EVAR Follow Up: Systematic Review with ☸SAIMSARA.

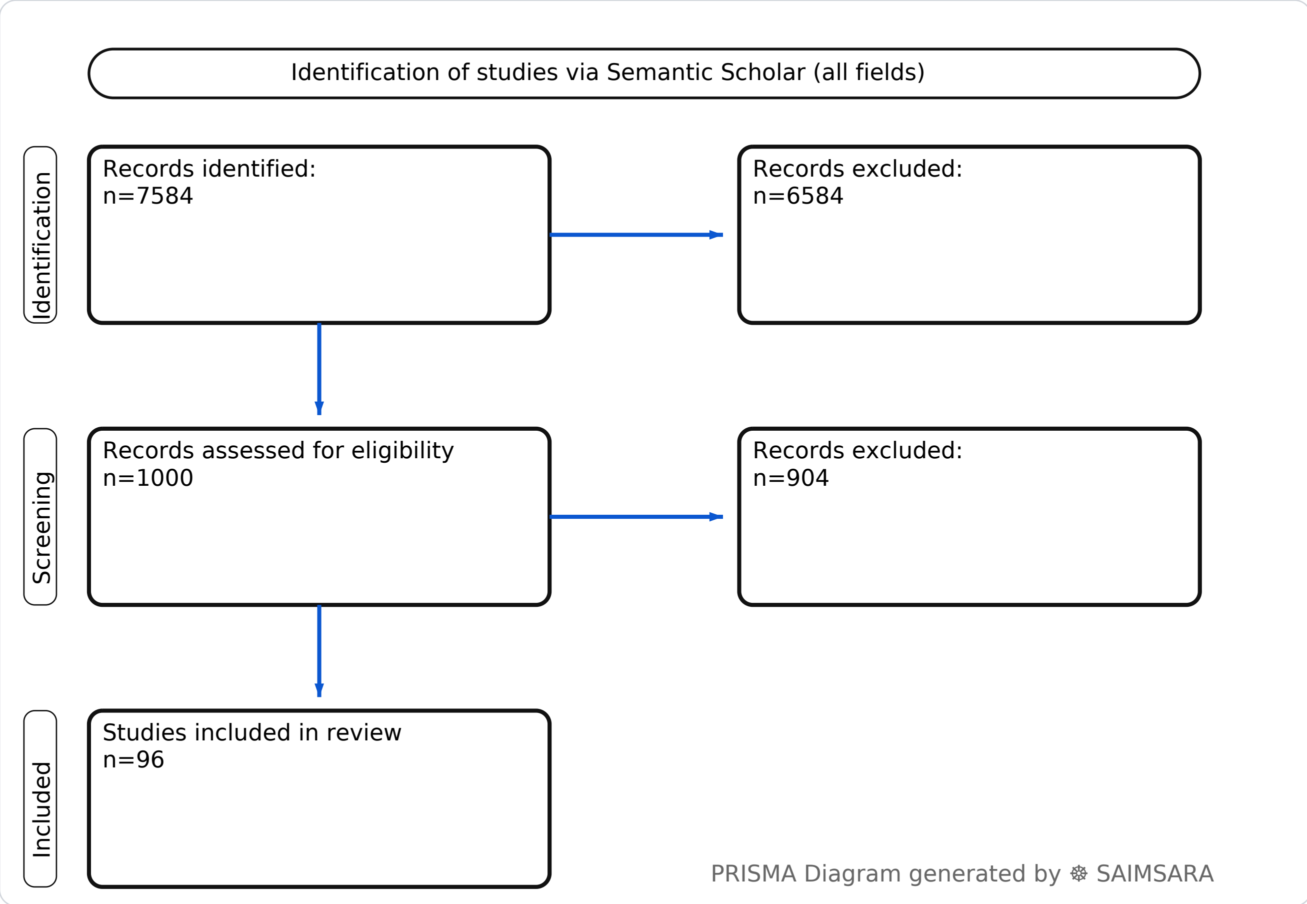
saimsara.com • Download PDF • URL

Abstract: This paper aims to systematically review and synthesize the current evidence regarding the follow-up of patients after Endovascular Aneurysm Repair (EVAR), focusing on long-term outcomes, diagnostic strategies, and emerging technologies, to identify key clinical implications and future research directions. The review utilises 96 studies with 485520 total participants (naïve ΣN). Reintervention rates following EVAR show considerable variability across studies and devices, with reported percentages ranging from 10% at mean follow-up to 27.0% at 5-year follow-up for specific devices. This high rate of reintervention, coupled with other potential complications, necessitates rigorous and often lifelong follow-up. The heterogeneity in study designs and outcome reporting across the literature remains the single limitation that most affects certainty regarding optimal surveillance strategies. Clinicians should prioritize the use of less invasive and radiation-free imaging modalities like ultrasound as a primary surveillance tool, especially given its comparable accuracy to CTA for endoleak detection.

