Impact of Early Cannulation Grafts on Quality and Cost of Care for Patients With End-Stage Renal Disease

Sapan S. Desai, Arlington Heights, Illinois

Background: The annual cost of care associated with end-stage renal disease (ESRD) per patient on hemodialysis is approaching $100,000, with nearly $42 billion in national spend per year. Early cannulation arteriovenous grafts (ECAVGs) help decrease the use of central venous catheters (CVCs), thus potentially decreasing the cost of care. However, a formal financial analysis that also includes the cost of CVC-related complications and secondary interventions has not been completed. The purpose of this project is to evaluate the overall financial costs associated with ECAVGs on patients with ESRD during a one-year period.
Methods: Access modality, complications, secondary interventions, hospital outcomes, and cost of care were determined for 397 sequential patients who underwent access creation between July 2014 and October 2018. A detailed financial analysis was completed, including an evaluation of implant, supplies, medications, laboratories, labor, and other direct costs. All variables were measured at the time of the index procedure, 30 days, 90 days, 180 days, 270 days, and one year.
Results: There were 131 patients who underwent arteriovenous fistula (AVF) and 266 who underwent ECAVG for dialysis access. The average cost of care was $17,523 for AVF and $5,894 for ECAVG at one year ($P < 0.01$). Fewer CVC-related complications and secondary interventions associated with ECAVGs saved $11,630 per patient with ESRD, primarily in the form of supply costs. Fewer CVCs in the patients receiving ECAVGs led to an additional $1,083 decrease in cost associated with sepsis reduction at one year. A subsequent decrease in length of stay and ICU utilization led to an additional $2.0 million decrease in annual cost of care for patients with ESRD.
Conclusions: The use of ECAVGs has significant cost savings over using an AVF and CVC for urgent-start dialysis in patients with ESRD. This cost savings is secondary to decreased CVC-related complications and fewer secondary interventions. Significant national savings are possible with appropriate use of ECAVGs in patients with ESRD.

INTRODUCTION

A total of $114 billion is spent every year on patients with chronic kidney disease (CKD) and end-stage renal disease (ESRD).[1] Of this total, $42 billion is spent annually on hemodialysis (HD) for ESRD. Known as the Medicare spend per beneficiary (MSPB), the annual cost of care per patient with ESRD was $90,971 in 2016.[2] Eighty percent of patients initiate dialysis via a central venous catheter (CVC), and CVCs have been associated with significant complications such as line infections and sepsis that can significantly increase the cost of care.[2–5]

Acting through ESRD seamless care organizations (ESCOs) and pay for performance (P4P) incentive models, there is a national goal to decrease the use of CVCs and their attendant complications.[6] Two of the key metrics for ESCOs include ''Bloodstream Infection in Hemodialysis Outpatients'' and ''Hemodialysis Vascular Access: Minimizing Use of

Director of Performance Improvement, Northwest Community Healthcare, Arlington Heights, IL.

Correspondence to: Sapan S. Desai, MD, PhD, MBA, FACS, Director of Performance Improvement Northwest Community Healthcare, 759 W Meryls Ct, Palatine, IL 60074; E-mail: sapan.desai@surgisphere.com

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Catheters as Chronic Dialysis Access.'' Downstream measures impacted by reducing CVCs include ''ESCO Standardized Hospitalization Ratio for Admissions,'' ''ESCO Standardized Mortality Ratio,'' and ''ESCO Standardized Readmission Ratio,'' all three of which have a greater measure weight than the two initial measures.[6]

Early cannulation arteriovenous grafts (ECAVGs) have been shown to decrease the use of CVCs and thereby avoid the complications associated with them when used for patients with ESRD who require urgent-start dialysis.[3,7–10] With fewer secondary interventions than arteriovenous fistulas (AVFs) used with CVCs and a clear advantage compared with CVCs alone, ECAVGs present a value proposition for patients with ESRD that it can help provide better quality health care at a lower annual cost.[11–13] However, there has not been a formal financial analysis completed for patients receiving ECAVGs, which includes the cost of CVC-related complications and secondary interventions. The purpose of this project is to evaluate the overall financial cost associated with ECAVGs among patients with ESRD during a one-year period.

