American Journal of Infection Control 47 (2019) 1382–1387

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Surveillance of home health central venous catheter care outcomes: Challenges and future directions

Regina E. Nailon PhD, RN [a,*], Mark E. Rupp MD [b]

[a] Nebraska Antimicrobial Stewardship Assessment and Promotion Program, Nebraska Infection Control Assessment and Promotion Program, Nebraska Medicine, Omaha, NE
[b] Division of Infectious Diseases, University of Nebraska Medical Center, Omaha, NE

Key Words:
Central line–associated bloodstream infection
Central line complications
Home infusion

Background: Limited data are available regarding central venous catheter (CVC)-related complications that occur in home care. A practical out-of-hospital surveillance mechanism is needed.
Methods: Home health/infusion agencies in 4 states submitted monthly data from January 2011 through March 2015. Data were collected by patient age and included number of patients on service with a CVC, device days, central line–associated bloodstream infection (CLABSI), CVC-occlusions, doses of fibrinolytics administered, and number of patients receiving fibrinolytics.
Results: Ten agencies from 4 states contributed data across the study period. A total of 913 occlusions and 73 CLABSIs occurred during the 51-month surveillance period. The CLABSI rates per 1,000 device days per year across the study surveillance period ranged from 0-0.40 for pediatric and from 0-0.37 for adult patients, whereas occlusion rates per 1,000 device days ranged from 0.26-1.59 for pediatric and from 2.59-33.29 for adult patients. Doses of fibrinolytic agents administered per 1,000 device days ranged from 0.26-1.80 in pediatric and 3.53-33.85 in adult patients.
Conclusions: Opportunities exist to further expand efforts to quantify the presence of CVCs in home settings to enable improvements with measuring and tracking patient outcomes as they relate to CVC care. Exploration of continued sustainability of surveillance and data validation are warranted to optimize home health/infusion care practices and outcomes.

Intravenous therapy, commonly referred to as infusion therapy,[1] is routinely provided in a variety of settings via central venous catheters (CVCs). It is estimated that 3 million CVCs are used each year in the United States in both inpatient and outpatient care.[2] Indications for CVC placement and outpatient care include the need for long-term antibiotic infusion, chemotherapy, parenteral nutrition, hydration, and reliable access to facilitate other therapies. An emphasis on reducing hospital admissions and length of stay has increased the incidence of patients living at home with a CVC and receiving outpatient, particularly home-based care. Home health care is "care provided by a professional to a person in his/her own home."[3] A home health agency may provide services beyond those that address patients' infusion therapy needs, whereas a home infusion agency is licensed to provide services that focus solely on patients' infusion therapy needs.[4]

Regardless of the care setting, receiving infusion therapy through a CVC puts patients at risk for complications such as occlusion, thrombosis, and central line–associated bloodstream infection (CLABSI)[5-14] that compromise safe, effective care and increase health care costs. At present, there exists no standardized system for reporting and monitoring outpatient care settings with the exception of outpatient hemodialysis centers and ambulatory surgical centers.[15] Several investigators have measured and described CVC-related complications in patients receiving home and/or outpatient infusion therapy through prospective follow-up,[5,8,16-20] or analyses using data from established reporting mechanisms.[21,22] However, these efforts lack a focused attempt to target home health and home infusion agencies (HHIAs) as the data sources to explicate CVC-related outcomes specific to this setting type.

The need for systematic health care–associated infection surveillance has been emphasized in light of the focus on the patient safety

* Address correspondence to Regina E. Nailon, PhD, RN, Nebraska Medicine, 987173 Nebraska Medical Center, Omaha, NE 68198-8173.
E-mail address: rnailon@nebraskamed.com (R.E. Nailon).
Funding/support: A 1-year grant award from the Cardinal Health Foundation in 2011 partially supported the development of a consensus catheter care guideline and formulation of the surveillance mechanism employed in this project. Information and data from the surveillance mechanism described in this manuscript was presented at the IDWeek conference in San Diego, CA, October 2012; the National Home Infusion Association Annual Conference & Exposition in Dallas, TX, April 2013; and the 3M Global IV Summit in Minneapolis, MN, May 2013.
Conflicts of interest: None to report.

https://doi.org/10.1016/j.ajic.2019.04.177
0196-6553/

and public health implications of health care–associated infections.[23] Not having a surveillance mechanism in place poses challenges with quantifying the incidence of these and other adverse events and their impact on safety and quality across multiple HHIAs. This study explored the feasibility of monitoring and comparing CVC-related outcomes across multiple HHIAs through the development and implementation of an innovative and practical surveillance mechanism.

