Address correspondence to Jennie H. Kwon DO, MSCI, Division of Infectious Diseases, Washington University School of Medicine, 4523 Clayton Ave, Campus Box 8051, St Louis, MO 63110 (j.kwon@wustl.edu).

Received June 28, 2017; accepted September 3, 2017; electronically published September 27, 2017
Infect Control Hosp Epidemiol 2017;38:1373–1375
 0899-823X/2017/3811-0019. DOI: 10.1017/ice.2017.207

REFERENCES

1. Antibiotic Resistance Threats in the United States, 2013. Centers for Disease Control and Prevention website. http://www.cdc.gov/drugresistance/threat-report-2013/. Published 2014. Accessed January 9, 2016.
2. Gambarotto K, Ploy MC, Dupron F, Giangiobbe M, Denis F. Occurrence of vancomycin-resistant Enterococci in pork and poultry products from a cattle-rearing area of France. *J Clin Microbiol* 2001;39:2354–2355.
3. Lopez M, Saenz Y, Rojo-Bezares B, et al. Detection of vanA and vanB2-containing enterococci from food samples in Spain, including *Enterococcus faecium* strains of CC17 and the new singleton ST425. *Int J Food Microbiol* 2009;133:172–178.
4. Basanisi MG, La Bella G, Nobili G, Franconieri I, La Salandra G. Genotyping of methicillin-resistant *Staphylococcus aureus* (MRSA) isolated from milk and dairy products in South Italy. *Food Microbiol* 2017;62:141–146.
5. de Boer E, Zwartkruis-Nahuis JT, Wit B, et al. Prevalence of methicillin-resistant *Staphylococcus aureus* in meat. *Int J Food Microbiol* 2009;134:52–56.
6. Vojkovska H, Myskova P, Gelbicova T, Skockova A, Kolackova I, Karpiskova R. Occurrence and characterization of food-borne pathogens isolated from fruit, vegetables and sprouts retailed in the Czech Republic. *Food Microbiol* 2017;63:147–152.
7. Kwon JH, Lanzas C, Reske KA, et al. An evaluation of food as a potential source for *Clostridium difficile* acquisition in hospitalized patients. *Infect Control Hosp Epidemiol* 2016;37:1401–1407.
8. Dubberke ER, Reske KA, Seiler S, Hink T, Kwon JH, Burnham CA. Risk factors for acquisition and loss of *Clostridium difficile* colonization in hospitalized patients. *Antimicrob Agents Chemother* 2015;59:4533–4543.
9. Clinical and Laboratory Standards Institute. Performance Standards for Antimicorbial Susceptibility Testing; Twenty-Fifth Informational Supplement. Vol. M100-S25. Wayne, Pennsylvania: Clinical and Laboratory Standards Institute; 2015.
10. Boye K, Bartels MD, Andersen IS, Moller JA, Westh H. A new multiplex PCR for easy screening of methicillin-resistant *Staphylococcus aureus* SCC*mec* types I–V. *Clin Microbiol Infect* 2007;13:725–727.

Placing Venous Catheters in the Home: Pilot Data from the Mobile VAD Program

Patients requiring vascular access devices (VADs) for home infusion therapy typically receive them as inpatients prior to discharge home. However, for years many otherwise-stable outpatients requiring VADs have avoided hospitalizations altogether by having the VADs placed in ambulatory healthcare settings.[1] In the novel Johns Hopkins Home Care Group Mobile VAD Program, VAD placement is even removed from ambulatory healthcare facilities such as clinics: trained nurses place VADs in patient homes. The program allows the entire home infusion therapy process (VAD placement, patient and caregiver training, delivery of supplies, infusion therapy, and assessment by home care nurses) to take place in the home, outside healthcare settings. We present preliminary outcomes from a prospective cohort of patients in the program.

METHODS

Starting in December 2015, outpatients[1] requiring VADs but not needing hospitalization were referred to the Mobile VAD program. Telephone screenings ensured patients had a location in the home appropriate for VAD placement (ie, with a clean bed and a clean accessible sink, and where traffic from other household residents and pets can be avoided). A trained nurse placed the VAD (peripherally inserted central catheter [PICC] or midline catheter), using electrocardiogram (EKG)-based technology to confirm placement (Bard Site Rite 8 Ultrasound System, Bard Access Systems, Salt Lake City, UT). Patients could then be followed by any home infusion agency for medications, infusions, and supplies, and by any home nursing agency for training and support in VAD care.