METHODS

All patients who had the creation of an AVF or arteriovenous graft (AVG) for ESRD were evaluated between July 2014 and October 2018. Patients who had placement of a HeRO graft, implantation of an AVF or AVG for reasons other than HD, and patients younger than 18 years were excluded from this study. Deidentified patient data were maintained as part of a registry (QuartzClinical, Surgisphere Corporation, Chicago, IL). Independent variables included patient demographics, comorbidities, cause of ESRD, hospital covariates, complications, secondary interventions, CVC days, and detailed cost information.

Patient demographics included age, gender, and ethnicity. Comorbidities included type of hypertension, diabetes, peripheral artery disease, coronary artery disease, chronic obstructive pulmonary disease, the presence of a thrombophilia/prothrombotic state, congestive heart failure, and body mass index. Hospital covariates included access site configuration, operating time, transfusion status, admission source, discharge disposition, length of stay (LOS), and inpatient mortality. Complications were grouped into deep vein thrombosis (DVT), line infections, sepsis, pneumothorax, and other.

Secondary interventions included angioplasty, angioplasty and stent-grafting, thrombectomy, surgical revision, and explantation. Dependent variables included LOS, inpatient mortality, 30-day readmission, discharge disposition, and cost of care. Direct costs were defined as those costs that could be completely attributed to the procedure performed and included the graft, supplies, medication, laboratory test, labor, and other direct costs. Indirect costs such as overhead, enterprise costs, malpractice insurance, and any costs not borne by the hospital were excluded. Costs are adjusted using the consumer price index and presented in 2018 USD. All variables were measured at the time of the index procedure, 30 days, 90 days, 180 days, 270 days, and one year.

Statistical analysis was performed using the built-in analytical functions of the registry and validated using SPSS 25 (IBM, Armonk, NY). Statistical significance was set at $P < 0.05$. Statistical testing included descriptive statistics, Student's *t*-tests, and Kaplan-Meier estimation for survival. This study was exempt from institutional review board approval given the deidentified nature of the data within a large database. Patients' consent was not required.

A Monte Carlo simulation was used to understand the financial impact of using an ECAVG in lieu of an AVF and CVC for patients with ESRD. This forecast model included the decrease in CVC days associated with an ECAVG, the decreased rate of CVC-related complications for patients receiving an ECAVG, the number of line infections that led to sepsis and subsequent admission to the intensive care unit (ICU), and the average LOS for these patients. The cost savings were calculated out to one year for this simulation, and the outcome was validated using actual direct cost data.

The ECAVG used in this study was the ACUSEAL vascular access graft (W.L. Gore & Associates, Newark, DE). The ACUSEAL graft is a trilayer graft with thin inner and outer expanded polytetrafluoroethylene layers and a middle elastomeric membrane. Both the 4-7 tapered and 6-mm second-generation grafts were used in this study.

RESULTS

The sample size for this study was 397 patients, of which 131 had placement of an AVF and 266 had placement of an ECAVG. Of the 131 AVF patients, 97 had placement of an AVF for ESRD and required concomitant CVC use for urgent-start dialysis. All the patients who had received an ECAVG were able to use their graft for dialysis, and none required a CVC. Of these 397 patients, 10 were lost to follow-up over one year and 68 died. The Kaplan-Meier survival estimate is given in Table I and Figure 1.

Table I. Kaplan-Meier survival estimate for AVFs and ECAVGs

Study period	Index case	30 Days	90 Days	180 Days	270 Days	1 Year
AVF survivors	131	128	122	114	106	101
AVF survival	100.0%	97.7%	93.1%	87.7%	82.3%	78.4%
ECAVG survivors	266	258	247	237	224	219
ECAVG survival	100.0%	97.0%	93.6%	90.2%	85.9%	84.8%
Significance	N/A	$P = 0.614$	$P = 0.229$	$P = 0.134$	$P = 0.092$	$P = 0.034$

There is a slight survival advantage for patients receiving ECAVGs which becomes statistically significant at one year ($P < 0.05$).

