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Nationwide Trends in Hospital Outcomes and Utilization after Lower Limb Revascularization in Patients on Hemodialysis

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Abstract

Background—Peripheral artery disease (PAD) is prevalent among end-stage renal disease (ESRD) patients on hemodialysis and is associated with significant morbidity and mortality. There is paucity of information on trends in endovascular and surgical revascularization and post procedure outcomes in this population.

Methods—We used the Nationwide Inpatient Sample (2002–2012) to identify hemodialysis patients undergoing endovascular or surgical procedures for PAD using diagnostic and procedural

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codes. We compared trends in amputation, post procedure complications, mortality, length of stay (LoS) and costs between the two groups using trend tests and logistic regression.

Results—There were 77,049 endovascular and 29,556 surgical procedures for PAD in hemodialysis patients. Adjusted trends showed that endovascular procedures increased by nearly 3-fold while there was a reciprocal decrease in surgical revascularization. Post-procedure complication rates were relatively stable in persons undergoing endovascular procedures but nearly doubled in those undergoing surgery. Surgery was associated with 1.8 times adjusted odds (95% CI 1.60 – 2.02) for complications and 1.6 times the adjusted odds the for amputations (95% CI 1.4 –1.75) but had similar mortality (aOR 1.05, 95% CI 0.85 –1.29) compared to endovascular procedures. LoS for endovascular procedures remained stable while a decrease was seen for surgical procedures. Overall costs increased marginally for both procedures.

Conclusion—Rates of endovascular procedures have increased while those of surgeries have decreased. Surgical revascularization is associated with higher odds of overall complications. Further prospective studies and clinical trials are required to analyze the relationship between the severity of PAD and the revascularization strategy chosen.

Keywords

Hemodialysis; Peripheral Artery Disease; Revascularization Procedures

INTRODUCTION

Peripheral artery disease (PAD) in end-stage renal disease (ESRD) patients on hemodialysis increases the risk of adverse cardiovascular outcomes, and serves as the key cause of limb loss and mortality, with rates much greater than in the general population.(1,2) Patients who do not achieve adequate symptomatic benefit from pharmacologic and exercise-based interventions are candidates for open or endovascular revascularization.(3) Recent data suggests that there is an increase in endovascular revascularization rates and decline in surgical revascularization along with an associated decline in the rates of amputation in hospitalizations with critical limb ischemia (CLI).(4) However such data is sparse among ESRD patients and is restricted to studies in single centers or in the Veterans Healthcare System. (2,5)

Patients with CLI and kidney disease are less likely to be treated with revascularization compared to persons without renal insufficiency(6) and are more likely to have a wound infection, lower extremity gangrene, ischemic ulceration, peri-operative sepsis and longer hospital stay after surgical revascularization.(7) Despite this, emerging data suggest improved long-term amputation free survival and improved rates of limb salvage with revascularization in persons with CLI across the spectrum of kidney disease.(8) However, the optimal method of revascularization, especially in ESRD patients remains unclear with a paucity of real world data on comparisons between post procedure complications of endovascular and surgical revascularization. We aimed to describe the secular trends and outcomes of endovascular and surgical revascularization in a large, nationally representative sample of ESRD patients on hemodialysis hospitalized for PAD.

METHODS

Study Data and Population

This was a retrospective observational study using data from the Healthcare Cost and Utilization Project (HCUP): the Nationwide Inpatient Sample (NIS) files between 2002 and 2012. The NIS is the largest publicly available all-payer inpatient care database in the United States and contains discharge-level data provided by states (n=46 in 2011) that participate in the HCUP.(9) The NIS was designed to approximate a 20% stratified sample of all United States community hospitals, representing more than 95% of the national population. Hospitalizations with ESRD on hemodialysis were identified using diagnosis codes for the hemodialysis diagnosis or procedure code.(10) We excluded hospitalizations with codes for acute kidney injury, peritoneal dialysis, and renal transplant, those that did not have an existing code for PAD, and those without codes for revascularization procedures (Supplemental Figure 1).(11) Endovascular and surgical procedures for lower limb PAD were also identified using various ICD-9 codes used previously (11) and are listed in Supplementary Table 1. Further, we also excluded hospitalizations with codes for both endovascular and surgical procedures during the same admission. Institutional Review Board approval was not needed because of the de-identified, publicly available, hospitalization level nature of the data.

