ID 133854

Unlocking Potential

Vascular Access Devices: A Comparative Analysis of Complications and Their Cost Implications

Bouguerra Houda, MS; Waltl Franziska, BS; Koenraad Dierick, MSc, MBA

Terumo Blood and Cell Technologies

INTRODUCTION

Vascular access devices (VADs) play a crucial role in healthcare by providing access to the circulatory system for various medical treatments and procedures.[1] These devices come in several types, including central venous catheters and peripheral catheters.[2]

By significantly enhancing patient care, vascular access devices allow for the efficient delivery of treatments, such as chemotherapy, while minimizing the need for repeated needle sticks and patient discomfort. However, it's essential to note the fact that these devices can also present potential risks and complications. [3,4]

The objective of this literature review is to identify and analyze the occurrence of adverse events linked to venous access, with a specific focus on peripheral vascular access and other frequently employed access devices. Additionally, it aims to estimate the economic impact and cost implications associated with these events.

METHODOLOGY

A literature review was conducted using PubMed to gather relevant studies and publications reporting on adverse events related to peripheral catheters (PVCs), peripherally inserted central catheters (PICCs), midline catheters (MCs), and central venous catheters (CVCs).

The identified adverse events included deep vein thrombosis (DVT), bloodstream infection (such as CLABSI or sepsis), pneumothorax, phlebitis, occlusion, and pulmonary embolism. Additionally, the cost associated with each of the adverse events was retrieved from the literature to assess its economic burden.

	Inclusion	Exclusion
Population	Adult patients requiring vascular access	▪ Non-human ▪ Pediatric patients
Intervention	PIVC, MC, PICC, CVC	Other VADs
Comparator	PIVC, MC, PICC, CVC	Other VADs
Outcomes	▪ Safety outcomes ▪ Adverse event costs	Non-relevant outcomes
Study Design	Any primary	▪ Non-clinical studies ▪ Literature reviews, meta-analyses ▪ Commentaries, editorials, letters
Timeframe	Up to 2023	None
Language	English language	Any other language

Figure 1. PICOS Selection Criteria

RESULTS

The literature search yielded several studies reporting on the rates of adverse events associated with the different types of catheters.

Data on various complications, such as deep vein thrombosis (DVT), bloodstream infections, pneumothorax, phlebitis, cellulitis, dislodgment, infiltration, occlusion, pain/discomfort, leaking, hematoma, bleeding, and pulmonary embolism, were extracted and analyzed.

	Peripheral Intravenous Catheter (PIVC)	Peripherally Inserted Central Catheter (PICC)	Midline Catheter (MC)	Central Venous Catheter (CVC)
Deep Vein Thrombosis (DVT)	2.3%[5,6]	2.8%[5,18,19,20,21,22,23,24,25]	2.5%[18,20,25,30,31]	10.9%[31,32]
Bloodstream Infection (BSI)	0.2%[5,7,8,9,10]	8.0%[5,20,21,24,25,26,27,28]	11.1%[20,25,30]	11.8%[27,33]
Pneumothorax	-	-	-	17.0%[32]
Phlebitis	11.9%[8,9,11,12,13,14,15,16]	17.0%[29]	-	-
Occlusion	8.8%[7,9,11,12,16,17]	3.4%[20,22]	1.8%[20]	-
Pulmonary Embolism (PE)	-	0.2%[20,27]	0.1%[20]	1.4%[27]

Figure 2. VADs Safety Profile

RESULTS (continued)

The findings revealed varying rates of adverse events across different types of vascular access. The rates of DVT ranged from 2.36% for peripheral catheters (PVCs) to 10.91% for central venous catheters (CVCs). Bloodstream infections had rates ranging from 0.21% for PVCs to 11.82% for CVCs. Other adverse events such as pneumothorax, phlebitis, occlusion, and pulmonary embolism also exhibited varying rates across the different access devices.

Adverse Event	Average Cost
DVT	$6,452 (SD: 3382) [24,34,35,36]
BSI	$11,197 (SD: 5963) [10,24,35,36]
Pneumothorax	$5,439 (SD: 4302) [37,38]
Phlebitis	$1,137[39]
Occlusion	$181[35]
PE	$8,670 (SD: 4376) [40]

Figure 3. Adverse Events Average Costs

	Peripheral Intravenous Catheter (PIVC)	Peripherally Inserted Central Catheter (PICC)	Midline Catheter (MC)	Central Venous Catheter (CVC)
Cost of Adverse Events				
DVT	$152.23	$184.91	$161.23	$703.84
BSI	$24.01	$897.69	$1,250.84	$1,323.80
Pneumothorax	-	-	-	$924.75
Phlebitis	$136.07	$193.41	-	-
Occlusion	$16.02	$6.22	$3.27	-
PE	-	$19.83	$8.67	$122.40
Total Cost of Adverse Events	**$328.33**	**$1,302.07**	**$1,424.02**	**$3,074.79**

Cost per patient, assuming a population of 1 adult patient.
Excluding other AEs such as hematoma, infiltration, and pain.