METHODS

Setting

Recruitment occurred in several phases. In 2011, the investigators worked with a group of 6 HHIAs in a midwestern metropolitan area to develop standardized CVC care guidelines aimed at out-of-hospital care provision.[24] The partnering HHIAs were invited to participate in this surveillance-based research project. In January 2012, a hard copy of the newly published CVC care guidelines[25] and the research letter of invitation were sent to all HHIA administrators across 2 midwestern states. Three agencies from 3 other states joined the surveillance network after learning about the project at scientific conferences. Each HHIA indicating interest in participating received a data use agreement that outlined the purpose of data submission and the data elements being requested, assurances of the use of the data, and the agency's right to terminate the agreement at any time. Institutional review board approval was obtained, and each agency representative signed and returned a data use agreement before any data were collected.

Data collection

A Microsoft Excel (Microsoft, Redmond, WA) data collection worksheet was developed and provided to each agency with an assigned code identifier to protect anonymity. Agencies were directed to populate the worksheet with data to be submitted on a monthly basis. The worksheet contained a drop-down menu for selection of agency code identifier, and the month and year of reporting. The data elements were categorized by patient age: 18 and younger (pediatric), and 19 and older (adult) and are displayed in Figure 1. Agencies were instructed to calculate device days by determining the number of patients with a CVC on agency service each day summed across all days of the month. If a patient had more than 1 CVC, agencies were instructed to count it as 1 device day; although we did not ask agencies to report when this occurred. We did not include hemodialysis catheters in our surveillance mechanism. An occlusion was defined as an obstruction in at least 1 lumen that required treatment with a thrombolytic agent. We used the criteria for CLABSI in home health care provided by the Association for Professionals in Infection Control.[4] Agency administrators were responsible for ensuring the criteria for CLABSI were met when reporting such events. Beginning in July 2012, more granular data were requested from participating HHIAs regarding type of CVC associated with each bloodstream infection and/or occlusion event and its number of lumens. Also, during 2012, the agencies submitting data were asked on 1 occasion to provide information about their processes of collecting and validating data prior to its being submitted to examine the burden placed on agencies related to their participation in the surveillance program.

Data analysis

Data were sent to the principal investigator via files attached within an encrypted email message. The principal investigator imported each agency's data collection worksheet into a larger, aggregate Excel workbook for descriptive analyses. The workbook was formatted to automatically update agency-specific and aggregate analyses with the import of each agency's worksheet, and to populate tables that displayed agency-specific data and outcomes as well as the aggregate data and mean for all outcomes. Each agency was provided via encrypted email a quarterly report displaying their contributed data compared with the aggregate data elements, as well as their performance against the aggregate mean for all outcomes (CLABSI rate per 1,000 device days, CVC occlusion rate per 1,000 device days, and ratio of fibrinolytic doses administered/occlusion event). No agency identifiers were exchanged. An additional table was added to quarterly reports after July 2012, which displayed the types of CVC devices and number of lumens for the reported events, in aggregate format only.

Year	
Month	
Agency Code Identifier	
Agency # of patients age 18 and younger on service with CVC in place	
Agency # of patients age 19 and older on service with CVC in place	
Agency CVC device days in patients age 18 and younger	
Agency CVC device days in patients age 19 and older	
Agency CVC blood stream infection count in patients age 18 and younger	
Agency CVC blood stream infection count in patients age 19 and older	
Agency CVC occlusion event count in patients age 18 and younger	
Agency CVC occlusion event count in patients age 19 and older	
Agency # of doses of a fibrinolytic used to dissolve line thromboses in patients age 18 and younger	
Agency # of doses of a fibrinolytic used to dissolve line thromboses in patients age 19 and older	
Agency # of patients age 18 and younger who received a fibrinolytic to dissolve line thromboses	
Agency # of patients age 19 and older who received a fibrinolytic to dissolve line thromboses	

Fig 1. Data collection worksheet. *CVC*, central venous catheter.

RESULTS

Over the course of the 51-month project, 10 agencies from 4 states submitted data. One agency provided CVC care to pediatric patients only, 2 provided CVC care to adults only, and 7 provided pediatric and adult CVC care. Seven were home health agencies and 3 were home infusion agencies. The number of agencies reporting data on a quarterly basis ranged from 2-7. Owing to the voluntary nature of data submission, and the fluctuation of patients on service in any given month, not every agency consistently submitted data on a monthly or quarterly basis for pediatric and/or adult data.

