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Catheter Securement Impact on PICC-related CLABSI: A University Hospital Perspective

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Highlights:

1. Subcutaneous securement influences patient safety and healthcare outcomes
2. Securement devices may impact vascular catheter associated blood stream infections
3. Provides risk reduction strategies in peripheral and central venous access
4. Subcutaneous securement provides improved securement over adhesive devices

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Abstract

The use of a subcutaneous engineered securement device (SESD) for peripherally inserted central catheters (PICC) in an acute care setting was found to have a direct impact on central line associated bloodstream infection (CLABSI) rates compared to traditional adhesive engineered securement devices (AESD). *Objective:* While the literature suggests the use of SESDs has had successful results for device securement, it is unknown to what extent they may impact CLABSI rates. Securement and stabilization performance among devices may be a direct risk factor for CLABSIs. *Methods:* A retrospective quality review of 7,776 cases was conducted at a large academic medical center. The primary researcher implemented a quantitative design which was analysed with demographics statistics and relative risk ratio. *Results:* There was a 288% (n=47) increase in relative risk of CLABSI found in the AESD group compared to the SESD group. The results imply the use of SESDs may improve nursing practice and patient outcomes lowering CLABSI rates in patients with PICCs by a reduction of risks associated with securement design differences.

Key Words: securement; catheter related blood-stream infection; peripherally inserted central catheter; risk reduction; patient safety; patient outcomes; bacteremia; catheterization; central venous catheter

Introduction

Securement solutions for intravascular catheters have provided many options in recent years. A primary focus of interest has been peripherally inserted central catheters (PICCs) and how securement attributes may be risk factors associated with central line associated blood stream infections (CLABSIs). All securement devices have pros and cons among types such as adhesive, subcutaneous, tissue adhesives, integrated dressings, and sutures. This study sought to further understand the impact of securement devices on the CLABSI rate in patients who had PICCs. Two commonly used securement devices in the facility were studied and analyzed for association with CLABI. With collaborative efforts among facility stakeholders, the study yielded clinically significant findings associated with risk factors of securement choices and CLABSI. The article further supports the literature and efforts in reducing CLABSI risk factors, potentially improving patient outcomes.

Background

Peripherally inserted catheters have been an essential part of patient care and served to provide access for administration of medications and treatments necessary. PICCs typically dwell medium to long range and undergo a regimen of care and maintenance which incurs inherent risks. CLABSIs, medical adhesive-related skin injuries (MARSIs), occlusions, thrombosis formations, and others may cause morbidity and mortality in patients and increase cost burdens to health care facilities.[1-5]

Burden of disease

CLABSIs have continued to be the focus of research and relevancy in practice. CLABSI-related mortality is assumed to range from 12 to 25 percent[6] and is the most clinically significant

metric at hand, causing immense impact to patients and their families. Excess mortality has been estimated at 0.15 per case and a relative risk (RR) of 2.72.[7] Although some mortality studies use slightly different definitions of CLABSI, the studies do not seem to influence cost estimates. The treatment of CLABSIs continues to be a burden on patients and health care facilities. After adjusting to 2020 U. S. dollars, the average CLABSI costs in a meta-analysis by the AHRQ were reported to range from $45,272 - $113,125, averaging $79,199.[8] Another meta-analysis by AHRQ estimating the additional hospital inpatient cost associated with hospital-acquired infections found CLABSI to range from $19,420–$102,961, averaging $52,206 (adjusted to 2020 U.S. dollars).[7] Although there has been a 50 percent decrease in CLABSIs between 2008 and 2014,[9] facilities continue to implement more granularity in the review of CLABSI occurrence.

Advancing scientific practice

Healthcare clinicians have made considerable effort to reduce CLABSI risks and adverse outcomes by the implementation of evidence-based practice and strategic selection of products for their populations. Bundles for insertions and dressing changes, surveillance, disinfection protocols, catheter types, securement types, etc. have all contributed to improving patient care.[10] The role of professional and governmental organizations has played a large part of helping clinicians and patients tackle CLABSI risks. The Joint Commission,[11] Centers for Disease Control (CDC),[12] the Institute for Healthcare Improvement (IHI) 5 Million Lives campaign,[13] and the Office of Disease Prevention and Health Promotion,[14] to name a few, have contributed action plans and guidelines to combat CLABSI risks with efforts to reduce morbidity and mortality. Additionally, an integral share of the clinicians' progress are quality measures which have found support from various program such as the Agency for Healthcare Research and Quality, National Database of Nursing Quality Indicators (NDNQI®), National Quality Forum,

and the Center for Medicare & Medicaid Services' (CMS) implementation of the Patient Protection and Affordable Care Act of 2010 (ACA). With abundant tools at hand, clinicians have opportunity to implement best practices, conduct surveillance, measure quality and outcomes, and directly improve practices associated with vascular access.