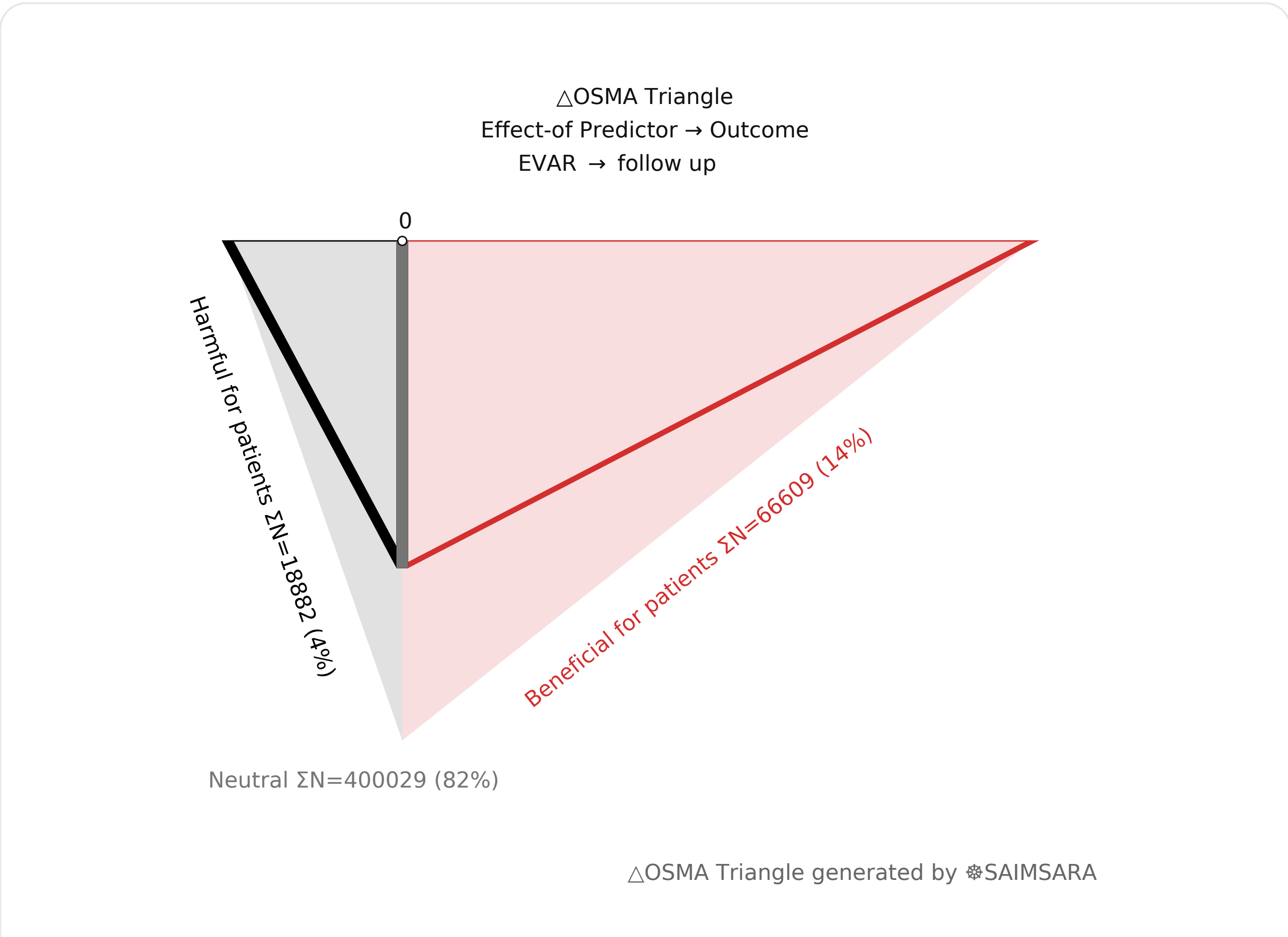
Keywords: Endovascular Aneurysm Repair; EVAR Surveillance; Abdominal Aortic Aneurysm; Endoleak; Computed Tomography Angiography; Ultrasound Imaging; Post-EVAR Complications; Reintervention; Long-term Outcomes; Radiation Exposure