Tables 1 and 2 display the data submitted by each agency and their outcomes over the 51-month surveillance period for pediatric and adult patients, respectively. Eight agencies submitted pediatric data over an average of 17 months (range: 1-49 months), whereas 9 agencies submitted adult data over an average of 22 months (range: 12-39 months). A total of 913 occlusions and 73 CLABSIs occurred during the study period. Per year across the surveillance period, agencies averaged 0-3.67 CLABSI and 0-16.67 occlusion events in pediatric patients, and 0-15 CLABSI and 2-182 occlusion events in adults. The cumulative mean CLABSI rate per 1,000 device days across all agencies was 0.13 in pediatric and 0.21 in adult patients, whereas the aggregate mean occlusion rate per 1,000 device days was 1.85 in pediatric and 5.87 in adult patients. Individual agency 51-month cumulative CLABSI rates per 1,000 device days ranged from 0.00-0.53 in pediatric and 0.00-0.58 in adult patients, whereas the cumulative occlusion rates per 1,000 device days ranged from 0-10.42 in pediatric and 0.77-31.71 in adult patients. Doses of fibrinolytic agents administered per 1,000 device days across all agencies ranged from 0-3.09 in pediatric and 0.88-37.26 in adult patients.

Tables 3 and 4 display aggregate pediatric and adult CVC-related data and outcomes reported by agencies per year during the study

Table 1
Pediatric surveillance data and outcomes per individual agency over 51-month study period

Agency	Number months reporting data	Number patients with CVC	Number device days	CLABSI count	Mean CLABSI count per year	Cumulative CLABSI rate per 1,000 device days	CVC-occlusion count	Mean occlusion count per year	Cumulative occlusion rate per 1,000 device days	Number doses fibrinolytic agent given	Doses fibrinolytic agent administered per 1,000 device days
Agency A	6	8	96	0	0	0.00	1	2*	10.42	0	0
Agency B	49	1,905	54,342	15	3.67	0.28	58	14.20	1.07	59	1.09
Agency C	2	2	49	0	0	0.00	0	0	0.00	0	0
Agency D	0										
Agency E	1	1	23	0	0	0.0	0	0	0.00	0	0
Agency F	21	429	11,319	6	3.43	0.53	9	5.14	0.80	6	0.53
Agency G	24	350	7,811	1	0.50	0.13	0	0	0.00	0	0
Agency H	18	474	10,017	1	0.67	0.10	25	16.67	2.50	31	3.09
Agency I	0										
Agency J	15	48	879	0	0	0.00	0	0	0.00	0	0
Total	-	3,217	84,536	23	-	-	93	-	-	96	-
Aggregate Mean	17					0.13			1.85		059

CLABSI, central line–associated bloodstream infection; *CVC*, central venous catheter.
*Agency's predicted mean occlusion count per year based on 6 months of data.

Table 2
Adult surveillance data and outcomes per individual agency over 51-month study period

Agency	Number months reporting data	Number patients with CVC	Number device days	CLABSI count	Mean CLABSI count per year	Cumulative CLABSI rate per 1,000 device days	CVC-occlusion count	Mean occlusion count per year	Cumulative occlusion rate per 1,000 device days	Number doses fibrinolytic agent given	Doses fibrinolytic agent administered per 1,000 device days
Agency A	24	446	7,569	2	1	0.26	240	120	31.71	282	37.26
Agency B	0										
Agency C	13	185	3,519	1	0.92	0.28	6	5.54	1.71	5	1.42
Agency D	39	1,164	13,166	5	1.54	0.38	103	31.70	7.82	181	13.75
Agency E	29	2,549	36,439	3	1.24	0.08	28	11.59	0.77	32	0.88
Agency F	21	1,694	40,087	4	2.29	0.10	60	34.29	1.50	79	1.97
Agency G	24	2,214	52,105	30	15	0.58	74	37	1.42	99	1.90
Agency H	18	3,188	57,979	2	1.33	0.03	273	182	4.71	356	6.14
Agency I	12	753	13,962	3	3	0.21	33	33	2.36	47	3.37
Agency J	18	160	3,632	0	0	0.00	3	2	0.83	6	1.65
Total	-	12,353	228,458	50	-	-	820	-	-	1,087	-
Aggregate Mean	22					0.21			5.87		7.59

CLABSI, central line–associated bloodstream infection; *CVC*, central venous catheter.