Definitions and Outcomes

Our outcomes of interest were trends in the use of endovascular and surgical revascularization over time and differences in composite and individual post procedure complications during the hospitalization. The complications included were amputation, bleeding, infection, post procedure cardiac events, respiratory complications, and shock (Supplementary Table 1). The denominator for complication rates was hospitalizations. For any complication, rates were calculated as the number of hospitalizations reporting each complication divided by the total number of hospitalizations per procedure. We also assessed the length of stay (LoS) and costs associated with endovascular and surgical revascularization. Total hospital charges were converted to costs using HCUP Cost-to-Charge Ratios based on hospital accounting reports from the Centers for Medicare & Medicaid Services.(12) Costs reflect the actual expenses incurred in the production of hospital services, such as wages, supplies, and utility costs; charges represent the amount a hospital billed for the case. Annual costs were inflation adjusted using the US government Consumer Price Index data), and are expressed in 2016 dollars.

Covariates

We extracted demographics and concurrent diagnoses using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes (Supplementary Table 1). We utilized the validated All Patient Refined Diagnosis Related Group (APRDRG) scores to account for severity of illness and mortality risk. (13,14)

Statistical Analysis

We included designated weight values to produce nationally representative estimates. The weight values are included in the dataset and are meant to help make the dataset nationally representative. A detailed explanation of the methods used can be found at https://www.hcup-us.ahrq.gov/db/nation/nis/trendwghts.jsp. We compared baseline patient characteristics and outcomes using Mann-Whitney tests for mean and median of continuous variables and chi-square for categorical variables. We evaluated temporal trends in the procedures and complications, reported frequencies (%) of procedures and complications and compared these by using Cochran-Armitage test.(15) We then evaluated the odds of overall and individual complications for surgical revascularization and compared to endovascular revascularization (reference group) using multi-level multivariable logistic regression. We developed a series of sequential models using *a priori* defined variables.(16–18) The first model included only calendar year while the second model additionally incorporated age, gender, race, APRDRG score (continuous), patient comorbidities and hospital procedure volume. Annual procedure volume was determined using the unique hospital identification number to calculate the total number of procedures performed by a particular institution in the study year as has been done.(19) Among the comorbidities, included diabetes, hypertension, chronic obstructive pulmonary disease (COPD), sepsis, heart failure, cardiac procedure, and mechanical ventilation. In addition to the above covariates, the third and final model included adjustment for hospital level characteristics (bed size, location, region, teaching status) as well as for the patient's zip code income and primary payer status. We reported odds ratios (OR) and the corresponding 95% confidence intervals (CI). We utilized SAS 9.3 (SAS Institute Inc. Cary, NC, USA) and R 3.2.0 (Vienna, Austria) for all analyses(20) and considered a two-tailed P value <0.05 as statistically significant.

RESULTS

Baseline characteristics

Between 2002 and 2012, there were 106,605 weighted hospitalizations for PAD revascularization in patients on long term hemodialysis. Overall <5% (4,789) of the hospitalizations had ICD9 codes for both endovascular and surgical revascularizations. As this was a small sample, these cases were excluded from our analysis sample in order to have distinctly different groups in which to compare trends over time.

Of the 106,605 hospitalizations, 77,049 (72.3%) were for endovascular procedures and 29,556 (26.7%) were for surgical procedures. Table 1 describes the baseline characteristics of hospitalizations by type of revascularization. Endovascular procedures were more common in younger (66.1 vs. 66.9 years, p<0.001), black (29.3 vs. 25.3%, p<0.001) and female patients (45.4% vs. 40.4%, p<0.001). These patients were more likely to have diabetes (77.7% vs. 72.2%, P<0.001), heart failure (31.1% vs. 28.2%, p<0.001), and sepsis (10.9% versus 7.5%, p<0.001).

Trends in revascularization over time

There was an increase in the number of endovascular procedures from 3,255 (44.0% of total procedures) in 2002 to 7,838 (84.0%) in 2012. Conversely, there was a significant drop in surgeries by over two third from 3,822 (56.0%) procedures in 2002 to 1,311 (16.0)%) in 2012 (Supplemental Figure 2). Age and sex standardized trends during this period showed similar trends (Figure 1, Figure 2) The proportion of patients with higher APRDRG scores (3–4) undergoing endovascular (59.5% in 2002 to 78.8% in 2012; p trend <0.01) and surgical procedures (72.0% in 2002 to 83.6% in 2012; p trend <0.01) increased significantly during the decade studied (Figure 3).

