ study); Markov model; 106 patients	Hospital costs	Procedural costs, clinical equipment and resources, and personnel/staffing costs	SAE had lower intervention costs but higher total costs (owing to increased life expectancy compared with that of the surgery group). SAE resulted in more QALYs than splenectomy and was found to be cost-effective compared with splenectomy under appropriate Dutch cost-effectiveness thresholds	Total costs for SAE (€233,755) were higher than those for surgery (€199,620) and included higher medical consumption costs (€149,167 vs €127,469) and higher productivity costs (€83,645 vs €70,277), resulting in an ICER of €11,010/QALY. Life expectancy was higher in the SAE group (31.5 y) than in the splenectomy group (26.6 y)

continued

Table E9. Cost Studies on Unclassified Service Line Councils *(continued)*

Author, year, country, currency	Disease condition	Comparators	Cost analysis	Cost source	Costs measurements	Results	Comments
Senekjian et al (57), 2021, United States, USD ($)	Splenic trauma	NOM SAE	Base-case scenario; decision tree cost-utility analysis	Hospital costing data using Healthcare Costs and Utilization Project	Procedural costs, clinical equipment and resources, hospitalization costs, pharmaceutical costs, and complication costs	Compared with SAE, NOM remained the dominant strategy in costs and QALYs in Grades III, IV, and V splenic injuries	At a WTP threshold of $50,000/QALY, NOM was 87.5% cost-effective. The benefit of adding SAE to NOM is to decrease the risk of failure of NOM, thus preventing splenectomy. Adding SAE did not dramatically influence costs regarding ICU LOS
Ascites							
Kwan et al (58), 2018, United States, USD ($)	Refractory ascites	TIPS LVP	Base-case scenario; Markov model	Claims data	Procedural, hospitalization and pharmaceutical costs	TIPS resulted in higher QALYs than LVP (2.76 vs 1.72) for an ICER of $57,003/QALY	At a WTP threshold of $50,000/QALY, there was no difference, but at WTP thresholds of $100,000/QALY, TIPS had a 62% probability of being more cost-effective than LVP
Wu et al (59), 2022, United States, USD ($)	Recurrent ascites	TPC Repeated LVP	Single hospital–level database; Markov model; 103 patients	2021 Medicare reimbursement rates	Procedural and hospitalization costs	TPC was more cost-effective than LVP, with lesser procedural costs than LVP ($3,043 vs $3,868) and a slightly higher health benefit (0.22980 QALY vs 0.22982 QALY)	At a WTP of $100,000/QALY, the ICER of LVP compared with that of TPC was not effective ($44,863,103/QALY). The greatest effect was due to the risk of complications and their associated costs. TPC was more cost-effective when complication risk was >0.81% per 22 d or the procedural cost of TPC was >$1,997
Wu et al (60), 2022, United States, USD ($)	Recurrent ascites	TPC Repeated LVP	Single hospital–level database Markov model; 100 patients	2021 Medicare reimbursement rates	Procedural and hospitalization costs	TPC ($4,151) was more cost-effective than LVP ($8,401), with a higher health benefit in patients with cirrhosis and malignant ascites	Rates of complications and their associated costs were the main drivers of comparison. Patients with LVP had more hospitalizations (30 ascites-related; 177 hospital days) than those with TPC (10 ascites-related; 15 hospital days). TPC was more cost-effective in 97.49% of all patients

AAA = abdominal aortic aneurysm; EVAR = endovascular repair; ICER = incremental cost-effectiveness ratio; ICU = intensive care unit; IMPROVE = Immediate Management of the Patient with Rupture; LOS = length of stay; LVP = large-volume paracentesis; NICE = National Institute For Health and Care Excellence; NOM = nonoperative management; QALY = quality-adjusted life-year; SAE = splenic artery embolization; SPLENIQ = SPLENic Injury and Quality of life; TDABC = time-driven activity-based costing; TIPS = transjugular intrahepatic portosystemic shunt; TPC = tunneled peritoneal catheter; WTP = willingness-to-pay.