Table 3
Aggregate central venous catheter-related data and outcomes reported per year by home health/infusion agencies 2011-2015: pediatric patients age 18 and younger

Year	Number agencies submitting data	Number patients with CVC (mean; SD)*	Number CVC device days (mean; SD)	Number CLABSI count (mean; SD)	CLABSI rate per 1,000 device days	Number CVC-occlusion count (mean; SD)	CVC occlusion rate per 1,000 device days	Number doses fibrinolytic agent administered (mean; SD)	Doses fibrinolytic agent administered per 1,000 device days
2011	2	888 (444; 621)	26,729 (13,365; 18,821)	4 (2; 3)	0.15	7 (3.5; 5)	0.26	7 (3.5; 5)	0.26
2012	5	486 (97; 135)	12,637 (2,527; 3,591)	5 (1; 1)	0.40	19 (4; 7)	1.50	18 (4; 7)	1.42
2013	5	904 (181; 112)	22,650 (4,530; 3,042)	9 (2; 2)	0.40	36 (7; 8)	1.59	33 (7; 8)	1.46
2014	4	860 (215; 157)	20,572 (5,143; 4,337)	5 (1.3; 2)	0.24	30 (7.5; 9)	1.46	37 (9; 11)	1.80
2015†	3	79 (26; 14)	1,948 (649; 461)	0	0	1 (0; 1)	0.51	1 (0; 1)	0.51

CLABSI, central line–associated bloodstream infection; *CVC*, central venous catheter.
*Overall mean and standard deviation are based on each agency's total data contributed during the course of each year.
†One-quarter of data (January-March).

surveillance period along with the mean and standard deviation for the data contributed by agencies each year. We noted wider variation during 2011 and 2012 than in the other years in the number of patients with CVCs across agencies reporting pediatric data than those submitting data for adults, owing to the aforementioned inconsistencies with having pediatric patients with a CVC on service and/or the voluntary nature of data reporting, which resulted in some agencies not submitting monthly or quarterly data. The CLABSI rates per 1,000 device days ranged from 0-0.40 for pediatric and from 0-0.37 for adult patients, whereas occlusion rates per 1,000 device days ranged from 0.26-1.59 for pediatric and from 2.59-33.29 for adult patients. Doses of fibrinolytic agents administered per 1,000 device days during each year ranged from 0.26-1.80 in pediatric and 3.53-33.85 in adult patients.

Table 4
Aggregate central venous catheter-related data and outcomes reported per year by home health/infusion agencies 2011-2015: adult patients age 19 and older

Year	Number agencies submitting data	Number patients with CVC (mean; SD)*	Number CVC device days (mean; SD)	Number CLABSI count (mean; SD)	CLABSI rate per 1,000 device days	Number CVC-occlusion count (mean; SD)	CVC occlusion rate per 1,000 device days	Number doses fibrinolytic agent administered (mean; SD)	Doses fibrinolytic agent administered per 1,000 device days
2011	2	196 (98; 110)	3,545 (1,773; 1,794)	0	0	118 (59; 81)	33.29	120 (60; 85)	33.85
2012	5	2,391 (478; 366)	45,699 (9,140; 9,220)	8 (2; 1)	0.18	219 (44; 49)	4.79	310 (62; 67)	6.78
2013	8	3,949 (494; 374)	79,007 (9,876; 8,630)	17 (2; 4)	0.22	219 (27; 35)	2.77	302 (38; 47)	3.82
2014	6	5,431 (905; 777)	92,098 (15,350; 13,768)	22 (4; 7)	0.24	243 (41; 60)	2.64	325 (54; 78)	3.53
2015†	3	386 (129; 110)	8,109 (2,703; 3,045)	3 (1; 1)	0.37	21 (7; 8)	2.59	30 (10; 11)	3.70

CLABSI, central line–associated bloodstream infection; *CVC*, central venous catheter.
*Overall mean and standard deviation are based on each agency's total data contributed during the course of each year.
†One-quarter of data (January-March).