Comparison of post procedure outcomes

Mortality after both endovascular (7.6 vs. 3.2%) and surgical (5.8 vs. 2.9%) revascularization procedures decreased by approximately 50% between 2002–2012 (Figure 4). Surgical revascularization was not associated with increased odds of death compared to endovascular treatment after multivariable adjustment. (aOR 1.05, 95% CI 0.85–1.29)). However, adjusted odds of amputation were 1.6 times that of endovascular revascularization (aOR 1.57, 95% CI 1.4 –1.75). Between 2002 and 2012, the incidence of major amputation decreased slightly from 6.7% to 5.8% after surgery and from 10.2% to 7.0% after endovascular procedures. Minor amputations after endovascular procedures increased from 8.5% in 2002 to 12.9% in 2012 while there was no trend seen with surgical revascularization (Figure 5). The incidence of overall complications increased marginally from 12.8% to 13.5% with endovascular revascularization, while it nearly doubled with surgery from 13.7% to 26.7%. The incidence of cardiac complications, stroke, respiratory complications and shock were consistently greater among those undergoing surgery, but they remained largely stable for both procedures across 2002–2012 (Figure 6). The incidence of infectious complications after endovascular procedures decreased between 2002 and 2012 (6.6% to 3.4%; p<0.01) although its incidence was greater than infection after surgery during all the years. Bleeding was the one complication that increased in both groups (5.7% in 2002 to 9.5% in 2012 for endovascular procedures; 7.8% in 2002 to 20.8% in 2012 for surgeries).

Table 2 shows odds of adverse outcomes among patients undergoing surgical revascularization compared to endovascular procedures. Adjusted odds of cardiac and respiratory complications, stroke, and bleeding were higher by 1.5–3 fold in persons undergoing surgical revascularization. The adjusted odds of infection were similar for both procedures (1.22. 95% CI 0.99 – 1.49).

The median LoS among persons undergoing endovascular procedures was 10 days and there was no significant trend over time (p=0.46). The median length of stay for person undergoing surgical revascularization was 12.9 days, with an associated decreased in the LoS between 2002–2012 (p=0.01). (Figure 7).

DISCUSSION

We utilized the NIS between 2002 and 2012 to analyze trends in lower limb revascularization and in-hospital outcomes in hemodialysis patients. Our study yielded several important findings. First, there was increased use of endovascular procedures and a decrease in surgical revascularization. Second, although the incidence of amputation after endovascular procedures has increased, it was still lower than incidence after surgery. Third, post-procedural complications, with the exception of bleeding, remained stable for both groups. Fourth, surgery had higher adjusted odds of all post procedural complications except infection. Finally, there was no difference in the adjusted odds of mortality after either procedure.

To date, the Bypass versus Angioplasty in Severe Ischaemia of the Leg (BASIL) trial is the only randomized controlled trial (RCT) comparing bypass surgery with endovascular therapy.(21) Although no difference in amputation free survival was noted between the two, observations from real-world practices have shown that there is an increasing trend towards the endovascular-first approach in the general population. Among hemodialysis patients, this change in practice is likely due to two reasons. First, these patients have an elevated risk of post procedure complications and mortality, especially after surgical revascularization. Second, advances and increasing expertise in endovascular procedures allow for revascularization in patients who would have otherwise either been treated with medical therapy alone or have undergone primary amputation. Although distal lesions which are more amenable to surgery are predominant in ESRD patients, a number of case series have been published reporting successful limb salvage and decreased mortality with endovascular revascularization.(22,23)

It is also important to note that prior data suggesting that at all levels of renal dysfunction including ESRD needing hemodialysis, those who undergo any form of lower limb revascularization have lower 1-year mortality compared to persons treated conservatively or those who underwent primary amputation.(6,8) Therefore endovascular revascularization in persons with prohibitively high surgical morbidity may be a practical approach. While current AHA/ACC guidelines have stressed the fact that surgical revascularization should be considered as first line revascularization therapy in persons with a life expectancy greater than 2 years,(3) whether this also applies to hemodialysis patients on remains to be determined.

The results of our study are consistent with findings in the general population with regard to the trends for revascularization.(4,11,24,25) Agarwal et al recently analyzed trends and outcomes for revascularization in CLI without restricting to those on dialysis.(4) While their findings possibly include hemodialysis patients, the outcomes for this subgroup were not reported separately and the results of our study present an interesting comparison. They too found trends showing increasing use of endovascular revascularization and decreasing use of surgical repair. There was no difference in adjusted odds of amputation between procedures in the general population in their study, but we found an increase in odds of amputation after surgery among ESRD hospitalizations. This is not surprising and there is evidence showing that being on hemodialysis puts patients at a high risk for perioperative complications.(26) Another divergence in the results of the two studies is the lack of difference in mortality between endovascular and surgical revascularization in our study compared with the lower odds of death with endovascular revascularization in the general population.(4) One explanation for this could be that events occurred in very high-risk patients, with prohibitive risk of surgery, who underwent endovascular revascularization in our study. Finally, the LoS and the total costs were also significantly lower among the general population compared to ESRD patients.