Figure 4. Economic Burden of Adverse Events (Average cost per patient)

Furthermore, the economic burden associated with these adverse events was calculated by multiplying the rates by their respective costs. The total economic burden was highest for CVC, with a total cost of $3,074.79, followed by PICC ($1,302.07), MC ($1,424.02), and PVC ($328.33).

CONCLUSIONS

This study highlights the prevalence of adverse events associated with different vascular access types, with varying rates observed among these devices.

The economic burden analysis underscores the substantial cost implications linked to these adverse events. PICCs and CVCs and MCs exhibited higher cost implications compared to PVCs.

Understanding the rates and the economic impact of these events can help healthcare providers improve patient safety and cost-effectiveness of vascular access procedures.

REFERENCES

1. Cheung E, Baerlocher MO, Asch M, Myers A. Venous access: a practical review for 2009. Can Fam Physician. 2009;55(5):494-496.; **2.**Ponsoye M, Espinasse F, Coutte L, Lepeule R, Gnamien S, Hanslik T. Utilisation des cathéters veineux : lesquels choisir, comment prévenir leurs complications ? [The use of venous catheter : Which ones to choose, how to prevent their complications?]. Rev Med Interne. 2021;42(6):411-420. doi:10.1016/j.revmed.2020.10.385. ; **3.**Carr PJ, Higgins NS, Cooke ML, Mihala G, Rickard CM. Vascular access specialist teams for device insertion and prevention of failure. Cochrane Database Syst Rev. 2018;3(3):CD011429. Published 2018 Mar 20. doi:10.1002/14651858.CD011429.pub2; **4.** Akhtar N, Lee L. Utilization and Complications of Central Venous Access Devices in Oncology Patients. Curr Oncol. 2021;28(1):367-377. Published 2021 Jan 10. doi:10.3390/curroncol28010039; **5.** Periard D, Monney P, Waeber G, et al. Randomized controlled trial of peripherally inserted central catheters vs. peripheral catheters for middle duration in-hospital intravenous therapy. J Thromb Haemost. 2008;6(8):1281-1288. doi:10.1111/j.1538-7836.2008.03053.x; **6.** Leung A, Heal C, Banks J, Abraham B, Capati G, Pretorius C. The Incidence of Peripheral Catheter-Related Thrombosis in Surgical Patients. Thrombosis. 2016;2016:6043427. doi:10.1155/2016/6043427; **7.** Idemoto BK, Rowbottom JR, Reynolds JD, Hickman RL, Jr. The AccuCath Intravenous Catheter System With Retractable Coiled Tip Guidewire and Conventional Peripheral Intravenous Catheters: A Prospective, Randomized, Controlled Comparison. Journal of the Association for Vascular Access. 2014;19(2):94-102. ; **8.** Anderson NR. Influencing Patient Satisfaction Scores: Prospective One-Arm Study of a Novel Intravenous Catheter System With Retractable Coiled-Tip Guidewire Compared With Published Literature for Conventional Peripheral Intravenous Catheters. J Infus Nurs. 2016;39(4):201-209. doi:10.1097/NAN.0000000000000173 ; **9.** Rickard CM, Marsh NM, Larsen EN, et al. Effect of infusion set replacement intervals on catheter-related bloodstream infections (RSVP): a randomised, controlled, equivalence (central venous access device)-non-inferiority (peripheral arterial catheter) trial. Lancet. 2021;397(10283):1447-1458. doi:10.1016/S0140-6736(21)00351-2 ; **10.** Drugeon B, Guenezan J, Pichon M, et al. Incidence, complications, and costs of peripheral venous catheter-related bacteraemia: a retrospective, single-centre study. J Hosp Infect. 2023;135:67-73. doi:10.1016/j.jhin.2023.02.012; **11.** Galang H, Hubbard-Wright C, Hahn DS, et al. A Randomized Trial Comparing Outcomes of 3 Types of Peripheral Intravenous Catheters. J Nurs Care Qual. 2020;35(1):6-12. doi:10.1097/NCQ.0000000000000421 ; **12.