Agencies submitted detailed data regarding the types of CVCs and number of lumens associated with occlusions and CLABSIs from July 2012 through December 2014 (agencies submitting data January-March 2015 did not report this information). Analyses revealed that >80% of occlusions occurred with peripherally inserted central venous catheters (PICCs) in each year, with 40%-72% involving double lumen catheters. Occlusions occurring with tunneled lines involved single lumen devices >72% of the time in each year. Conversely, the majority of CLABSIs occurred with tunneled devices, ranging from 57%-68% across each year, with single lumen catheters involved in ≥50% of these events. CLABSIs occurring with PICCs primarily involved double lumen devices in ≥80% of these events. We did not ask agencies to report the types of CVCs that all patients on service had each month; we sought this information only in relation to adverse events and only from July 2012 forward. Therefore, the proportion or rate ratio of adverse events occurring in any type of catheter relative to other or all types cannot be known from our data and we cannot make any inferences regarding whether one type of CVC was more prone to adverse events than the others because we do not have the denominator data. Table 5 displays the resources that were required by 6 agencies to collect and validate the accuracy of their surveillance data.

Two of these agencies reported not previously having a system or processes in place to track CVC device days or CVC-related complications prior to their participation and found it quite approachable and user-friendly. All of the HHIAs collected occlusion-related data from reports they received from their affiliated pharmacy. Only 2 reported having an automated system to collect CLABSI-related data, whereas the other 4 performed manual data extraction through medical record review. All reported having a mechanism for data validation, which involved manual review of medical records (4 sites) as well as case discussions involving pharmacists and home care nurses (2 sites). The number of individuals involved in data collection and validation ranged from 1-3 per facility, with an average of 2 hours/month across the HHIAs, ranging from 1-3 hours.

DISCUSSION

We examined the feasibility of monitoring CVC-related complications through an innovative surveillance mechanism that enabled comparisons of outcomes among a group of HHIAs located in multiple states across the United States. Using standardized denominator data, our study is the first that we know of that reports CVC-related events derived from monthly surveillance and includes reporting by multiple agencies over a period of several years.

There have been attempts made over the past 20 years to monitor CVC-related outcomes in the home setting, however, these efforts have not yielded sustainable mechanisms that provide surveillance for a broad geographic region.[5,16,26,27] Although data regarding CVC-associated complications that occur in the home setting are not required to be reported, the Centers for Medicare and Medicaid Services (CMS) has required home health agencies that are CMS-certified to collect and submit quality measures for all adult patients whose

Table 5
Data management resources required by agencies for monthly surveillance data collection and validation

Agency	Monthly surveillance data collection process	Number of individuals involved in data collection and validation	How are events identified?		Data validation method	Hours per month on data collection and validation
			CVC occlusion	CLABSI		
A	Manual chart extraction	1	Pharmacy report	Chart review	Weekly manual review of medical records	2
B	Manual chart extraction	2	Pharmacy report	Chart review	Monthly manual review of medical records	2-3
C	Manual chart extraction	1	Pharmacy report	Home care nurse written documentation	Weekly case discussion with home care nurse and pharmacist	1.5-2
D	Manual chart extraction	1	Pharmacy report	Infection control department	Monthly manual review of medical records	2
E	Automated report	2-3	Pharmacy report	Weekly case conference	Monthly manual review of medical records	2
F	Automated report	1	Pharmacy report	Event report from information technology system	Daily morning meeting to discuss all cases	1-1.5

CLABSI, central line–associated bloodstream infection; *CVC*, central venous catheter.

care is reimbursed by CMS (excluding patients who receive pre- and postnatal care) since 1999. The data recording tool currently used to collect and report performance data by home health agencies is the Outcome and Assessment Information Set.[28] Reporting elements include whether the patient is receiving ongoing infusion therapy or parenteral nutrition at home, and the presence of a surgical wound, which, by definition in the accompanying guidance manual includes centrally inserted venous catheters but excludes "PICC (peripherally inserted venous catheter) either tunneled or non-tunneled."[28] The tool does not direct one to collect the specific type of infusion device in place nor the status of the CVC insertion site unless it is the only observable surgical wound that the patient has.[28]

The American Society for Parenteral and Enteral Nutrition developed and implemented a patient registry in 2011 to collect nutrition-related care and measure outcomes associated with receiving HPN.[29] The registry includes data submitted by hospitals as well as HHIAs, and has provided evidence of risk factors and predictive factors of CLABSI relative to this population in Thailand.[30] Reports of patient characteristics and CVC-related outcomes in the United States from data derived from the American Society for Parenteral and Enteral Nutrition registry thus far have lacked detailed analyses and descriptions specific to patients receiving home infusion services.[22,31]