In another recent study, investigators used the First-Line Treatments in Patients With Critical Limb Ischemia (CRITISCH) registry to compare outcomes after revascularization for CLI in 102 patients with ESRD.(27) Similar to our results, the authors noted that an endovascular approach was the first line of therapy in two-thirds of patients. This and other studies demonstrate that patients on dialysis have a worse short and long term prognosis than counterparts not on dialysis and that percutaneous treatment of severe PAD is feasible with seemingly good short and long term results.(22,23,28)

We found that while most post procedural complications had remained stable between 2002 and 2012, bleeding complications steadily rose. This may be due to hemodialysis patients having an increased risk of bleeding due to platelet dysfunction.(29) In addition, the use of antiplatelet agents, oral anticoagulants and heparin during hemodialysis or peri-operatively may explain the high incidence of bleeding. Although we are unable to evaluate peri-procedure antibiotic use, it is possible that the lower rates of infection in patients undergoing surgery may be due to the use of routine prophylactic antibiotics peri-operatively.(30) In comparison, routine prophylaxis is not recommended in endovascular procedures.(31)

The findings of our study should be interpreted in light of its limitations. First, patients on dialysis are often diabetic, have significant vascular calcifications, multi-segment vessel disease and thus may not be selected for endovascular therapy. However these same patients often have uncontrolled blood pressure, heart failure, CAD and other co-morbidities which make them poor surgical candidates. Given that our study is observational, it is therefore prone to indication bias. We adjusted for a large number of potential confounders, but residual confounding may still affect our results. Second, our data is abstracted from ICD-9 codes, and thus we are unable to determine certain specific characteristics of the PAD, such as the location, laterality, character, severity and extent of lesions – all of which could influence the revascularization strategy. Third, ICD-9 codes pertain to individual medical encounters and diagnoses, and thus patients with multiple admissions would be counted multiple times. Fourth, although prior revascularization is a risk factor for future revascularization need and for adverse long term outcomes, the NIS database does not allow for us to identify persons who may have undergone prior PAD revascularization procedures. Fifth, we could not capture endovascular procedures performed outpatient and thus could not assess the impact of this increase. However, it is likely that patients with ESRD on HD, which typically have more comorbidities than a population undergoing outpatient endovascular procedures, are more likely to be admitted for a procedure. Thus, it is unlikely that the increasing percentage of outpatient endovascular procedures will have a qualitative impact on our results. Finally, by its observational nature, this study can show associations only, but cannot determine any causal relationships and is subject to limitations inherent to administrative databases including information bias and incomplete data capture. However, given the lack of trial information on optimal modality of revascularization and short-term outcomes in hemodialysis patients, this observational study provides valuable and nationally representative information.

Despite these limitations, our study has significant strengths. It is the first to our knowledge to explore trends and outcomes of revascularization strategies for PAD in ESRD patients on hemodialysis in the United States. Our results are also likely generalizable to the dialysis population in the US undergoing inpatient lower limb revascularization since the dataset was abstracted from a nationally representative, all payer registry including private and Medicare beneficiaries. In addition to looking at mortality and amputations, our study analyzes post-procedure outcomes like bleeding, infections, cardiac and respiratory complications and shock that have not been described before. Despite the fact that observational studies have shown that decreased kidney function serves as a risk factor for PAD and its consequent adverse outcomes,(2,32) past trials of PAD therapies have traditionally excluded patients with severe kidney disease, even though such individuals represent the highest-risk population. Guidelines for the management of PAD in ESRD populations have necessarily been created by extrapolation of the risk: benefit data observed in the general population. In the absence of high quality randomized control trials, registry data such as ours provide important insights.

CONCLUSION

In summary, we demonstrate that revascularization strategies for PAD have been changing over time among hemodialysis patients. Endovascular procedures have increased while surgical revascularization has decreased. Endovascular procedures are associated with lower odds of amputation and post-procedure complications. However, no short-term mortality benefit was seen with endovascular procedures. Further prospective studies and clinical trials are required to analyze the relationship between the severity of PAD and the revascularization strategy chosen.