Review Stats

- Generated: 2026-02-13 21:39:18 CET
- Plan: Pro (expanded craft tokens; source: Semantic Scholar)
- Source: Semantic Scholar
- Scope: All fields
- Keyword Gate: Fuzzy (≥60% of required terms, minimum 2 terms matched in title/abstract)
- Total Abstracts/Papers: 7584
- Downloaded Abstracts/Papers: 1000
- Included original Abstracts/Papers: 96
- Total study participants (naïve ΣN): 485520



Identification of studies via Semantic Scholar (all fields)
Identification
Records identified:
n=7584
Records excluded:
n=6584
Screening
Records assessed for eligibility
n=1000
Records excluded:
n=904
Included
Studies included in review
n=96
PRISMA Diagram generated by ☸ SAIMSARA



△OSMA Triangle
Effect-of Predictor → Outcome
EVAR → follow up
0
Harmful for patients ΣN=18882 (4%)
Beneficial for patients ΣN=66609 (14%)
Neutral ΣN=400029 (82%)
△OSMA Triangle generated by ☸SAIMSARA

Outcome-Sentiment Meta-Analysis (OSMA): *(LLM-only)*

Frame: Effect-of Predictor → Outcome • *Source*: Semantic Scholar

Outcome: follow up Typical timepoints: 30-day, peri/post-op. Reported metrics: %, CI, p.

Common endpoints: Common endpoints: mortality, complications, survival.

Predictor: EVAR — procedure/intervention. Routes seen: subcutaneous. Typical comparator: open repair of abdominal, open repair, computerized tomography, evar without this intervention….

- **1) Beneficial for patients** — follow up with EVAR — [22], [39] — ΣN=66609
- **2) Harmful for patients** — follow up with EVAR — [44], [45] — ΣN=18882
- **3) No clear effect** — follow up with EVAR — [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [23], [24], [25], [26], [27], [28], [29], [30], [31], [32], [33], [34], [35], [36], [37], [38], [40], [41], [42], [43], [46], [47], [48], [49], [50], [51], [52], [53], [54], [55], [56], [57], [58], [59], [60], [61], [62], [63], [64], [65], [66], [67], [68], [69], [70], [71], [72], [73], [74], [75], [76], [77], [78], [79], [80], [81], [82], [83], [84], [85], [86], [87], [88], [89], [90], [91], [92], [93], [94], [95], [96] — ΣN=400029

1) Introduction

Endovascular Aneurysm Repair (EVAR) has revolutionized the treatment of abdominal aortic aneurysms (AAAs), offering a less invasive alternative to open surgical repair (OSR). While EVAR provides clear early operative benefits, its long-term durability necessitates diligent and often lifelong postoperative surveillance to detect and manage potential complications such as endoleaks, device migration, and aneurysm sac changes. The effectiveness and optimal strategies for this follow-up remain areas of active research, balancing diagnostic accuracy, patient burden, and healthcare costs. This paper synthesizes current evidence on EVAR follow-up, exploring its long-term outcomes, surveillance modalities, and associated challenges.

2) Aim

This paper aims to systematically review and synthesize the current evidence regarding the follow-up of patients after Endovascular Aneurysm Repair (EVAR), focusing on long-term outcomes, diagnostic strategies, and emerging technologies, to identify key clinical implications and future research directions.

3) Methods

Systematic review with multilayer AI research agent: keyword normalization, retrieval & structuring, and paper synthesis (see SAIMSARA About section for details).

- **Bias:** Qualitatively inferred from study design fields. Randomized Controlled Trials (RCTs) [1, 3, 5, 10, 26, 67, 84, 88] generally offer higher certainty, while cohort [8, 9, 11, 22, 28, 30, 32, 43, 44, 48, 50, 51, 52, 54, 59, 62, 64, 66, 71, 73, 75, 76, 79, 81, 83, 87], case-control [38], and mixed-design studies [2, 4, 6, 7, 12, 13, 14, 15, 16, 17, 18, 19, 20, 23, 24, 25, 27, 31, 33, 34, 35, 36, 37, 39, 41, 42, 45, 46, 47, 49, 53, 55, 56, 57, 58, 60, 61, 63, 65, 68, 69, 70, 72, 77, 78, 80, 82, 89, 90, 91, 92, 93, 94, 95, 96] may be subject to various biases including selection bias, confounding, and lack of blinding. Retrospective studies [7, 9, 11, 22, 23, 25, 30, 35, 49, 52, 55, 60, 61, 68, 70, 72, 75, 77, 78, 79, 80, 81, 83, 85, 86, 89, 90, 92, 93, 94, 95] are inherently more prone to bias than prospective ones [1, 3, 5, 10, 26, 27, 36, 46, 50, 53, 57, 59, 69, 82, 84, 87]. Studies with unspecified design or directionality [4, 6, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 24, 28, 29, 31, 32, 33, 34, 37, 39, 40, 41, 42, 43, 44, 45, 47, 48, 54, 56, 62, 63, 64, 65, 67, 71, 73, 74, 76, 88, 91, 94, 95, 96] limit the ability to assess internal validity.

