Cardiovascular Implantable Electronic Devices (CIED) in Hemodialysis Patients: Prevalence and Impact on Arteriovenous Hemodialysis Access

Theodore F. Saad MD, Waqas Ahmed MD, Karen Davis NP

Nephrology Associates, PA and Christiana Care Health System, Newark, DE

INTRODUCTION

Pacemakers and implantable cardioverter-defibrillators (ICDs), collectively known as cardiovascular implantable electronic devices (CIEDs) are frequently utilized for treatment of cardiac rhythm disorders in patients with chronic kidney disease (CKD) and end-stage renal disease (ESRD) receiving hemodialysis. The ICD implantation rate in prevalent United States ESRD patients in 2008 was 0.7% (1). From 1996 to 2006, 9528 US Medicare-insured dialysis patients underwent ICD implantation, with 88% of these occurring after the year 2000 (2). The prevalence of CIEDs in the overall US ESRD population has not been well described. In one single-center retrospective study of 590 hemodialysis patients from 1995 to 2010 (3), CIEDs were identified in 43 patients (7.3%)

In this study, we assess the point-prevalence of CIEDs in a complete single-practice hemodialysis population. In addition, we examine the relationship between CIEDs and arteriovenous (AV) hemodialysis access, rates of percutaneous interventions, and CIED-associated superior vena cava (SVC) stenosis.

MATERIALS & METHDS:

This study received Christiana Care Health System institutional review board approval and met Health Insurance Portability and Accountability Act waiver requirements. All chronic hemodialysis patients in Delaware and Maryland under the care of Nephrology Associates, PA who received treatment from January 1, 2011 through March 31 2011 were included in this study. Patient demographic data and hemodialysis access history were obtained from a continuously maintained clinical database, including all surgical and minimally invasive procedures related to hemodialysis vascular access as well as all CIED implantations and procedures. Additional data and radiographic images for review were obtained from Christiana Care and Nephrology Associates electronic health records and PACS.

Data collected for each subject included age, gender, current primary and secondary hemodialysis vascular access type (fistula, graft, or chronic venous catheter), location, and date of initial creation or insertion. For patients with a CIED, additional data was collected including device type (ICD or pacemaker), date, side and vein used for transvenous lead placement. The indication for ICD implantations was classified as “primary-prevention” or “secondary-prevention” of ventricular dysrhythmia. The number of interventional procedures performed on the hemodialysis access circuit in general and on the central veins in particular was recorded from the date that both the existing vascular access and CIED were first present. For all cases where radiographic images were available, these were reviewed for the presence or absence of SVC stenosis based upon conventional angiographic criteria. Patients who had stents placed in association with CIED leads were noted, as well as those who had previously failed ipsilateral AV access due to CIED leads. Each patient with a CIED in place was evaluated for symptomatic venous hypertension (V-HTN) related to CIED-associated central vein stenosis and grouped according to clinical severity: No V-HTN, no intervention required; V-HTN controlled with ≤2 percutaneous interventions per year; V-HTN controlled with >2 interventions per year; V-HTN not controlled by percutaneous intervention.

1236 patients met the enrollment criteria and formed the study cohort. The primary hemodialysis vascular access was a native AV fistula in 766 (62%), non-autologous AV graft in 271 (22%), and chronic venous catheter in 197 (16%). In two patients the primary access type could not be determined.

RESULTS

A CIED was present in 131 of 1236 patients (10.6%); this was an ICD in 72 (5.8%) and a pacemaker in 59 (4.8%). 1102 (89.2%) patients had no CIED and in 3 patients the presence or absence of a CIED could not be determined. Of patients with a CIED, mean age was 72.2 years; 50 were female and 81 male. Primary vascular access was native AV fistula in 77 (59%), non-autologous AV graft in 37 (28%), and chronic venous catheter in 17 (13%). CIED implantation preceded placement of AV access in 77 patients (59%). AV access preceded CIED implantation in 51 patients (39%); in 3 patients the timing of CIED versus vascular access placement could not be determined.

All CIED leads were placed via the subclavian or cephalic vein, as determined from implantation procedure report, radiographic images, or central venography. No CEID leads were placed via internal jugular, femoral, or other transvenous route. No patient in this study had epicardial CIED leads.

Excluding 17 patients with venous catheters, 114 patients had both a CIED and AV access. One had a femoral graft. Of the remaining113 patients with CIED and upper-extremity AV access, the device and access were ipsilateral in 44 patients (39%) and contralateral in 69 patients (61%). Rates of intervention on the access circuit, central vein stenosis associated with CIED leads, and V-HTN grade are reported in the table below. No clinically or angiographically significant SVC stenosis was identified in any subject & no percutaneous interventions were utilized for treatment of SVC stenosis.

Six patients with contralateral CIED and AV access had previously failed ipsilateral AV access due to intractable venous hypertension not manageable by percutaneous intervention. Three patients with ipsilateral CIED and AV access had venous stents in place for treatment of CIED-associated central vein stenosis.