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ABBREVIATIONS

PAD	Peripheral artery disease
ESRD	End-stage renal disease
CLI	Critical limb ischemia
HCUP	Healthcare Cost and Utilization Project
NIS	Nationwide Inpatient Sample
LoS	Length of stay
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification

APRDRG All Patient Refined Diagnosis Related Group

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PERSPECTIVES

WHAT IS KNOWN?

Current guidelines regarding revascularization strategies for PAD developed in the general population may not be completely applicable to ESRD patients on hemodialysis.

WHAT IS NEW?

Endovascular procedures are increasingly being performed for PAD among dialysis patients. Despite this increase, in-hospital complication rates remain stable and lower than for surgical revascularization. In persons undergoing dialysis who are not surgical candidates, endovascular procedures may be an acceptable therapeutic strategy.

WHAT IS NEXT?

Long term observational studies, registry follow up and randomized trials are needed to help determine the most appropriate first choice for revascularization in hemodialysis patients.

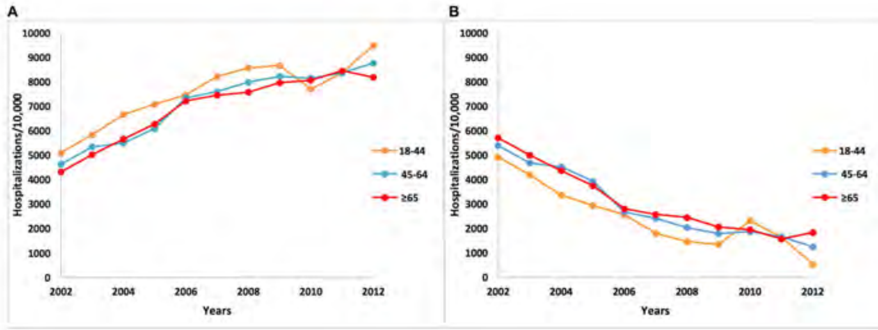

Figure 1. Trends in endovascular(A) and open revascularizations(B) by age

This figure demonstrates the temporal trends in the proportion of hospitalizations for different revascularization procedures among end-stage renal disease (ESRD) patients with peripheral artery disease (PAD), subdivided by age, across 2002–2012 in the United States. The dots represent the number of hospitalizations for a given procedure per 10,000 hospitalizations in given year for a given age group. Panel A pertains to endovascular revascularization and Panel B pertains to open revascularization.

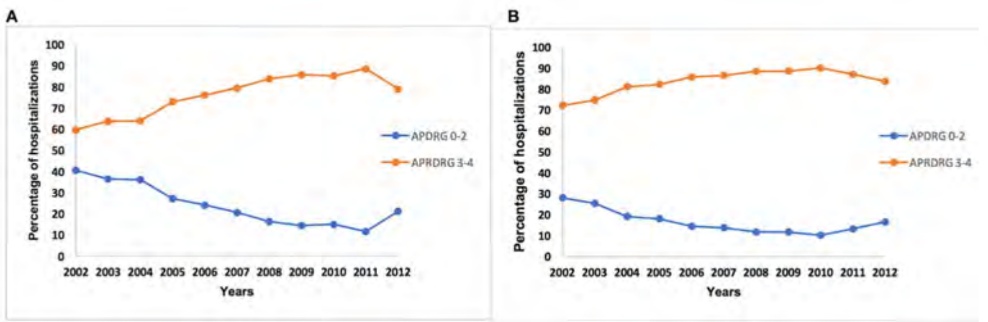

Figure 2. Trends in endovascular(A) and open revascularization(B) by gender

This figure demonstrates the temporal trends in the proportion of hospitalizations for different revascularization procedures among end-stage renal disease (ESRD) patients with peripheral artery disease (PAD), subdivided by sex, across 2002–2012 in the United States. The dots represent the number of hospitalizations for a given procedure per 10,000 hospitalizations in a given year for a given sex. Panel A pertains to endovascular revascularization and Panel B pertains to open revascularization.

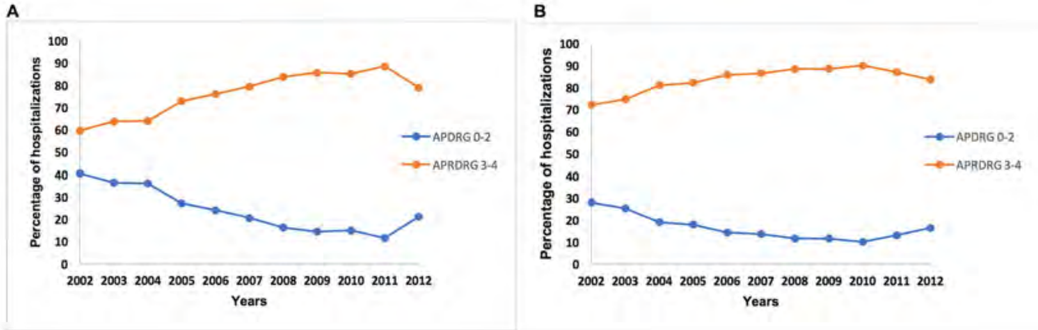

Figure 3. Trends in endovascular (A) and open (B) revascularization by All Patient Refined Diagnosis Related Group (APRDRG) status