4) Results

4.1 Study characteristics:

The included studies comprise a mix of randomized controlled trials (RCTs), cohort studies, and mixed-design studies, with both prospective and retrospective approaches. Populations generally consist of patients undergoing EVAR for abdominal aortic aneurysms (AAAs), including those unfit for open repair, and some studies specifically address complex aneurysms (e.g., pararenal, thoracoabdominal, juxtarenal) or specific patient subgroups (e.g., octogenarians, young patients, those with sarcopenia). Follow-up durations vary widely, ranging from 30 days [49, 67, 79, 80] to very long-term, including 15 years [1] and mean follow-ups of 12.7 years [3].

4.2 Main numerical result aligned to the query:

Reintervention rates following EVAR show considerable variability across studies and devices, with reported percentages ranging from 10% at mean follow-up [85] to 27.0% at 5-year follow-up for specific devices [28]. The median of reported percentage reintervention rates is approximately 17.35% (derived from 10% [85], 14.9% [28], 15.4% [94], 16.7% [28], 18% [39], 19.5% [28], 22% [75], 27% [28]). This is notably higher than rates for open repair, with one study reporting 4.1 vs 1.7 per 100 person-years for EVAR vs open repair ($p<0.001$) [3].

4.3 Topic synthesis:

- **Long-term Comparative Outcomes:** EVAR offers an early survival benefit over open repair but an inferior late survival benefit in fit patients, with higher reintervention rates (4.1 vs 1.7 per 100 person-years, $p<0.001$) [3, 10, 42]. For patients unfit for open repair, EVAR does not prolong life but can reduce AAA-related mortality [3, 5, 10].
- **Surveillance Modalities:** Color Doppler ultrasound (CDUS), Superb Micro-vascular Imaging (SMI), and Contrast-Enhanced Ultrasound (CEUS) show comparable diagnostic accuracy to Computed Tomography Angiography (CTA) for endoleak detection (e.g., SMI/CEUS accuracy 95.9% vs CTA [2], 97% vs CTA [6]), offering advantages of availability, cost-effectiveness, and lack of nephrotoxicity/radiation [2, 4, 6, 13, 33]. DUS has an overall low sensitivity (39%) but improves for patients requiring reintervention (73%) [57].
- **Endoleak Detection and Management:** Type II endoleaks are a common concern, with incidence significantly reduced by inferior mesenteric artery embolization (24.5% vs 49.1%; $P = 0.009$) [26]. Persistent type II endoleaks may necessitate surgical repair in 3.9% of cases [9]. Radiomic features can predict aggressive type II endoleaks with high accuracy (AUC 95.5%) [36]. Type I endoleaks can spontaneously seal in 70% of cases [86].
- **Complications:** Delayed complications include limb graft occlusion (10.6% of patients, average 7.8 months) [19, 51], spondylodiscitis (0.5% incidence) [74], and acute kidney injury (AKI) (14.1% incidence), which is an independent risk factor for long-term renal function decrease (HR 3.01) [64, 70, 76]. Non-access-related re-interventions occur in 22% of patients [75].
- **Patient-Specific Factors:** Low skeletal muscle index (SMI) and subcutaneous fat index (SFI) are associated with poorer long-term survival (1-year mortality 10% vs 3% for low vs high SMI) [30]. Radiological sarcopenia is linked to inferior survival (HR 2.61) [43]. Octogenarians experience significantly increased mortality during follow-up, with 5-year survival being very low (51.08% mortality) [24]. Women are more likely to have unfavorable neck anatomy and an increased risk of 30-day mortality (50% increased risk) and type 1 endoleak [49]. High preoperative C-reactive protein (CRP) predicts increased long-term mortality [81].
- **Cost-effectiveness of Surveillance:** Color duplex ultrasound as a first-line surveillance tool is associated with reduced cost without compromising accuracy [13]. Chimney EVAR (ch-EVAR) is significantly more cost-effective than fenestrated EVAR (f-EVAR) for complex aortic pathologies [58].
- **Radiation Exposure:** Routine CT examinations contribute to a significant radiation burden (median effective dose 24.5 mSv, cumulative up to 310 mSv) [8, 88]. Single-acquisition, split-bolus dual-energy CT can reduce radiation dose while maintaining 96% accuracy for endoleak detection [53, 31].
- **Device-Specific Outcomes:** Device-specific risks in long-term reintervention exist, with the early AFX device showing higher rates (27.0% at 5 years) compared to others like Excluder

(14.9%) [28]. The Ovation-iX system showed improved eligibility rates within device instructions for use (IFU) compared to other devices [55].