** Miliani K, Taravella R, Thillard D, et al. Peripheral Venous Catheter-Related Adverse Events: Evaluation from a Multicentre Epidemiological Study in France (the CATHEVAL Project). PLoS One. 2017;12(1):e0168637. Published 2017 Jan 3. doi:10.1371/journal.pone.0168637; **13.** Larsen EN, Marsh N, O'Brien C, Monteagle E, Friese C, Rickard CM. Inherent and modifiable risk factors for peripheral venous catheter failure during cancer treatment: a prospective cohort study. Support Care Cancer. 2021;29(3):1487-1496. doi:10.1007/s00520-020-05643-2 ; **14.** Villa G, Giua R, Amass T, et al. In-line filtration reduced phlebitis associated with peripheral venous cannulation: Focus on cost-effectiveness and patients' perspectives. J Vasc Access. 2020;21(2):154-160. doi:10.1177/1129729819861187 ; **15.** Marsh N, Larsen EN, Takashima M, et al. Peripheral intravenous catheter failure: A secondary analysis of risks from 11,830 catheters. Int J Nurs Stud. 2021;124:104095. doi:10.1016/j.ijnurstu.2021.104095 ; **16.** Liu C, Chen L, Kong D, Lyu F, Luan L, Yang L. Incidence, risk factors and medical cost of peripheral intravenous catheter-related complications in hospitalised adult patients. J Vasc Access. 2022;23(1):57-66. doi:10.1177/1129729820978124 ; **17**. Carr PJ, Rippey JCR, Cooke ML, et al. From insertion to removal: A multicenter survival analysis of an admitted cohort with peripheral intravenous catheters inserted in the emergency department. Infect Control Hosp Epidemiol. 2018;39(10):1216-1221. doi:10.1017/ice.2018.190 ; **18.** Bahl A, Karabon P, Chu D. Comparison of Venous Thrombosis Complications in Midlines Versus Peripherally Inserted Central Catheters: Are Midlines the Safer Option?. Clin Appl Thromb Hemost. 2019;25:1076029619839150. doi:10.1177/1076029619839150; **19.** Wilson TJ, Brown DL, Meurer WJ, Stetler WR Jr, Wilkinson DA, Fletcher JJ. Risk factors associated with peripherally inserted central venous catheter-related large vein thrombosis in neurological intensive care patients. Intensive Care Med. 2012;38(2):272-278. doi:10.1007/s00134-011-2418-7; **20.** Swaminathan L, Flanders S, Horowitz J, Zhang Q, O'Malley M, Chopra V. Safety and Outcomes of Midline Catheters vs Peripherally Inserted Central Catheters for Patients With Short-term Indications: A Multicenter Study. JAMA Intern Med. 2022;182(1):50-58. doi:10.1001/jamainternmed.2021.6844 ; **21.** Capozzi VA, Monfardini L, Sozzi G, et al. Peripherally Inserted Central Venous Catheters (PICC) versus totally implantable venous access device (PORT) for chemotherapy administration: a meta-analysis on gynecological cancer patients. Acta Biomed. 2021;92(5):e2021257. Published 2021 Nov 3. doi:10.23750/abm.v92i5.11844; **22.** Yu B, Hong J. Safety and Efficacy of Peripherally Inserted Central Catheter Placement by Surgical Intensivist-Led Vascular Access Team. Vasc Specialist Int. 2022;38:41. Published 2022 Dec 30. doi:10.5758/vsi.220054; **23.** Rydell H, Huge Y, Eriksson V, et al. Central Venous Access and the Risk for Thromboembolic Events in Patients Undergoing Neoadjuvant Chemotherapy and Radical Cystectomy for Muscle-Invasive Bladder Cancer. Life (Basel). 2022;12(8):1198. Published 2022 Aug 6. doi:10.3390/life12081198; **24.** Comas M, Domingo L, Jansana A, et al. Cost-effectiveness Analysis of Peripherally Inserted Central Catheters Versus Central Venous Catheters for in-Hospital Parenteral Nutrition. J Patient Saf. 2022;18(7):e1109-e1115. doi:10.1097/PTS.0000000000001028 ; **25.** Bing S, Smotherman C, Rodriguez RG, Skarupa DJ, Ra JH, Crandall ML. PICC versus midlines: Comparison of peripherally inserted central catheters and midline catheters with respect to incidence of thromboembolic and infectious complications. Am J Surg. 2022;223(5):983-987. doi:10.1016/j.amjsurg.2021.09.029 ; **26.