In 2009, the National Home Infusion Association (NHIA) began an "Industry-Wide Data Initiative" aimed at identifying ways in which infusion industry stakeholders can best prepare for value-driven payment models and be strategically prepared with data that effectively prove the cost-effectiveness of the home infusion industry.[32] This involves, among other activities, determining what metrics are needed to produce the specific outcomes that reflect best practices and optimal patient care in the infusion industry.[32] An extensive member provider survey conducted in 2010 provided comprehensive data about the size and scope of the infusion industry but also revealed the importance of standardized terminology when wanting to develop baseline data with which to base future benchmarking efforts.[32] A subsequent provider survey conducted in 2012 resulted in the development of standard definitions for patient outcome data elements, including access device events that encompass occlusion and suspected bloodstream infection among other types.[33] At this time, the NHIA data initiative does not involve the ongoing collection of provider data or a means by which home infusion providers can benchmark their performance against an industry aggregate, however, the NHIA encourages the use of the standard definitions when collecting data for internal, quality improvement purposes.[34]

At present, there are no surveillance data or mechanisms available in the United States to quantify and provide on-going monitoring of the incidence of CLABSI or other CVC-related complications that occur when care is provided by HHIAs. One noted challenge of accurate measurement and comparisons across settings is the variation of CLABSI definitions used across HHIAs.[35,36] Several authors have described additional challenges with home CVC care outcomes surveillance with particular attention given to a lack of agreement on numerator and denominator data,[28,29] and the determination of attribution of events that occur, such as CLABSIs.[36] Quantifying CVC-related complications in patients whose care is facilitated by HHIAs is not a matter of attempting to attribute cause of the events onto a particular individual or agency, or to infer care provision is insufficient, but rather, provides meaningful data with which to drive quality improvement efforts. Many different individuals interact with the CVC of a patient living at home including the patients themselves and family members, HHIA nurses, and health care providers in a variety of outpatient settings. Therefore, establishing causation for adverse events or attributing complications solely to the HHIA is unfitting. However, it is important for HHIAs to examine CVC-related adverse events, identify potential contributing factors and benchmark their performance against like agencies to examine care provision processes, ensure standardization of best practices, and improve outcomes. In our study, several of the agencies anecdotally reported that they used their quarterly performance reports to examine processes, such as fibrinolytic usage. Because of their participation in the surveillance project, they realized their usage of the medication was well above the aggregate mean in the database. As a result, they focused on improving nurses' understanding of CVC flushing protocols to reduce occlusions and were successful with lowering their occlusion events.

The work done to reduce CLABSIs in hospital settings illustrates how standardizing practices within a structured framework such as CVC insertion and maintenance bundles can dramatically improve patient safety and outcomes.[37] The same requisite of standardizing practices extends to non-hospital care delivery. Implementing a standardized CVC care bundle by home care nurses and family caregivers in ambulatory care settings proved successful at decreasing CLABSI rates by 48% over 24 months in a pediatric oncology population.[38] Examining surveillance data enables HHIAs to monitor the effectiveness of standardization on patient outcomes, such as CLABSI and occlusions. However, not all CLABSI are necessarily related to factors within the control of patients or HHIA care providers. Barriers to CLABSI prevention in home care settings include insurance companies limiting reimbursement for supplies such as sterile gloves, caps, needles, tubing, and dressings.[38]

In addition to not classifying types of CVCs involved in adverse events relative to all CVCs of patients on service, our study has several other limitations. We did not collect data on microbiologic etiology of infections, which could help in understanding how best to optimize prevention in the home setting, when applicable. We did not ascertain information about compliance with recommended insertion procedures or ask agencies to indicate how long the CVC was in place at the time of the adverse event. We relied on each agency's internal process of data collection and validation to ensure compliance with application of definitions. It is not known what training these individuals received prior to and during their participation in this project, or of the availability of personnel with training in infection prevention or health care epidemiology to ensure event criteria were met. Further, we did not collect data about events that may have occurred within 48 hours of the patient's discharge from HHIA service, nor did we ask agency administrators if they are routinely given this information from the patient's primary provider if CVC-related adverse events do occur. Finally, we did not formally collect information about how agency personnel were using their quarterly benchmarking reports (ie, for quality improvement purposes). However, several agencies indicated their reduction in the use of fibrinolytics during the course of their participation in the project, leading these authors to surmise that agency data and benchmarking were influential in administrators' examination of how care processes were being carried out.

CONCLUSIONS

Our study revealed the feasibility of developing and implementing a surveillance mechanism to monitor and evaluate CVC-related outcomes in the home setting. Opportunities exist to further expand efforts to quantify the presence of CVCs in home settings to enable improvements with measuring and tracking patient outcomes as they relate to CVC care provision. Exploration of continued sustainability of surveillance and data validation are warranted to optimize HHIA care practices and outcomes.