We expanded a previously described prospective cohort of home infusion therapy patients[2] to include Mobile VAD patients. Eligible patients (>18 years of age, with a PICC or midline catheter placed in the home through the Mobile VAD program December 2015 through April 2017 for home infusion therapy) consented to a telephone survey and chart abstraction 2 weeks after VAD placement. Patients were ineligible if they were in hospice care, did not speak English, or could not verbally consent. Consenting patients completed a 10-minute telephone survey focusing on VAD complications.[2] The electronic health record (EHR) was abstracted for demographic and clinical information through 1 month after VAD removal. VAD days were calculated as the number of days between VAD placement and removal. The Charlson Comorbidity Index was calculated.[3]

The primary outcome was any VAD complication per 1,000 home VAD days and included any of the following: central-line–associated bloodstream infection (CLABSI), catheter-associated venous thromboembolism (CA-VTE), bloodstream infection (BSI), or VAD occlusion, dislodgement, accidental removal, kinking, coiling, breaking, phlebitis, or linking. CA-VTE was defined as a venous thromboembolism (VTE) on imaging in any location, as PICCs may be risk factors for upper and lower VTEs.[4] CLABSI were defined based on Association for Professionals in Infection Control (APIC) criteria for CLABSI in home infusion[5] (adapted from National Healthcare Surveillance Network [NHSN] CLABSI definitions).[6] Bloodstream infections were defined as at least 2 positive samples

of cultured blood within 48 hours of VAD removal that did not meet CLABSI criteria (eg, in patients with midline catheters).[6] VAD occlusion was defined as a blockage in at least 1 VAD lumen necessitating medical treatment or VAD removal.

The study was approved as expedited with oral consent by the Johns Hopkins University School of Medicine Institutional Review Board.

RESULTS

Of 84 eligible patients, 30 could not be reached and 9 refused consent. We enrolled 45 patients (53.6%). Most patients received a PICC (82.2%, N = 37, Table 1) and outpatient parenteral antimicrobial therapy (OPAT; N = 40; 88.9%), for indications such as neuroborreliosis (N = 8; 20.0%), chronic osteomyelitis (N = 16; 40.0%), septic arthritis (N = 4; 10.0%), and cystic fibrosis exacerbation (N = 10; 25.0%). The most common complication was inadvertent VAD removal (N = 4; 8.9%; 2.03 per 1,000 VAD days). The total rate of complications was 3.05 per 1,000 VAD days (N = 6; 13.3%). In addition, 2 patients were admitted within 30 days of VAD placement (4.4%) for planned surgical procedures.

TABLE 1. Demographic and Clinical Characteristics and Outcomes of 45 Patients With PICCs and Midline Catheters Placed in the Home

Variable	Total (% of N = 45)[a]	Rate per 1,000 VAD Days
Age, mean y, median (IQR)	52.8, 55 (43–62)	
Female gender	18 (40.0)	
Race/Ethnicity		
White non-Hispanic	34 (75.6)	
African American	6 (13.3)	
Other	5 (11.1)	
Insurance		
Private	33 (73.30)	
Medicare	4 (8.9)	
Medicaid	6 (13.3)	
Veteran's or military insurance	2 (4.4)	
Charlson comorbidity index, mean, median (IQR)[3]	2.2, 2.0 (1–3)	
Type of catheter		
PICC	37 (82.2)	
Midline	8 (17.8)	
Indication for home infusion		
OPAT	40 (88.9)	
Chemotherapy	1 (2.2)	
Total parenteral nutrition	1 (2.2)	
Venous access	1 (2.2)	
Other	3 (6.7)	
Admissions within 30 days of VAD placement	2 (4.4)	
Catheter inadvertently removed	4 (8.9)	2.03
Catheter leakage	1 (2.2)	0.51
Venous thromboembolism	2 (4.4)	1.02
Catheter occlusion	1 (2.2)	0.51
Bloodstream infection	0 (0.0)	
Central-line–associated bloodstream infection	0 (0.0)	
Any catheter complication[b]	6 (13.3)	3.05

NOTE. PICC, peripherally inserted central catheter; IQR, interquartile range; OPAT, outpatient parenteral antimicrobial therapy; VAD, vascular access device.
[a]Unless otherwise specified.
[b]Three patients had 2 catheter complications.

DISCUSSION

We present the first report of patients having PICCs and midline catheters placed in the home instead of in a healthcare facility. Overall, patients did well; 6 patients had VAD-related complications, primarily inadvertent VAD removal. In other studies, inadvertent VAD removal occurred in 1%–2% of OPAT patients.[2] Rates of other complications were similar to that seen in other studies of home infusion therapy patients. A Scottish OPAT study found an incidence of 4.1% of "other line events" including inadvertent VAD removal, VAD occlusion, VAD leaking or phlebitis.[7] In a previously described cohort of home infusion therapy, 23.4% had a VAD-related complication (4.37 per 1,000 home VAD days).[2] These studies focused on patients who had their VADs placed as inpatients. Those who have VADs placed in the home may need a period of adjustment to navigating with the VAD prior to going home, or they may be more mobile than those with VADs placed in inpatient settings. Future work should compare VAD placement in the hospital, in ambulatory facilities, and in the home.

