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Short-Term Mortality Associated with Outpatient Vascular Access Restoration Procedures

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Key Points:
*This study confirms the safety of endovascular interventions for thrombosis of hemodialysis access in outpatient and office-based settings.

*Risk of death in the week following vascular access procedure was not associated with hemodialysis access type (Fistula vs Graft).

Abstract:

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Author Contributions: Deepika Paratane: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Visualization; Writing - original draft; Writing - review and editing Margaret Doll: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Writing - original draft; Writing - review and editing Carol-Ann Swain: Conceptualization; Methodology; Writing - original draft; Writing - review and editing Katie Cardone: Conceptualization; Methodology; Writing - review and editing Colleen McLaughlin: Conceptualization; Formal analysis; Investigation; Methodology; Supervision; Validation; Writing - original draft; Writing - review and editing

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Short-Term Mortality Associated with Outpatient Vascular Access Restoration Procedures

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Key Points:

- This study confirms the safety of endovascular interventions for thrombosis of hemodialysis access in outpatient and office-based settings.
- Risk of death in the week following vascular access procedure was not associated with hemodialysis access type (Fistula vs Graft).

In the end-stage kidney disease (ESKD) population, the overall high risk of death may obscure short-term increases in mortality related to endovascular procedures. Single institution studies have reported little to no increased risk of short-term mortality following outpatient endovascular intervention [1, 2]; however, no studies have evaluated procedure-related mortality risks in the United States (US) ESKD population nationally. This study aims to estimate the risk of all-cause mortality within the first 7 days following an endovascular access (VA) restoration procedure due to thrombosis and to identify patient and procedural risk factors associated with 7-day mortality among a national cohort of US ESKD patients.

We conducted a case-cohort study of US ESKD patients identified from the US Renal Data System (USRDS) from 1/1/2011 – 9/30/2015 [3]. This end date was chosen because it marks the conversion of Medicare claims data to ICD-10. Baseline inclusion criteria were hemodialysis (HD) treatment for at least one year; use of an arteriovenous fistula (AVF) or graft (AVG); age 18 years or older; and Medicare as the primary payer. Within this base population, we identified the first VA procedure with thrombosis diagnosis for each patient (index procedure). We then excluded patients for whom the index procedure was performed in an inpatient hospital or emergency department setting, as well as all patients who had additional VA procedures within 90-days of the index procedure. Patients for whom the index procedure was not endovascular were also excluded.

We identified 356 deaths within 90 days among 6,381 unique patients meeting the inclusion criteria. Among patients experiencing mortality, the cause of death was missing for 50% of patients, and it was not possible to associate this information with VA procedures among persons for whom these data were available. There was no increase in mortality in days 0-7 days following VA procedures (n=31, mean 3.9 deaths per day) compared to 8-90 days (n=325, mean 4.0 deaths per day). A modified self-controlled case series analysis [4] yielded a relative incidence of 1.0, 95% confidence interval 0.7 to 1.5.

We used logistic regression to examine risk factors for mortality within 7 days (cases) versus 8-90 days post-procedure (controls), adjusting for age and Liu Comorbidity Index [5]. We found an increased risk associated with a duration of 3 days since last dialysis relative to 0-2 days (Table 1).
This finding and the increased risk associated with inadequate dialysis dose measured by single-pool Kt/V less than or equal to 1.2 at the time of the procedure may have been related to the indication for the procedure, rather than the procedure itself. While we did not detect a difference in risk associated with dialysis ≥4 days relative to 0-2 days since last dialysis, our estimates were highly imprecise (odds ratio 0.6, 95% confidence intervals 0.1 – 4.7), due to a small number of cases and controls whose last dialysis was 4 or more days before their procedure.

The only risk factor associated with increased risk which was not potentially due to the procedure indication was a diagnosis of heart failure. Risk was not associated with procedure setting, type of vascular access, proceduralist specialty, gender, race or ethnicity, or other comorbidities available on the USRDS dataset (data not shown). The lack of an association between death within 7 days and age or Liu comorbidity index indicates that cases and controls represent a similar pool of patients. The median age was 77 for cases and 75 for controls.

To our knowledge, this is the first US study evaluating the risk of mortality related to HD restoration endovascular procedures nationally that was controlled in a comprehensive manner. Since we restricted the study population to deaths within 90 days of a VA procedure, we limited bias related to mortality risk associated with the primary indication for the VA procedure (i.e., thrombosis) [6]. Restriction to patients on hemodialysis for at least one year limited the increased mortality risks associated with early loss of AV patency [7]. Restriction to the outpatient setting also reduces bias due to competing causes and confounding by comorbidities not captured in USRDS or the comorbidity index. Further, since we only included patients for whom the indication for the endovascular procedure was thrombosis, we limited confounding by indication in our analyses from other causes of VA failure, such as infection, where the short-term risk of mortality is likely to be higher.