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The total number of CVC days was calculated for patients receiving AVFs and ECAVGs. Patients who had an AVF for ESRD all required a CVC for urgent-start dialysis. While no patients who had placement of an ECAVG required a CVC for dialysis, some patients had a CVC placed before the ECAVG as the nephrologists and interventional radiologists became familiar with our institutional dialysis access protocol. The total number of CVC days for patients receiving an AVF was 19,930 out of 40,555 patient days over the two-year period (49.1%). The CVC days for patients receiving an ECAVG was 5,830 out of 84,855 patient days (6.9%; $P < 0.001$).

There were 140 CVC-related complications out of 652 opportunities for patients receiving an AVF (21.5%) and 24 CVC-related complications out of 1,458 opportunities for patients receiving an ECAVG (1.6%). Details on the type of CVC-related complication, cost of complications, and rate per 1,000 patient days and rate per 1,000 catheter days are provided in Table II. Primary-assisted patency was 52.5% for AVF and 80.8% for ECAVG at one year. Secondary-assisted patency was 65.3% for AVF and 84.0% for ECAVG at one year. Significantly more secondary interventions were completed for AVF (347 interventions out of 661 opportunities, 52.5%) than for ECAVGs (232 interventions out of 1,364 opportunities, 17.0%; $P < 0.001$).

Direct costs for AVFs were lower than those for ECAVGs only at the time of the index procedure (Table III). Owing to the disproportionately greater number of secondary interventions and complications associated with CVCs, the overall direct cost for placement of ECAVGs was lower starting at 30 days. This cost difference accelerated for the remainder of the study period and led to a reduction in the cost of care of $11,630 for ECAVGs at one year (Fig. 2). Overall direct cost differences reach significance at 30 days ($P < 0.05$), and AVF versus ECAVG individual direct costs (excluding CVCs) reach significance at 180 days ($P < 0.05$). Details on individual direct costs for AVFs are provided in Table IV and for ECAVGs in Table V.

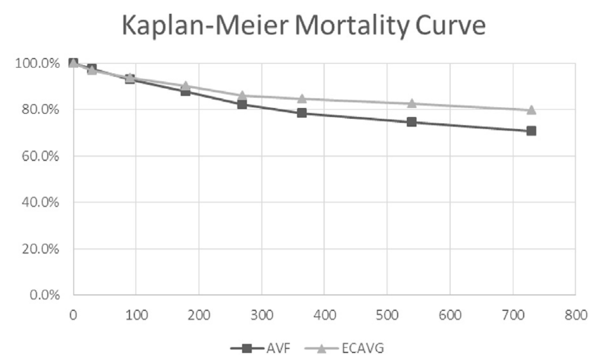

Fig. 1. Kaplan-Meier survival curve for AVFs and ECAVGs. There is a slight survival advantage for patients receiving ECAVGs which becomes statistically significant at one year ($P < 0.05$).

Avoidance of CVC-related complications led to a decrease in cost of care associated with central line–associated blood stream infections (CLABSIs; $99 per patient), DVT ($16 per patient), pneumothorax ($6 per patient), CVC replacement ($31 per patient), sepsis ($437 per patient), and others ($25 per patient) when using an ECAVG instead of an AVF and CVC combination for patients with ESRD. Per patient per year, there was a 1.9-day decrease in LOS for patients receiving ECAVGs through avoidance of a CVC ($462 per patient; Fig. 3). The total additional savings per patient is $1,083, which can be achieved by switching to ECAVGs instead of an AVF and CVC for urgent-start dialysis in patients with ESRD.

A Monte Carlo simulation was created to calculate the clinical and financial impact of the sepsis reduction in patients receiving ECAVGs. We found an overall 5.3% rate of sepsis (0.56/1,000 patient

Table II. CVC-related complications and rates per patient days and catheter days for AVFs and ECAVGs over a two-year period