This figure demonstrates the temporal trends in the proportion of revasculrization hospitalizations for end-stage renal disease (ESRD) patients with peripheral artery disease (PAD) with different All Patient Refined Diagnosis Related Group (APRDRG) Scores, across 2002–2012 in the United States. Panel A pertains to endovascular revascularization and Panel B pertains to open revascularization. The blue dots represent the proportion of hospitalizations for patients undergoing with APRDRG scores from 0 to 2, while the orange dots represent those with scores from 3 to 4.

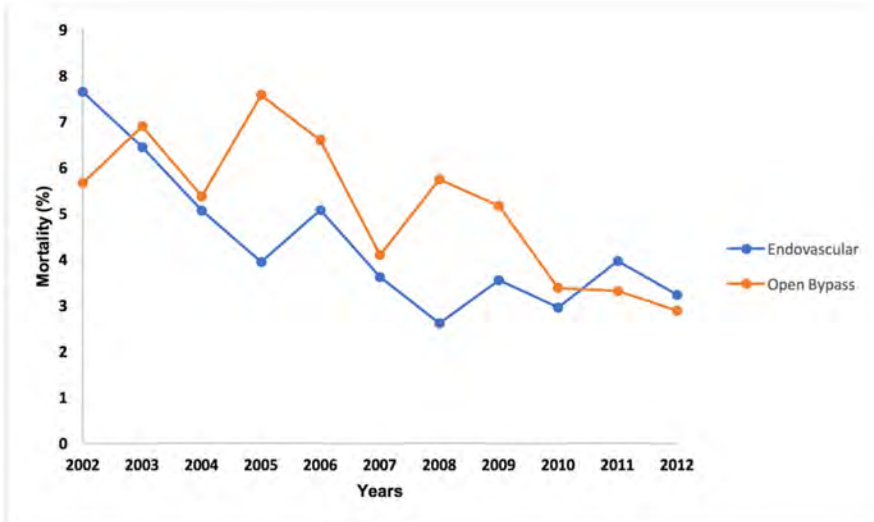

Figure 4. Trends in mortality for endovascular and open revascularization

This figure demonstrates temporal trends in in-hospital mortality for revascularization hospitalizations among end-stage renal disease (ESRD) patients with peripheral artery disease (PAD) across the period 2002–2012 in the United States. The blue dots represent the incidence of in-hospital mortality for endovascular revascularization hospitalizations, while the orange dots represent in-hospital mortality for open revascularization hospitalizations.

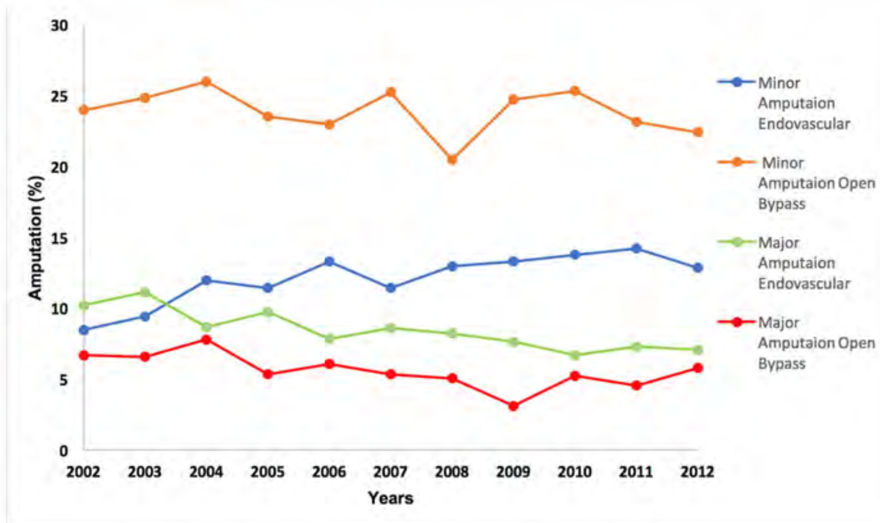

Figure 5. Trends in amputation incidence for endovascular and open revascularization

This figure demonstrates the temporal trends in amputations for hospitalized end-stage renal disease (ESRD) patients with peripheral artery disease (PAD) undergoing endovascular and open revascularization across the period 2002–2012 in the United States. The blue and green dots represent the incidence of minor and major amputations respectively for those undergoing endovascular procedures, while the orange and red dots represent the incidence of minor and major amputations respectively for those undergoing open revascularization.