This study confirms the safety of endovascular interventions performed in the outpatient and office-based settings, at least within the patient population we studied. Given that procedure techniques and greater patient access to vascular access centers have likely improved survival in the time period after 2015, our results may be viewed as conservative. These findings should be reassuring to providers and patients. Our finding of increased risk associated with time since last dialysis supports early referral for intervention. Our design did not enable us to examine time between VA procedure and subsequent dialysis, as a result we could not determine if VA procedure followed immediately by dialysis was protective for individuals who had not been adequately dialyzed. Further, our design did not allow us to examine the risk of mortality among patients experiencing multiple VA procedures within 90 days, who may be at higher risk of mortality by indication. Additional studies are also
needed to confirm the role of heart failure in short-term mortality and investigate potential preventive measures for this population.

Disclosures:

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Author Contributions:

Deepika Paratane: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Visualization; Writing - original draft; Writing - review and editing. Margaret Doll: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Writing - original draft; Writing - review and editing. Carol-Ann Swain: Conceptualization; Methodology; Writing - original draft; Writing - review and editing. Katie Cardone: Conceptualization; Methodology; Writing - review and editing. Colleen McLaughlin: Conceptualization; Formal analysis; Investigation; Methodology; Supervision; Validation; Writing - original draft; Writing - review and editing.
Table 1. Adjusted risk ratios comparing death within 7 days of an outpatient endovascular procedure for thrombosis relative to death between 8 and 90 days among end-stage kidney disease patients, United States Renal Data System, 1/1/2011 – 9/30/2015

| Variable                                                                 | Adjusted Risk Ratio | 95% Confidence Interval |
|-------------------------------------------------------------------------|---------------------|--------------------------|
| Age at time of VAP (continuous, in years)                                | 1.0                 | 1.0                      |
| Liu Comorbidity index                                                   | 1.1                 | 1.0                      |
| Days since last dialysis (3 vs <=2)                                     | 3.7                 | 1.3                      |
| Days since last dialysis (>=4 vs <=2)                                   | 0.6                 | 0.1                      |
| Single-pool Kt/V < 1.2²                                                | 3.8                 | 1.1                      |
| Heart Failure                                                           | 4.2                 | 1.3                      |
| Procedure Setting (Outpatient/Ambulatory Surgery vs Office)             | 1.1                 | 0.5                      |
| Hemodialysis Access Type (Arteriovenous Fistula vs Graft)              | 0.8                 | 0.3                      |

1. All risk ratios adjusted for age at time of procedure, comorbidity index, congestive heart failure, and days since last dialysis. Complete case analysis: all models except single-pool Kt/V included 30 cases and 323 controls due to missing data for days since last dialysis.

2. Single-pool Kt/V was missing for 35 patients.
References:

1. Mestres G, Yugueros X, Fontseré N, Fierro A, Sala X, Derosa TM, et al. Vascular access surgery can be safely performed in an ambulatory setting. The journal of vascular access. 2019;20(2):195-201. Epub 2018/08/18. doi: 10.1177/1129729818794356. PubMed PMID: 30117363.

2. Aurshina A, Ostrozhynskyy Y, Alsheekh A, Kibrik P, Chait J, Marks N, et al. Safety of vascular interventions performed in an office-based laboratory in patients with low/moderate procedural risk. Journal of vascular surgery. 2021;73(4):1298-303. Epub 2020/10/17. doi: 10.1016/j.jvs.2020.09.024. PubMed PMID: 33065244.

3. U.S. Renal Data System. 2019 USRDS annual data report: Epidemiology of kidney disease in the United States. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2019.

4. Farrington CP, Whitaker HJ, Hocine MN. Case series analysis for censored, perturbed, or curtailed post-event exposures. Biostatistics (Oxford, England). 2009;10(1):3-16. Epub 2008/05/24. doi: 10.1093/biostatistics/kxn013. PubMed PMID: 18499654.

5. Liu J, Huang Z, Gilbertson DT, Foley RN, Collins AJ. An improved comorbidity index for outcome analyses among dialysis patients. Kidney international. 2010;77(2):141-51. Epub 2009/11/13. doi: 10.1038/ki.2009.413. PubMed PMID: 19907414.

6. Girerd S, Girerd N, Frimat L, Holdaas H, Jardine AG, Schmieder RE, et al. Arteriovenous fistula thrombosis is associated with increased all-cause and cardiovascular mortality in haemodialysis patients from the AURORA trial. Clinical kidney journal. 2020;13(1):116-22. Epub 2020/02/23. doi: 10.1093/ckj/sfz048. PubMed PMID: 32082562; PubMed Central PMCID: PMCPMC7025348.

7. Yap YS, Chi WC, Lin CH, Liu YC, Wu YW. Association of early failure of arteriovenous fistula with mortality in hemodialysis patients. Scientific reports. 2021;11(1):5699. Epub 2021/03/13. doi: 10.1038/s41598-021-85267-6. PubMed PMID: 33707591; PubMed Central PMCID: PMCPMC7952912.