- **Predictive Modeling:** Artificial Neural Network (ANN) models can stratify patients into low- and high-risk groups for endograft complications and mortality (e.g., 5-year freedom from aortic complications 95.9% vs 67.9% for low vs high risk) [52]. AI-based software achieved high accuracy (Se 89.47%, Sp 91.25%) in detecting endoleaks [23]. Machine learning (ML) approaches can diagnose endoleaks with 95% accuracy [56]. Radiomic models show better predictive performance for EVAR outcomes (AUC 0.93) than morphological feature models (AUC 0.76) [35].
- **New Techniques/Technologies:** Fenestrated and branched EVAR (FB-EVAR) for complex aneurysms shows low aortic-related mortality (0.7%) and 5-year freedom from secondary intervention (64% ± 4%) [27]. Percutaneous EVAR (PEVAR) demonstrates high long-term safety with a very low complication rate (0.8%) [7]. Augmented reality technology aims to optimize visualization during EVAR [40].
- **Hospital Volume Effects:** Higher hospital volume is associated with significantly lower failure to rescue (FtR) rates after EVAR (OR 0.54 in highest vs lowest volume centers) [32] and lower perioperative mortality in complex EVAR (2.5% vs 9.1% for high vs low volume centers) [46].
- **Aneurysm Sac Dynamics:** Aneurysm sac shrinkage (pooled incidence 48% at 12 months) is correlated with improved survival and reduced complications (HR 0.73 for death) [38]. Aneurysm wall enhancement is associated with shrinkage, while type II endoleaks are associated with expansion [77].
- **Impact of Preoperative Interventions:** Preoperative coil embolization to aortic branched vessels [11] and inferior mesenteric artery embolization [26] prior to EVAR lead to greater aneurysmal sac diameter reduction and reduced type II endoleak incidence, respectively.
- **Quality of Life/Patient Experience:** EVAR results in less physical and emotional decline than OSR in the early postoperative period, with patients returning to near baseline at 90 days [87].
- **Mortality and Readmissions:** EVAR patients had higher all-cause mortality (6.4% vs 4.6%, adjHR 1.34) and readmissions (16.5% vs 8.4%, adjHR 2.15) compared to OAR patients in one study [68]. EVAR for ruptured AAAs was associated with a higher 30-day readmission rate (18.9% vs 14.3% for open repair) [79]. Postoperative EVAR surveillance acquisition decreased (67%→49%), and patients without imaging had a 4-fold greater 1-year mortality (9.2% vs 2.0%) [22].

5) Discussion

5.1 Principal finding:

The principal finding of this synthesis is that reintervention rates following EVAR are substantial and variable, with reported percentages ranging from 10% to 27.0% across different follow-up durations and device types, and a median of approximately 17.35% [28, 85]. This highlights the critical need for continuous and effective post-EVAR surveillance.

5.2 Clinical implications:

- **Lifelong Surveillance Necessity:** The persistent risk of complications, particularly reinterventions (median 17.35%) [28, 85], underscores the need for lifelong surveillance after EVAR to ensure long-term device integrity and patient safety.
- **Ultrasound as Primary Tool:** Ultrasound modalities (CDUS, SMI, CEUS) offer high diagnostic accuracy for endoleak detection (e.g., 95.9% accuracy [2]) with benefits of cost-effectiveness, lack of radiation, and reduced invasiveness, making them suitable as first-line surveillance tools [2, 4, 6, 13, 33].
- **Personalized Risk Assessment:** Patient-specific factors such as age (octogenarians have higher mortality [24]), sex (women face higher risks of complications and mortality [49]), and body composition (low SMI linked to poorer survival [30, 43]) should guide personalized follow-up strategies and risk stratification.
- **Endoleak Management:** Early detection and appropriate management of endoleaks, especially aggressive Type II endoleaks [36] and persistent Type II endoleaks leading to sac growth [9], are crucial for preventing aneurysm-related morbidity and mortality.
- **Hospital Volume Impact:** Performing EVAR in high-volume centers is associated with significantly lower failure to rescue rates [32] and reduced perioperative mortality for complex EVAR [46], suggesting a benefit for patient outcomes.