Variable	None	DVT	Line infection—antibiotics only	Line infection—removal	Sepsis	Pneumothorax	Other	Line replacement
AVF								
N	652	20	24	24	42	1	17	12
%	82.3%	2.5%	3.0%	3.0%	5.3%	0.1%	2.1%	1.5%
Total cost		$25,513	$74,532	$108,652	$721,680	$9,804	$46,241	$52,765
Cost/episode		$1,276	$3,106	$4,527	$17,183	$9,804	$2,720	$4,397
Rate/1000 patient days		0.27	0.32	0.32	0.56	0.01	0.23	0.16
Rate/1000 catheter days		0.48	0.58	0.58	1.02	0.02	0.41	0.29
AVG								
N	1,458	1	3	7	4	-	5	4
%	98.4%	0.1%	0.2%	0.5%	0.3%	0.0%	0.3%	0.3%
Total cost	-	$ 1,463	$ 10,253	$ 38,368	$ 54,034	-	$ 12,131	$ 6,292
Cost/episode		$ 1,463	$ 3,418	$ 5,481	$ 13,509	-	$ 2,426	$ 1,573
Rate/1000 patient days		0.01[a]	0.02[a]	0.04[a]	0.02[a]	-	0.03[a]	0.02[b]
Rate/1000 catheter days		0.09[a]	0.26[b]	0.60	0.35[a]	-	0.43	0.35

[a] $P < 0.01$.
[b] $P < 0.05$.

Table III. Cost of care comparison of AVFs and ECAVGs including secondary interventions and complications

Modality	Initial	30 Days	90 Days	180 Days	270 Days	1 Year	18 Months	2 Years
AVF	$1,655	$2,584	$3,690	$4,692	$6,718	$8,831	$9,443	$11,737
CVC	$534	$1,612	$2,616	$4,253	$5,842	$8,693	$9,941	$11,547
Total	$2,189	$4,197	$6,307	$8,945	$12,560	$17,523	$19,384	$23,284
ECAVG	$2,396	$2,734	$3,189	$3,675[a]	$4,453[a]	$5,341[b]	$6,283[b]	$6,631[b]
CVC	$279[a]	$377[b]	$393[b]	$434[b]	$481[b]	$553[b]	$597[b]	$607[b]
Total	$2,675	$3,111[a]	$3,582[b]	$4,109[b]	$4,934[b]	$5,894[b]	$6,880[b]	$7,238[b]

Overall direct cost differences reach significance at 30 days ($P < 0.05$), and AVF versus ECAVG individual direct costs (excluding CVCs) reach significance at 180 days ($P < 0.05$).
[a]$P < 0.05$.
[b]$P < 0.01$.

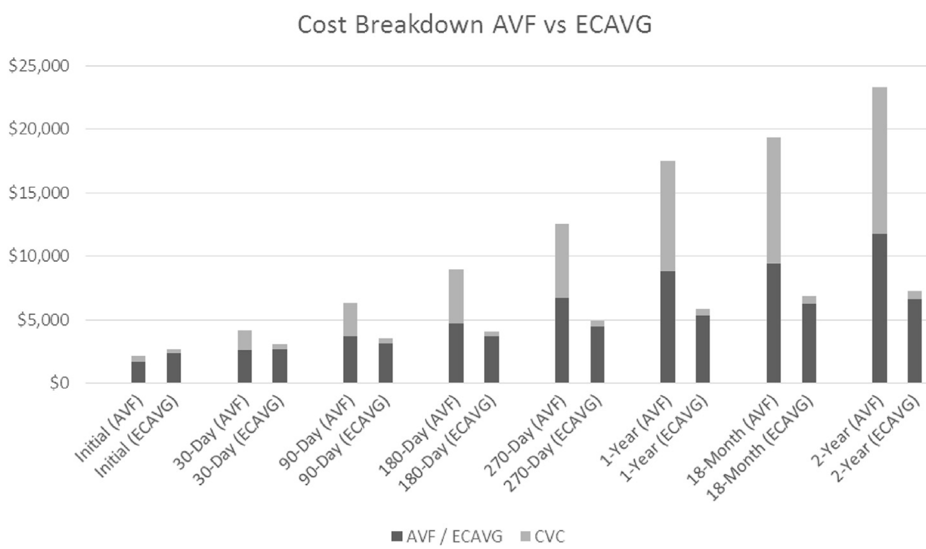

Fig. 2. Cost comparison between AVFs and ECAVGs with cost breakout for CVCs. Overall cost differences reach significance at 30 days ($P < 0.05$), and AVF versus ECAVG individual costs reach significance at 180 days ($P < 0.05$).

days) for patients receiving AVF compared with 0.3% (0.02/1,000 patient days) for patients receiving ECAVG. The average LOS in the ICU was 7.2 days for patients receiving AVFs with sepsis compared with 3.3 days for patients receiving ECAVGs. The occupancy rate in the ICU was calculated as a function of total ICU days available for a modest 25-bed unit. If a switch to ECAVG is made instead of the use of AVFs and CVCs for urgent-start dialysis in patients with ESRD, 796 days would be freed up in the ICU, leading to addition of 2.2 more open beds on average and a further reduction in annual cost of care of $1,999,143.