Our pilot study was not powered to detect differences in potential risk factors and outcomes. We did not have a comparison group, so we were unable to determine whether outcomes here differed from outcomes among other home infusion therapy populations.

Ours is the first description of VAD placement in the home versus in a healthcare setting. Overall, these patients did well, with no CLABSIs or BSIs and no unplanned readmissions. Home-based VAD placement may be particularly helpful for outpatients unable to access an ambulatory clinic due to transportation or work schedule, and the cost is similar to the cost of placement in an outpatient center. While future work needs to investigate why VADs might be inadvertently removed, the lack of serious complications suggests that this program might be beneficial in other populations.

ACKNOWLEDGMENTS

We appreciate the contributions of Amanda Krosche, BS; Matthew Naumann, BS; and Mayo Levering, BS, in enrolling patients in the study. We would like to acknowledge the contributions of Vicky Belotserkovsky and Nekia Murphy of the Johns Hopkins Home Care Group for their assistance with providing the study team a database of eligible participants.

Financial support: S.C.K. receives funding from the National Center for Advancing Translational Sciences/Johns Hopkins Institute for Clinical and Translational research, KL2 Award (grant no. KL2TR001077). This work

was supported by the Sherrilyn and Ken Fisher Center for Environmental Infectious Diseases Discovery Award.

Potential conflicts of interest: All authors report no conflicts of interest relevant to this article.

Sara C. Keller, MD, MPH, MSHP;[1]
Deborah Williams, RN, BSN, MPH;[2]
Nathasha Hamler, RN;[2]
Mitra Gavgani, PharmD;[2]
David Hirsch, RN, MSN, MBA;[2]
John Adamovich, MHA;[2]
Dawn Hohl, RN, MSN, PhD;[2]
Sara E. Cosgrove, MD, MS[1]

Affiliations: 1. Division of Infectious Diseases, Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland; 2. Johns Hopkins Home Care Group Baltimore, Maryland.

Address correspondence to Sara C. Keller, MD, MPH, MSHP, Division of Infectious Diseases, Johns Hopkins University School of Medicine, 1600 N. Wolfe St, Baltimore, MD 21287 (skeller9@jhmi.edu) or Sara E. Cosgrove, MD, MS, Division of Infectious Diseases, Department of Medicine, Johns Hopkins University School of Medicine, 1600 N. Wolfe St, Baltimore, MD 21287 (scosgro1@jhmi.edu).

PREVIOUS PRESENTATION. These data were presented in part at the Society of Healthcare Epidemiology of America Spring 2017 meeting in St Louis, Missouri, on March 29, 2017.

Received June 16, 2017; accepted August 11, 2017; electronically published September 28, 2017

Infect Control Hosp Epidemiol. 2017;38:1375–1377

 0899-823X/2017/3811-0020. DOI: 10.1017/ice.2017.200

REFERENCES

1. Paladino JA, Poretz D. Outpatient parenteral antimicrobial therapy today. *Clin Infect Dis* 2010;51(Suppl 2):S198–S208.
2. Keller SC, Williams D, Gavgani M, et al. Environmental exposures and the risk of central venous catheter complications and readmissions in home infusion therapy patients. *Infect Control Hosp Epidemiol* 2016:1–8.
3. D'Hoore W, Sicotte C, Tilquin C. Risk adjustment in outcome assessment: the Charlson comorbidity index. *Methods Inf Med* 1993;32:382–387.
4. Greene MT, Flanders SA, Woller SC, Bernstein SJ, Chopra V. The association between PICC Use and venous thromboembolism in upper and lower extremities. *Am J Med* 2015;128:986–993; e1.
5. APIC-HICPAC surveillance definitions for home health care and home hospice infections. Association of Professionals in Infection Control website. http://www.apic.org/Resource_/TinyMceFileManager/Practice_Guidance/HH-Surv-Def.pdf. Published 2008. Accessed May 10, 2016.
6. Centers for Disease Control and Prevention/National Healthcare Safety Network Device Associated Module. Central Line Associated Bloodstream Infection (CLABSI) Event. Centers for Disease Control and Prevention website. http://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf. Published 2015. Accessed September 5, 2017.
7. Barr DA, Semple L, Seaton RA. Outpatient parenteral antimicrobial therapy (OPAT) in a teaching hospital-based practice: a retrospective cohort study describing experience and evolution over 10 years. *Int J Antimicrob Agents* 2012;39:407–413.