5.3 Research implications / key gaps:

- **Optimal Surveillance Protocols:** Further research is needed to establish standardized, evidence-based, and cost-effective surveillance protocols that balance diagnostic accuracy with reduced patient burden and radiation exposure for all patient subgroups [8, 17].
- **AI-Driven Risk Prediction:** Development and validation of AI-based predictive models for identifying patients at high risk of specific complications (e.g., endoleaks, reintervention, mortality) could enable truly personalized surveillance intervals and interventions [23, 35, 36, 48, 52, 56].
- **Long-Term Comparative Effectiveness:** Continued very long-term (beyond 15 years) comparative studies between EVAR and open repair are essential to fully understand the durability and overall survival benefits, particularly for younger patients and those with complex anatomies [1, 3, 5, 10, 34].

- **Impact of Preoperative Interventions:** Prospective studies are warranted to further evaluate the long-term impact and cost-effectiveness of preoperative interventions, such as coil embolization, on reducing endoleak incidence and improving sac regression [11, 26].
- **Patient-Reported Outcomes:** More comprehensive studies are needed to assess patient-reported outcomes, quality of life, and long-term functional status after EVAR, including the impact of surveillance burden, beyond early postoperative periods [87].

5.4 Limitations:

- **Study Heterogeneity** — The included studies vary significantly in design, population, follow-up duration, and reported outcomes, limiting direct comparisons and meta-analysis.
- **Inconsistent Outcome Reporting** — Metrics for reintervention, mortality, and complication rates are not uniformly defined or reported across all studies, making synthesis challenging.
- **Radiation Exposure Data** — While radiation exposure is noted, detailed, long-term cumulative dose data and its clinical impact across diverse surveillance protocols are limited.
- **Generalizability Concerns** — Some studies focus on specific patient subgroups (e.g., octogenarians, young patients) or device types, which may limit the generalizability of findings to the broader EVAR population.
- **Qualitative Bias Inference** — Bias was qualitatively inferred from study design, and a formal quantitative bias assessment was not performed, potentially affecting the interpretation of evidence strength.

5.5 Future directions:

- **Standardized Surveillance Protocols** — Develop and validate harmonized, risk-stratified surveillance guidelines for post-EVAR patients.
- **AI-Enhanced Predictive Models** — Integrate machine learning and radiomics to create robust tools for personalized complication risk assessment.
- **Long-Term Comparative Trials** — Conduct extended follow-up studies comparing EVAR outcomes against open repair beyond 15 years.
- **Personalized Risk Stratification** — Research the utility of biomarkers and imaging features to tailor follow-up intensity and modality.
- **Radiation Dose Optimization** — Investigate novel imaging techniques to minimize cumulative radiation exposure during lifelong surveillance.

6) Conclusion

Reintervention rates following EVAR show considerable variability across studies and devices, with reported percentages ranging from 10% at mean follow-up [85] to 27.0% at 5-year follow-up for specific devices [28]. This high rate of reintervention, coupled with other potential complications, necessitates rigorous and often lifelong follow-up. The heterogeneity in study designs and outcome reporting across the literature remains the single limitation that most affects certainty regarding optimal surveillance strategies. Clinicians should prioritize the use of less invasive and radiation-free imaging modalities like ultrasound as a primary surveillance tool, especially given its comparable accuracy to CTA for endoleak detection.