DISCUSSION

The findings in this article related to the decrease in CVC-related complications and secondary interventions associated with ECAVGs are consistent with what has been previously published.[3–5,8–13] The use of ECAVGs for urgent-start dialysis in patients with ESRD leads to a decrease in CVC use, thus a lower rate of CVC-related complications.[3,5,7,10–12] ECAVGs are also associated with fewer secondary interventions than AVFs that are used for patients with ESRD.[8–11,13] The cost savings that are possible from the delivery of higher quality health care are significant when ECAVGs are used in lieu of AVFs and CVCs for patients with ESRD who require immediate dialysis.[10]

The decrease in secondary interventions in patients receiving ECAVGs leads to a reduction of $11,630 in the annual cost per patient. Most of this cost decrease is secondary to a decreased supply cost due to fewer procedures being performed on patients receiving ECAVGs. There is a concomitant decrease in the cost of medications, laboratory tests,

Table IV. Direct costs for AVFs by time period

Cost	Initial	30 Days	90 Days	180 Days	270 Days	1 Year
Direct (supply)	$1,379	$2,602	$4,006	$5,775	$8,415	$11,048
Direct (medications)	$197	$504	$572	$722	$1,256	$2,928
Direct (laboratory tests)	$104	$184	$318	$502	$541	$681
Direct (labor)	$131	$210	$254	$632	$654	$701
Direct (other)	$378	$697	$1,208	$1,393	$1,694	$2,165
Total direct	$2,189	$4,197	$6,359	$9,024	$12,560	$17,523

Table V. Direct costs for ECAVGs by time period

Cost	Initial	30 Days	90 Days	180 Days	270 Days	1 Year
Direct (supply)	$2,040	$2,329	$2,722	$3,009	$3,433	$4,243
Direct (medications)	$241	$252	$289	$334	$455	$490
Direct (laboratory tests)	$180	$289	$301	$409	$551	$600
Direct (labor)	$187	$220	$144	$167	$253	$300
Direct (other)	$27	$57	$155	$260	$354	$370
Total direct	$2,675	$3,148	$3,612	$4,179	$5,046	$6,004

Overall cost differences reach significance at 30 days ($P < 0.05$), and AVF versus ECAVG individual costs reach significance at 180 days ($P < 0.05$).

labor, and others. Overall cost differences reach significance at 30 days ($P < 0.05$), and AVF versus ECAVG individual costs reach significance at 180 days ($P < 0.05$). While the index procedure may be cheaper for AVF + CVC patients, annual costs are 3 times lower for patients who had placement of ECAVGs ($P < 0.001$).

The reduction in CVC utilization and the lower number of CVC days per patient receiving ECAVGs also lead to a decreased risk exposure related to CVC complications. This leads to a decrease in the rate of sepsis, CLABSI, DVT, pneumothorax, and subsequent line replacement for patients receiving ECAVGs. The costs associated with CLABSI have been estimated to range between $6,005 and $9,738, while the cost for sepsis is estimated to be as high as $39,000.[14–18] However, these cost calculations vary with regard to the attribution of direct and indirect costs, the quality of care provided at their institution, and the degree of sepsis or CLABSI seen with their patients.