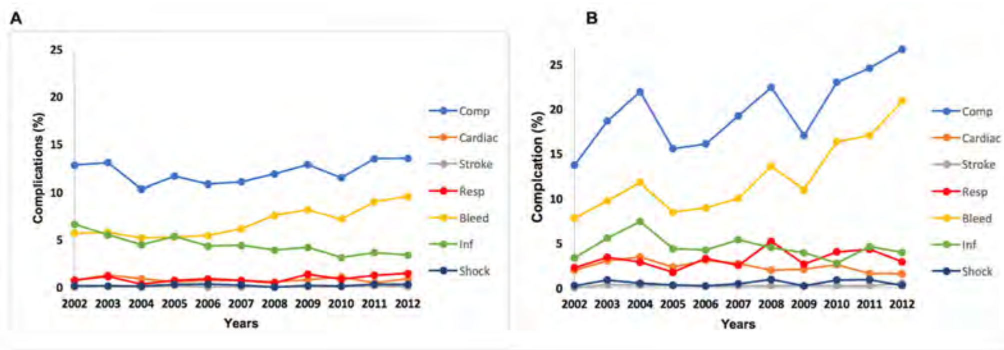

Figure 6. Trends in complications for endovascular (A) and open (B) revascularization

This figure demonstrates the temporal trends in complications for hospitalized end-stage renal disease (ESRD) patients with peripheral artery disease (PAD) undergoing endovascular and open revascularization across the period 2002–2012 in the United States. The blue dots represent the incidence of overall complications in a given year, whereas the various other colored dots each represent the incidence of a particular complication. Panel A pertains to endovascular procedures, while panel B refers to open revascularizations.

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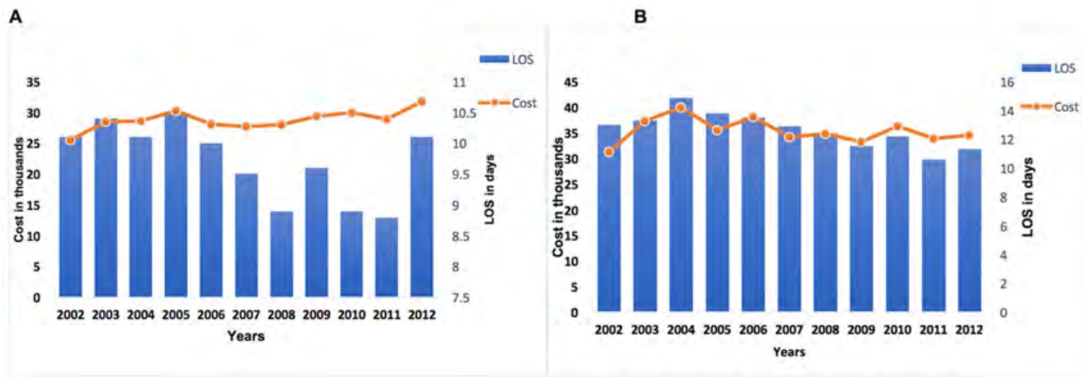

Figure 7. Trends in mean costs and length of stay for endovascular (A) and open (B) revascularization

This figure demonstrates the trends in length of stay (LoS) and cost of endovascular and open revascularizations for hospitalized end-stage renal disease (ESRD) patients with peripheral artery disease (PAD) across 2002–2012 in the United States. The orange dots represent LoS in days and the blue bars represent cost in US dollars. Panel A pertains to endovascular procedures, while panel B refers to open revascularizations.