References

SAIMSARA Session Index — session.json

Figure 1. Publication-year distribution of included originals

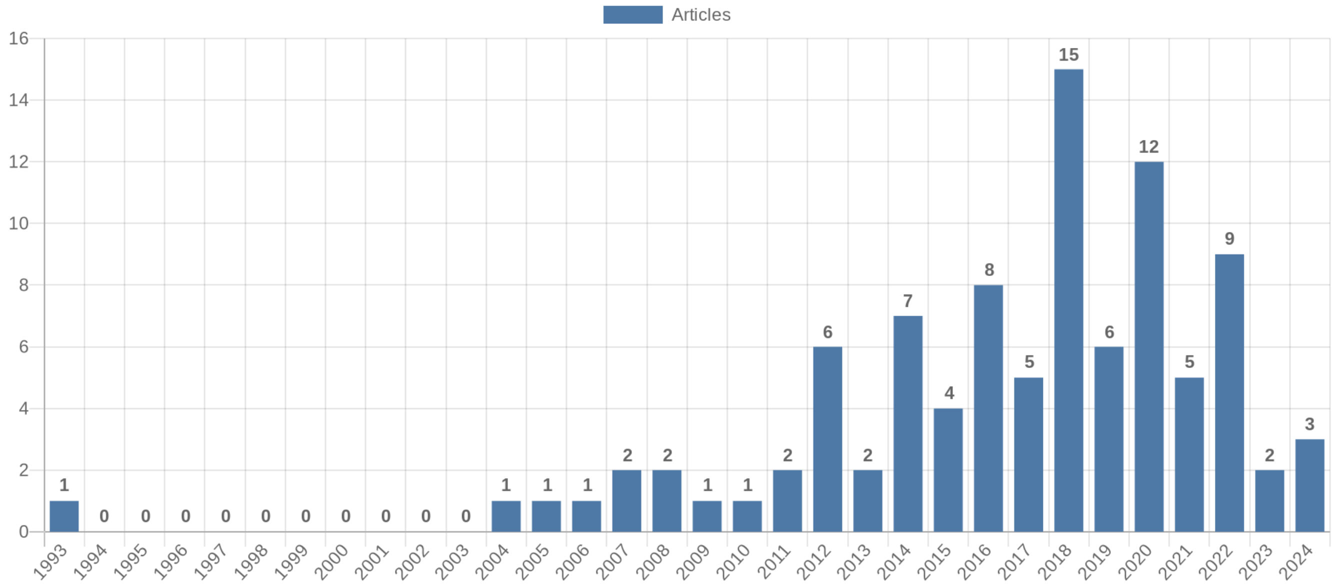


Figure 2. Study-design distribution of included originals

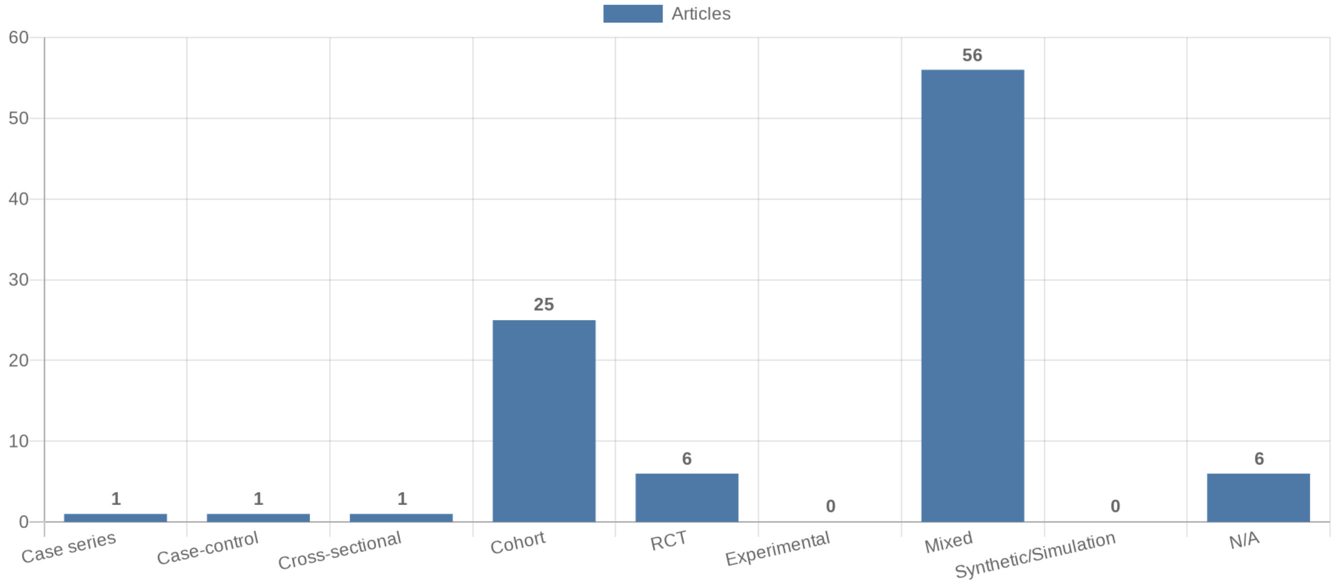