We used actual direct cost data for CLABSI and sepsis at our institution for our cost analysis and normalized the savings across all patients to derive a per-patient per-year average value. We found a $437 annual savings related to sepsis, $99 annual savings related to CLABSI, and $78 savings related to other CVC-related complications per patient; these values are similar to findings from prior publications.[11,13,14,16–18] We used a value of $2,512 to calculate the average cost per day in the ICU, which is consistent with the numbers previously reported

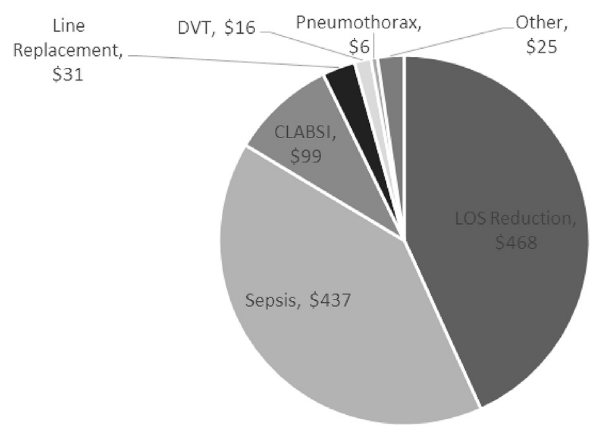

Fig. 3. Additional cost of CVC-related complications and excess LOS per patient. The total additional savings per patient is $1,083, which can be achieved by switching to ECAVGs instead of an AVF and CVC for urgent-start dialysis in patients with ESRD.

in the literature.[19–21] With the 4.0 reduction in ICU LOS associated with patients receiving ECAVGs, this averaged out to a per-patient per-year additional cost reduction of $468.

When combining the cost savings associated with fewer secondary interventions ($11,630), decreased complications ($615), and a shorter LOS ($468), the total decrease in annual per-patient direct costs comes to $12,713. With MSPB at $90,971 in 2016, the most recent year for which cost figures are available, switching to ECAVGs for urgent-start dialysis in patients with

ESRD could lead to a 14% cost reduction per patient. With 124,675 patients having initiated dialysis in 2016, only 29.6% of whom had a functioning graft, the use of ECAVGs for urgent-start dialysis could have led to savings of $1.1 billion. If all patients with ESRD who had a CVC in 2016 had an ECAVG for HD, there could have been $3.8 billion in savings.[22]

The Monte Carlo simulation evaluates the impact of switching to ECAVGs for urgent-start dialysis instead of using an AVF and CVC combination for patients with ESRD. The reduction in sepsis and ICU LOS is evaluated as a part of this simulation, which finds that a 25-bed ICU could have an additional 2.2 beds freed up over the course of a year, translating to $2M in additional cost savings. These are direct cost savings for the hospital in the form of decreased supply, laboratory test, and labor expenditures.

In addition to the significant decrease in MSPB, there is a meaningful impact on key metrics for ESCOs and hospital systems as it relates to a decrease in the incidence of CVC utilization, CLABSI, sepsis, 30-day readmission, LOS, and inpatient mortality. This equates to additional reimbursement for access centers, hospitals, and physicians as part of a Medicare shared savings program. Additional quality-based incentives are also possible through the merit-based incentive payment system, a part of the Medicare Quality Payment Program.[23]

In our practice, ECAVGs are used preferentially for patients with ESRD who require urgent-start dialysis. This has changed how the ‘‘Fistula-First’’ paradigm is applied to our patients. While we continue to place an AVF in patients with CKD who have not yet progressed to HD, any patient who presents with ESRD and requires urgent-start dialysis receives an ECAVG. This greatly reduces the use of CVCs and prevents downstream complications associated with catheters, thus providing higher quality care at a lower cost. Owing to the considerable impact this practice has had on health-care economics related to dialysis access, we would recommend the utilization of ECAVGs for all patients with ESRD who require urgent-start dialysis. Continuing efforts to refer patients with CKD for elective AVF placement should continue to be bolstered. Together, this concerted strategy can reduce CVC utilization and avoid high-cost complications associated with catheters.

CONCLUSION

ECAVGs are associated with a significant improvement in the quality of health care for patients with ESRD who require urgent-start dialysis. Compared with initiating HD via an AVF and CVC, ECAVGs lead to fewer secondary interventions, fewer CVC-associated complications, and a lower cost of care. Implementing a dialysis access program that seeks to maximize the use of ECAVGs for patients with ESRD can significantly improve the quality of care while decreasing costs.