Acknowledgements

The authors want to thank and acknowledge the home health and home infusion agency personnel who participated in this important work.

References

1. National Home Infusion Association. About infusion therapy. Available from: http://www.nhia.org/about-home-infusion.cfm. Accessed March 2, 2019.
2. Joint Commission. Preventing central line–associated bloodstream infections: a global challenge, a global perspective. Oak Brook (IL): Joint Commission Resources; 2012 p. 4.
3. Thomé B, Dykes A, Hallberg IR. Home care with regard to definition, care recipients, content and outcome: systematic literature review. J Clin Nurs 2003;12:860-72.
4. Embry C, Chinnes L. APIC-HICPAC surveillance definitions for home health care and home hospice infections. February 2008. Available from: http://www.apic.org/Resource_/TinyMceFileManager/Practice_Guidance/HH-Surv-Def.pdf. Accessed March 2, 2019.
5. Crispin A, Thul P, Arnold D, Schild S, Weimann A. Central venous catheter complications during home parenteral nutrition: a prospective pilot study of 481 patients with more than 30,000 catheter days. Onkologie 2008;31:605-9.
6. Santarpia L, Alfonsi L, Tiseo D, Creti R, Baldassarri L, Pasanisi F, et al. Central venous catheter infections and antibiotic therapy during long–term home parenteral nutrition: an 11–year follow–up study. J Parenter Enteral Nutr 2010;34:254-62.
7. Shang J, Ma C, Poghosyan L, Dowding D, Stone P. The prevalence of infections and patient risk factors in home health care: a systematic review. Am J Infect Control 2014;42:479-84.
8. Keller SC, Williams D, Gavgani M, Hirsch D, Adamovich J, Hohl D, et al. Environmental exposures and the risk of central venous catheter complications and readmissions in home infusion therapy patients. Infect Control Hosp Epidemiol 2017;38:68-75.
9. Paladino JA, Poretz D. Outpatient parenteral antimicrobial therapy today. Clin Infect Dis 2010;51(Suppl 2):S198-208.
10. Barr D, Semple L, Seaton R. 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;39:407-13.
11. Morano SG, Latagliata R, Girmenia C, Massaro F, Berneschi P, Guerriero A, et al. Catheter-associated bloodstream infections and thrombotic risk in hematologic patients with peripherally inserted central catheters (PICC). Supportive Care Cancer 2015;23:3289-95.
12. Pinon M, Bezzio S, Tovo PA, Fagioli F, Farinasso L, Calabrese R, et al. A prospective 7-year survey on central venous catheter-related complications at a single pediatric hospital. Eur J Pediatr 2009;168:1505-12.
13. Revel-Vilk S, Yacobovich J, Tamary H, Goldstein G, Nemet S, Weintraub M, et al. Risk factors for central venous catheter thrombotic complications in children and adolescents with cancer. Cancer 2010;116:4197-205.
14. Beckers MMJ, Ruven HJT, Seldenrijk CA, Prins MH, Biesma DH. Risk of thrombosis and infections of central venous catheters and totally implanted access ports in patients treated for cancer. Thromb Res 2010;125:318-21.
15. Centers for Disease Control and Prevention. National healthcare safety network (NHSN). Available from: https://www.cdc.gov/nhsn/index.html. Accessed March 2, 2019.
16. Gorski LA. Central venous access device outcomes in a homecare agency: a 7-year study. J Infus Nurs 2004;27:104-11.
17. Hord JD, Lawlor J, Werner E, Billett AL, Bundy D, Winkle C, et al. Central line associated blood stream infections in pediatric hematology/oncology patients with different types of central lines. Pediatr Blood Cancer 2016;63:1603-7.
18. Liscynesky C, Johnston J, Haydocy KE, Stevenson KB. Prospective evaluation of peripherally inserted central catheter complications in both inpatient and outpatient settings. Am J Infect Control 2017;45:1046-9.
19. Kelly MS, Conway M, Wirth KE, Potter-Bynoe G, Billett AL, Sandora TJ. Microbiology and risk factors for central line-associated bloodstream infections among pediatric oncology outpatients: a single institution experience of 41 cases. J Pediatr Hematol Oncol 2013;35:e71-6.