** Al Raiy B, Fakih MG, Bryan-Nomides N, et al. Peripherally inserted central venous catheters in the acute care setting: A safe alternative to high-risk short-term central venous catheters. Am J Infect Control. 2010;38(2):149-153. doi:10.1016/j.ajic.2009.06.008 ; **27.** Moss JG, Wu O, Bodenham AR, et al. Central venous access devices for the delivery of systemic anticancer therapy (CAVA): a randomised controlled trial. Lancet. 2021;398(10298):403-415. doi:10.1016/S0140-6736(21)00766-2 ; **28.** Mariggiò E, Iori AP, Micozzi A, et al. Peripherally inserted central catheters in allogeneic hematopoietic stem cell transplant recipients. Support Care Cancer. 2020;28(9):4193-4199. doi:10.1007/s00520-019-05269-z ; **29.** Griffiths VR, Philpot P. Peripherally inserted central catheters (PICCs): do they have a role in the care of the critically ill patient?. Intensive Crit Care Nurs. 2002;18(1):37-47. doi:10.1054/iccn.2002.1615 ; **30.** Jeon MH, Kim CS, Han KD, Kim MJ. Efficacy and Safety of Midline Catheters with Integrated Wire Accelerated Seldinger Technique. Vasc Specialist Int. 2022;38:2. Published 2022 Mar 21. doi:10.5758/vsi.210062 ; **31.** Sebolt J, Buchinger J, Govindan S, Zhang Q, O'Malley M, Chopra V. Patterns of vascular access device use and thrombosis outcomes in patients with COVID-19: a pilot multi-site study of Michigan hospitals. J Thromb Thrombolysis. 2022;53(2):257-263. doi:10.1007/s11239-021-02559-4 ; **32.** Lindgren S, Gustafson P, Hammarskjöld F. Analysis of central venous access injuries from claims to the Swedish Patient Insurance Company 2009-2017. Acta Anaesthesiol Scand. 2019;63(10):1378-1383. doi:10.1111/aas.13430 ; **33.** Zingg W, Sandoz L, Inan C, et al. Hospital-wide survey of the use of central venous catheters. J Hosp Infect. 2011;77(4):304-308. doi:10.1016/j.jhin.2010.11.011; **34.** Fernandez MM, Hogue S, Preblick R, Kwong WJ. Review of the cost of venous thromboembolism. Clinicoecon Outcomes Res. 2015;7:451-462. Published 2015 Aug 28. doi:10.2147/CEOR.S85635 ; **35.** Ullman AJ, Gibson V, Takashima MD, et al. Pediatric central venous access devices: practice, performance, and costs. Pediatr Res. 2022;92(5):1381-1390. doi:10.1038/s41390-022-01977-1. ; **36.** Tito F, Davidson-Peck D, Roettger AD, Borghetti F, Corbo M, Tozzi M. Hemodialysis patients and complications management costs in Italy: Plastic cannulae a potentially cost-effective strategy [published online ahead of print, 2022 Oct 16]. J Vasc Access. 2022;11297298221129898. doi:10.1177/11297298221129898 ; **37.** Kim D, Jung B, Jang BH, Chung SH, Lee YJ, Ha IH. Epidemiology and medical service use for spontaneous pneumothorax: a 12-year study using nationwide cohort data in Korea. BMJ Open. 2019;9(10):e028624. Published 2019 Oct 28. doi:10.1136/bmjopen-2018-028624 ; **38.** Roeggla M, Roeggla G, Muellner M, Wagner A, Laggner AN. The cost of treatment of spontaneous pneumothorax with the thoracic vent compared with conventional thoracic drainage. Chest. 1996;110(1):303. doi:10.1378/chest.110.1.303-a. ; **39**. Furlan MDS, Lima AFC. Direct cost of procedures for phlebitis treatment in an Inpatient Unit. Custo direto dos procedimentos para o tratamento do evento adverso flebite em Unidade de Internação Clínica. Rev Esc Enferm USP. 2020;54:e03647. Published 2020 Dec 11. doi:10.1590/S1980-220X2019011403647; **40.** Fernandez MM, Hogue S, Preblick R, Kwong WJ. Review of the cost of venous thromboembolism. Clinicoecon Outcomes Res. 2015;7:451-462. Published 2015 Aug 28. doi:10.2147/CEOR.S85635