REFERENCES

1. https://www.usrds.org/. Last accessed November 25, 2018.
2. Section K. Healthcare Expenditures for ESRD. USRDS, 2018. Available at: https://www.usrds.org/2018/ref/ESRD_Ref_K_Expenditures_2018.xlsx. Accessed November 25, 2018.
3. Böhlke M, Uliano G, Barcellos FC. Hemodialysis catheter-related infection: prophylaxis, diagnosis and treatment. J Vasc Access 2015;16:347–55.
4. Machowska A, Alscher MD, Vanga SR, et al. Dialysis access, infections, and hospitalisations in unplanned dialysis start patients: results from the OPTiONS study. Int J Artif Organs 2017;40:48–59.
5. Al-Balas A, Lee T, Young CJ, et al. The clinical and economic Effect of vascular access Selection in patients initiating hemodialysis with a catheter. J Am Soc Nephrol 2017 Dec;28:3679–87.
6. Comprehensive End Stage Renal Disease Care (CEC) Model 2018 Quality Measure Set. Available at: https://innovation.cms.gov/Files/x/cec-qualityperformance-ldo.pdf. Accessed November 25, 2018.
7. Arhuidese IJ, Orandi BJ, Nejim B, et al. Utilization, patency, and complications associated with vascular access for hemodialysis in the United States. J Vasc Surg 2018;68:1166–74.
8. Besarab A, Kumbar L. How arteriovenous grafts could help to optimize vascular access management. Semin Dial 2018;31:619–24.
9. Wagner JK, Truong S, Chaer R, et al. Current experience and midterm follow-up of immediate-access arteriovenous grafts. Ann Vasc Surg 2018;53:123–7.
10. Desai SS. Two-year outcomes of early cannulation arteriovenous grafts for end stage renal disease. Ann Vasc Surg 2019. In Press.
11. Leake AE, Yuo TH, Wu T, et al. Arteriovenous grafts are associated with earlier catheter removal and fewer catheter days in the United States Renal Data System population. J Vasc Surg 2015;62:123–7.
12. Shechter SM, Chandler T, Skandari MR, et al. Cost-effectiveness analysis of vascular access Referral Policies in CKD. Am J Kidney Dis 2017;70:368–76.
13. Glickman MH, Burgess J, Cull D, et al. Prospective multicenter study with a 1-year analysis of a new vascular graft used for early cannulation in patients undergoing hemodialysis. J Vasc Surg 2015;62:434–41.
14. Saint S, Veenstra DL, Lipsky BA. The clinical and economic consequences of nosocomial central venous catheter-related infection: are antimicrobial catheters useful? Infect Control Hosp Epidemiol 2000;21:375–80.
15. Rubio-Terrés C, Garau J, Grau S, et al. Cast of Resistance Study group. Cost of bacteraemia caused by methicillin-resistant vs. methicillin-susceptible Staphylococcus aureus in Spain: a retrospective cohort study. Clin Microbiol Infect 2010;16:722–8.
16. Burchardi H, Schneider H. Economic aspects of severe sepsis: a review of intensive care unit costs, cost of illness

and costeffectiveness of therapy. Pharmacoeconomics 2004;22:793—813.
17. Khwannimit B, Bhurayanontachai R. The direct costs of intensive care management and risk factors for financial burden of patients with severe sepsis and septic shock. J Crit Care 2015;30:929—34.
18. Brun-Buisson C, Roudot-Thoraval F, Girou E, et al. The costs of septic syndromes in the intensive care unit and influence of hospital-acquired sepsis. Intensive Care Med 2003;29:1464—71.
19. Norris C, Jacobs P, Rapoport J, et al. ICU and non-ICU cost per day. Can J Anaesth 1995;42:192—6.
20. Lefrant JY, Garrigues B, Pribil C, et al., CRREA Study Group., AzuRea Group. The daily cost of ICU patients: a micro-costing study in 23 French Intensive Care Units. Anaesth Crit Care Pain Med 2015;34:151—7.
21. Karabatsou D, Tsironi M, Tsigou E, et al. Variable cost of ICU care, a micro-costing analysis. Intensive Crit Care Nurs 2016;35:66—73.
22. Section D. Treatment Modalities. USRDS, 2018. Available at: https://www.usrds.org/2018/ref/ESRD_Ref_D_Modality_2018.xlsx. Last. Accessed November 25, 2018.
23. MIPS. Available at: https://qpp.cms.gov/mips/overview. Accessed November 25, 2018.