20. Rinke ML, Milstone AM, Chen AR, Mirski K, Bundy D, Colantuoni E, et al. Ambulatory pediatric oncology CLABSIs: epidemiology and risk factors. Pediatr Blood Cancer 2013;60:1882-9.
21. Shang J, Larson E, Liu J, Stone P. Infection in home health care: results from national outcome and assessment information set data. Am J Infect Control 2015;43:454-9.
22. Ross VM, Guenter P, Corrigan ML, Kovacevich D, Winkler M, Resnick H, et al. Central venous catheter infections in home parenteral nutrition patients: outcomes from sustain: American society for parenteral and enteral nutrition's national patient registry for nutrition care. Am J Infect Control 2016;44:1462-8.
23. Centers for Disease Control and Prevention. Vital signs: central line–associated blood stream infections: United States, 2001, 2008, and 2009. Ann Emerg Med 2011;58:447-50.
24. Nailon R, Rupp ME. A community collaborative to develop consensus guidelines to standardize out-of-hospital maintenance care of central venous catheters. J Infus Nurs 2015;38:115-21.
25. Nailon R, O'Neill S, Wardian S, Tyner LK, Tomb P, Rupp ME, et al. Standardizing central venous catheter care: hospital to home. 2012. Available from: https://www.nebraskamed.com/sites/default/files/documents/scorch-guidelines.pdf. Accessed March 2, 2019.
26. Tokars JI, Cookson ST, McArthur MA, Boyer CL, McGeer AJ, Jarvis WR. Prospective evaluation of risk factors for bloodstream infection in patients receiving home infusion therapy. Ann Intern Med 1999;131:340-7.
27. Moureau N, Poole S, Murdock MA, Gray SM, Semba CP. Central venous catheters in home infusion care: outcomes analysis in 50,470 patients. J Vasc Interv Radiol 2002;13:1009-16.
28. Centers for Medicare and Medicaid Services. Outcome and assessment information set OASIS-D, guidance manual. 2019. Available from: https://Www.cms.gov/medicare/quality-initiatives-patient-assessment-instruments/HomeHealthQualityInits/downloads/OASIS-D-guidance-manual-final.pdf. Accessed March 19, 2019.
29. Guenter P, Robinson L, DiMaria-Ghalili RA, Lyman B, Steiger E, Winkler MF. Development of sustain: ASPEN's national patient registry for nutrition care. J Parenter Enteral Nutr 2012;36:399-406.
30. Pichitchaipitak O, Ckumdee S, Apivanich S, Chotiprasitsakul D, Shantavasinkul PC. Predictive factors of catheter-related bloodstream infection in patients receiving home parenteral nutrition. Nutrition 2018;46:1-6.
31. Winkler MF, DiMaria-Ghalili RA, Guenter P, Resnick H, Robinson L, Lyman B, et al. Characteristics of a cohort of home parenteral nutrition patients at the time of enrollment in the sustain registry. J Parenter Enteral Nutr 2016;40:1140-9.
32. Kramer N. Yes, it makes sense - but can you prove it? Infusion 2012;2018(July/August):21-22-24. Available from: http://www.nhia.org/data/documents/DataJulAug2012_FINAL.pdf. Accessed December 16, 2018.
33. National Home Infusion Association Outcomes Task Force. Standard definitions for patient outcome data elements. NHIA Data Initiative Web site 2016, Available from: http://www.nhia.org/data/data_def/Access_Device_Events.pdf. Accessed December 16, 2018.
34. National Home Infusion Association. NHIA data initiative. Available from: http://nhia.org/data/index.cfm. Accessed March 4, 2019.
35. Rinke ML, Bundy DG, Milstone AM, Deuber K, Chen AR, Colantuoni E, et al. Bringing central line-associated bloodstream infection prevention home: CLABSI definitions and prevention policies in home health care agencies. Jt Comm J Qual Patient Saf 2013;39:361-70.
36. Keller SC, Williams D, Rock C, Deol S, Trexler P, Cosgrove SE. A new frontier: central line–associated bloodstream infection surveillance in home infusion therapy. Am J Infect Control 2018;46:1419-21.
37. Pronovost P, Needham D, Berenholtz S, Sinopoli D, Chu H, Cosgrove S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. N Engl J Med 2006;355:2725-32.
38. Rinke ML, Bundy DG, Chen AR, Milstone AM, Colantuoni E, Pehar M, et al. Central line maintenance bundles and CLABSIs in ambulatory oncology patients. Pediatrics 2013;132:e1403-12.