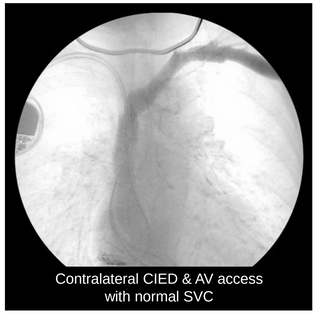
CIED and Upper-Extremity AV Access

	Contralateral	Ipsilateral
Subjects	69	44
All Access Circuit Interventions (Number / Rate per AY)	202 / 1.50	168 / 1.53
CIED-Related Central Venous Interventions	0	66/0.60
Interventions for V-HTN		
None	69	30 (68%)
≤2 per year	0	7 (16%)
>2 per year	0	7 (16%)
Uncontrollable V-HTN	0	0
CIED prior to AV Access	29 (42.0%)	34 (77%)
AV Access prior to CIED	38 (55.1%)	9 (21%)
Unknown	2	1

Poster printed by Medical Photography, Visual Presentation Technology Services, Christiana Care Health Services

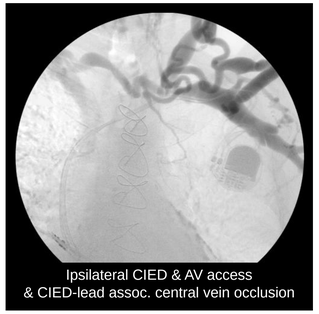
DISCUSSION & CONCLUSIONS

- CIEDs were present in 10.6% of the hemodialysis patient population described in this study
- Central vein stenosis associated with subclavian vein CIED leads and ipsilateral AV access may require repeated interventions to control venous hypertension and in some cases may result in failure of the AV access
- Overall access circuit intervention rates are similar for patients with ipsilateral and contralateral CIED & AV access
- It is preferable to avoid ipsilateral CIED and AV access in order to minimize potential complications of venous hypertension
- With proper pre-operative imaging and careful patient selection, an AV access can be constructed ipsilateral to existing CIED leads and in many cases achieve sustained function without requirement for excessively frequent percutaneous interventions
- There are important clinical and anatomical considerations when creating AV access in a patient with existing CIED, and when implanting a CIED into patient with existing AV access. In both situations, careful planning and communication between nephrologist, vascular access surgeon, and CIED implanting physician are essential to achieving optimal outcomes



Contralateral CIED & AV access with normal SVC

Ipsilateral CIED & AV access without significant venous stenosis



Ipsilateral CIED & AV access & CIED-lead assoc. central vein occlusion

REFERENCES

1. US Renal Data System, USRDS 2010 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD. Cardiovascular special studies; defibrillators. Pg 338-339
2. Charytan DM, Patrick AM, Liu J, MD, Setoguchi S, Herzog CA, MD, Brookhart A, Winkelmayer WC: Trends in the use and outcomes of implantable cardioverter-defibrillators in patients undergoing dialysis in the United States. Am J Kidney Dis, 2011;58:409-417
3. Drew DA, Myers KB, Weiner DE: Transvenous cardiac device wires and vascular access in hemodialysis patients. Am J Kidney Dis 2011;58:494-495 (Letter)
4. Cuculich P, Sanchez JM, Kerzner R, Greenberg SL, Sengupta J, Chen J, Faddis MN, Gleva ME, Smith TW, Lindsay BD: Poor Prognosis for Patients with Chronic Kidney Disease Despite ICD Therapy for the Primary Prevention of Sudden Death. *PACE* 2007; 30:207-213
5. Robin J, Weinberg K, Tiongson J, Carnethon M, Reddy M, Ciaccio C, Quadrini M, Hsu J, Fan J, Choi P, Kadish A, Goldberger J, Passman R: Renal dialysis as a risk factor for appropriate therapies and mortality in implantable cardiac defibrillator recipients. *Heart Rhythm* 2006; 3:1196-1201
6. Herzog CA, Li S, Weinhandl ED, Strief JW, Collins AJ, Gilbertson DT: Survival of dialysis patients after cardiac arrest and the impact of implantable cardioverter defibrillators. *Kidney Int* 2005; 68:818-825
7. Aggarwal A, Wang Y, Rumsfeld JS, Curtis JP, Heidnereich PA: Clinical characteristics and in-hospital outcome of patients with end-stage renal disease on dialysis referred for implantable cardioverter-defibrillator implantation. *Heart Rhythm* 2009; 6:1565-1571
8. Dasgupta A, Montalvo J, Medendorp S, Lloyd-Jones DM, Ghossein C, Golberger J, Passman R: Increased complication rates of cardiac rhythm management devices in ESRD patients. *Am J Kidney Dis* 2007; 49:656-663
9. Lam N, Leong-Sit P, Garg AX: The role of implantable cardioverter-defibrillators in long-term dialysis patients. Am J Kidney Dis 2011;58:338-339
10. Teruya TH, Abou-Zamzam AM, Limm W, Wong L, Wong L: Symptomatic subclavian vein stenosis and occlusion in hemodialysis patients with transvenous pacemakers. *Ann Vasc Surg* 2003; 17:526-529
11. Asif A, Salman L, Carrillo RG, et al.: Patency rates for angioplasty in the treatment of pacemaker-induced central venous stenosis in hemodialysis patients: results of a multi-center study *Semin Dialysis* 2009; 22:671-676
12. Saad TF, Myers GR, Cicone JS: Central vein stenosis or occlusion associated with cardiac rhythm management device leads in hemodialysis patients with ipsilateral arteriovenous access: A retrospective study of treatment using stents or stent-grafts. *Journal of Vascular Access* 2010; 11:293-302
13. Asif A, Carrillo R, Garisto JD, Lopera G, Ladino M, Barakat U, Eid N, Salman L: Epicardial Cardiac Rhythm Devices for Dialysis Patients: Minimizing the Risk of Infection and Preserving Central Veins. *Seminars in Dialysis*, no. doi: 10.1111/j.1525-139X.2010.00757.x; Aug 27 Epub ahead of print