Table 1

Baseline characteristics of patients undergoing lower limb revascularization

Characteristics	Endovascular Procedure N=77049	Open Bypass Procedures N= 29556	P-value
PATIENT CHARACTERISTICS			
Age in years, (%)	66.1 (57.7 –74.1)	66.9 (58.9 – 74.7)	<.0001
18–44	4.2	3.1	
45–64	39.2	36.7	
≥65	56.5	60.3	
Gender, (%)			<.0001
Male	54.6	59.6	
Female	45.4	40.4	
Race, (%)			<.0001
White	36.4	39.8	
Black	29.3	25.3	
Hispanic	15.2	12.3	
Others	5.8	4.9	
APRDRG Severity Scale, (%)			<.0001
Minor loss of function	0.6	0.1	
Moderate loss of function	20.1	17.2	
Major loss of function	57.4	60.5	
Extreme loss of function	21.5	20.5	
APRDRG Mortality Scale, (%)			0.004
Minor likelihood of dying	0.8	0.4	
Moderate likelihood of dying	46.4	46.9	
Major likelihood of dying	45.5	44.6	
Extreme likelihood of dying	6.8	6.4	
Co-morbidities, (%)			
Diabetes Mellitus	77.7	72.2	<.0001
Hypertension	92.4	91	0.57
COPD	14.3	15.8	0.01
Coronary Artery Disease	52.4	52.3	0.39
Sepsis	10.9	7.5	<.0001
Heart Failure	31.1	28.2	<.0001
Mechanical Ventilation	3.2	4.2	0.002
Cardiac procedures	4.2	3	0.003
Hospital Characteristics			
Hospital bed size, (%)			0.86
Small	7.3	7.7	
Medium	21.3	20.9	

Characteristics	Endovascular Procedure N=77049	Open Bypass Procedures N= 29556	P-value
Large	70.9	71.1	
Hospital Location, (%)			0.3
Rural	4.9	4.4	
Urban non-teaching	42.6	40.8	
Urban teaching	51.9	54.6	
Hospital Region, (%)			0.0007
Northeast	15.1	21.2	
Midwest/North Central	18.8	17.1	
South	33.8	30.2	
West	15.9	15.6	
Length of Stay, Median (IQR)	6.3 (2.3–12.1)	9.3 (5.1 –16.1)	<.0001
Cost, Median (IQR)	22,014 (1,3730–35,076)	26,872 (17,178–42,414)	<.0001
Median household income category for patient's zip code3, (%)			0.001
0–25th percentile	35.3	27.8	
26–50th percentile	22.8	21.6	
51–75th percentile	19.6	19.7	
76–100th percentile	15.9	15.9	
Discharge Disposition, (%)			<.0001
Routine	44.8	29.8	
Discharge to specialized care	51	64.4	
Against Medical Advice	0.4	0.2	
Died	3.6	5.3	
Primary Payer type, (%)			<.0001
Medicare	85.2	83.9	
Medicaid	5.6	3.9	
Private	7.8	11	
Self-pay or No Charge or Others	1.2	0.9	

Table 2

Complications in patients undergoing open revascularization compared to endovascular procedures

	Model 1		Model 2		Model 3	
	Odds Ratio (95% CI)	**P-value**	**Odds Ratio (95% CI)**	**P-value**	**Odds Ratio (95% CI)**	**P-value**
Any Complication	1.82 (1.65 – 2.01)	<.0001	1.81 (1.61 – 2.03)	<.0001	1.79 (1.60 – 2.02)	<.0001
Cardiac	3.38 (2.60 – 4.40)	<.0001	2.86 (2.13 – 3.84)	<.0001	2.6 (1.89 – 3.57)	<.0001
Stroke	3.30 (1.43–7.59)	0.005	3.99 (1.63 – 9.78)	0.003	3.35 (1.32 –8.52)	0.01
Respiratory	3.62 (2.83 – 4.64)	<.0001	3.50 (2.58 –4.75)	<.0001	3.62 (2.62 – 5.01)	<.0001
Bleeding	1.96 (1.73 – 2.23)	<.0001	1.76 (1.52 –2.03)	<.0001	1.73 (1.49 –2.01)	<.0001
Infection	1.03 (0.87 –1.22)	0.72	1.20 (0.99 –1.45)	0.06	1.22 (0.99 – 1.49)	0.05
Shock	3.01 (1.67 – 5.39)	0.0002	3.02 (1.60 –5.71)	0.0007	2.85 (1.42 – 5.71)	0.003
Mortality	1.27 (1.08–1.49)	0.003	1.04 (0.85 – 1.26)	0.72	1.05 (0.85 –1.29)	0.68
Amputation	1.65 (1.52 – 1.80)	<.0001	1.73 (1.56 – 1.93)	<.0001	1.57 (1.4 –1.75)	<.0001

Model 1: Adjusted for calendar year

Model 2: Adjusted for calendar year, Age, Gender, Race, APRDRG, comorbidities,

Model 3: Adjusted for calendar year, Age, Gender, Race, APRDRG, comorbidities, Hospital level, Bed size, Location, Region, Disposition, Zip code income, Primary payer