Figure 3. Study-type (directionality) distribution of included originals

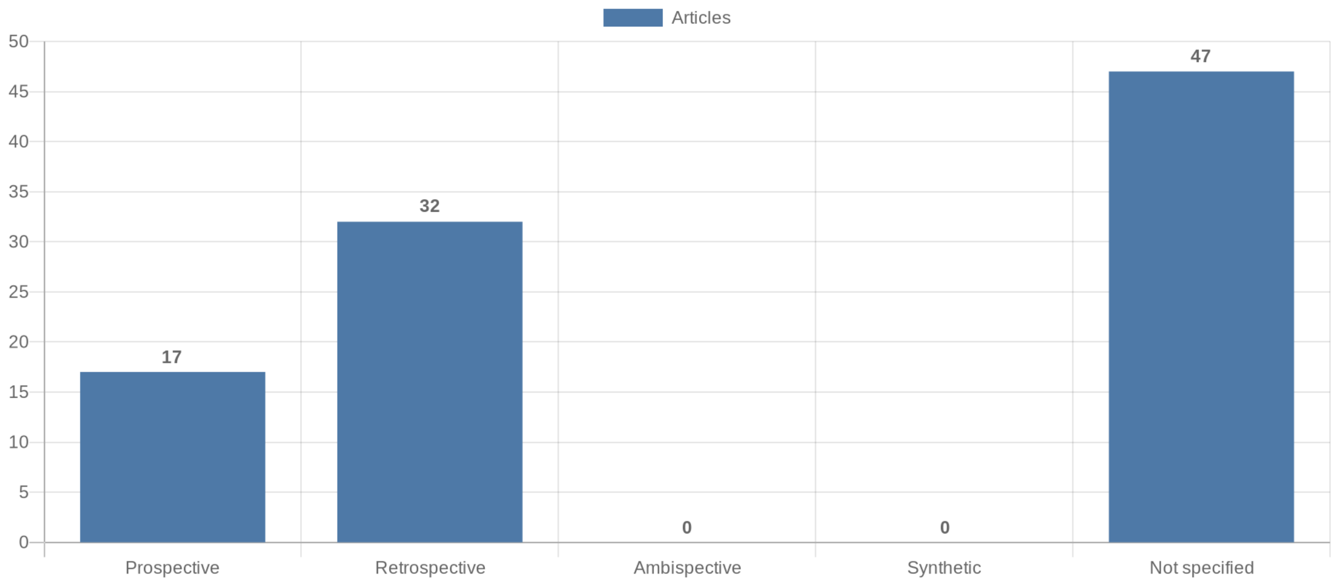


Figure 4. Main extracted research topics

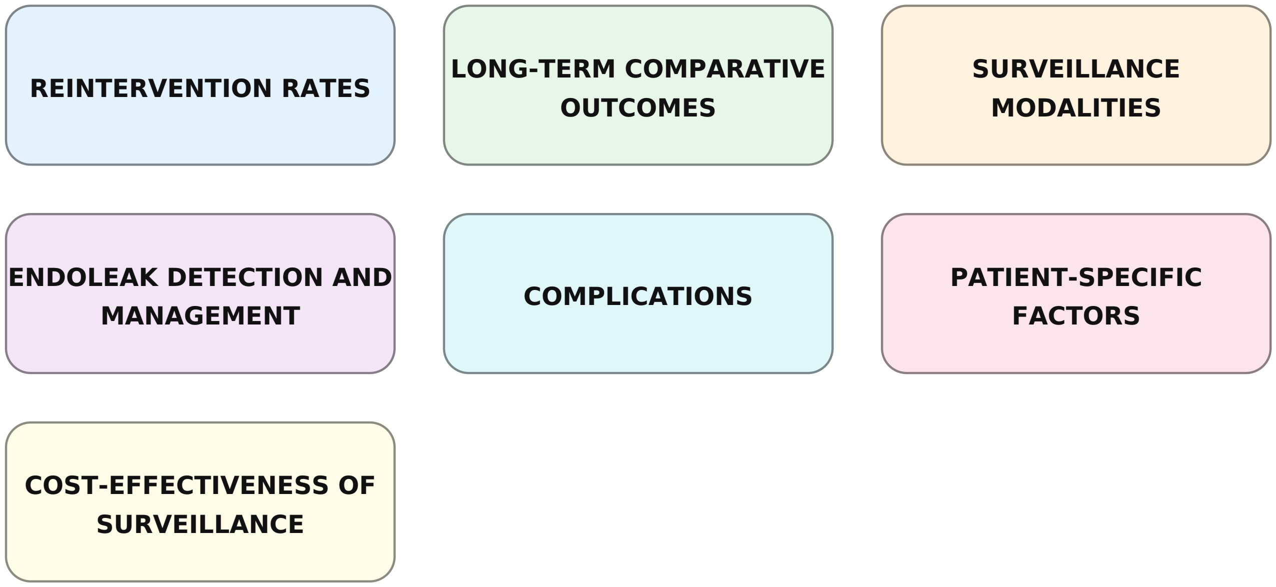


Figure 5. Limitations of current studies (topics)

Figure 6. Future research directions (topics)