Theoretical Foundation

Comparative effective research (CER) attempts to identify effective nursing interventions for specific patient populations.[15] A meta-analysis has been a valuable form of CER which has emphasized the magnitude of intervention effects. Lesser strength studies have also been valuable in adding to patient-centered outcomes research, assisting in calculating outcome patterns.[16] CER has helped to inform health-care decisions by providing evidence on the effectiveness, benefits, and harms of different treatment options.[16] Primary research for PICCs and factors related to CLABSIs has been in the intensive care unit setting. With the use of PICCs in many settings throughout the continuum of care, the research has considerable room for additional studies. The area of interest for this study focused on the risk factors for CLABSI and the potential association with two securement types. The association of CLABSI to securement devices has been limited in the literature primarily to sutures compared to non-sutured devices.[17]

Conceptual framework

Nursing theories and models have been useful in framing projects to improve patient care. Middle range theories have been helpful in meeting the demands in the nursing discipline by asking direct questions which yield significant, positive outcomes.[18] The quality project within this study evaluated the CER research using the Iowa model created by the University of Iowa Hospitals in the 1990's.[19] The authors realized this was considered a reactive model and used the quality review as step three in the model: 1) Trigger based topic, 2) Form a team, 3)

Retrieve literature and perform quality review, 4) Assess literature and results, 5) Develop a standard, 6) Implement, 7) Evaluate. Based in a strong theoretical foundation and framework, the project discovered possible key factors for improving patient care within their facility.

Purpose of study

The purpose of this retrospective observational study was to examine to what extent the use of SESDs impact CLABSI rates compared to the use of AESDs in an acute care hospital setting. Many variables may contribute to risks for related CLABSI.[20] Intravascular device failure from accidental dislodgement and migration is a large cause for concern,[21] recent studies have shown that the use of an appropriate securement device is instrumental in preventing unwarranted catheter related complications.[22,23] A European study by Zerla and colleagues suggested that subcutaneous securement is a highly efficient and cost-effective device for securing medium to long-term PICCs.[24] No cases of dislodgment, infection, or thrombotic episodes were reported. This had a positive impact, with authors reporting reducing mechanical complications and the number of PICC replacements, a net decrease in the risk of therapy interruption and improved cost savings.[24]

The University of Arkansas for Medical Sciences (UAMS) is a General Acute Care Hospital, located in Little Rock, Arkansas, USA. As the only major academic health center in the state, UAMS has provided the largest range of trauma, surgical, and medical services, with a significant portion dedicated to cancer therapies and research. It has had a vascular access team (VAT) of four vascular access clinicians and has provided the majority of vascular access services throughout the facility, along with Interventional Radiology (IR) and other Critical Care areas.

The VAT has routinely reviewed all CLABSI surveillance data from the infection prevention team (IPT). To further improve their practice and patient outcomes, the VAT collaborated with the IPT on a quality improvement project to review past patient data. Standardized Infection Ratios (SIR) compare the actual number of infections at a hospital to the "predicted" number of infections.[25] During the study period, national surveillance methods changed to SIR, hence the inclusion of both CLABSI and SIR rates in this discussion, namely to provide a transparent view of reported facility rates – annual SIR were 0.463 (2017), 0.228 (2018) and 0.482 (2019), with an overall specific CLABSI rate of 0.66/1000 days.[26] CLABSI rates (at the time of reporting) were lower than both the state (1.098) and national benchmark average (1.000), as reported by NHSN (2017 reported data).[27] Infection surveillance at UAMS is from time of insertion to 72 hours to determine insertion versus maintenance related CLABSI. If a PICC or CVC is received from an outside facility to UAMS, infection prevention uses 72 hours from admission to deem CLABSI by UAMS or outside facility.[28] During this review process, zero PICC CLABSIs were associated with insertion-related processes based upon the above criteria. Thus, the question was proposed, "Do PICC-related infections potentially had an association among the choice of two securement devices being utilized in the facility?" The advanced team had a high level of experience with the two different product solutions for securement and stabilization of PICCs. The vascular access team postulated that potential attributes of securement devices may impact risks for CLABSI as follows: catheter stability at site, catheter migrations, dislodgement requiring device replacement, and/or clinician's ability to disinfect skin/insertion site 360 degrees.

Material and Methods

This single-center, retrospective observational quality review was undertaken at the University of Arkansas for Medical Sciences, a private 500+ bed, Level 1 trauma center, in Little Rock, Arkansas, USA. Internal Review Board submission (IRB#229047) was tendered for ethical review and approved as a non-human subject study to perform a retrospective observational study of hospital PICC data, focusing on device related CLABSI outcomes for the study period. Variables included relevant demographics, insertion-related data, and securement devices applied. Adult patients from general surgical, medical, oncology wards and from critical care areas who received a peripherally inserted central venous catheter between January 2015 and December 2018 were reviewed. The study population was identified as adult patients, 18 years and older, in the hospital setting which had received a PICC. This population included all adult patient units in the facility, even though reportable CLABSI typically excludes step down and oncology units. Patients who were admitted with a PICC kept their current securement device. A convenience sample was obtained from all 7779 patients admitted between January 2015 and December 2018 who received a PICC as shown in Table 1. The sample (n=47) included all patients with CLABSI reportable infections as per NHSN guidelines during the study period. The sample was grouped by securement device type applied (AESD, n=15; SESD, n=32).

Data was collected utilizing query tools in the electronic medical record (EMR) and manual chart review of each patient in the sample. The use of EMRs is considered to have high validity but each application of use should be evaluated for reliability of data. The authors manually verified data points in this quality review to provide the use of the EMR as reliable. Data was cross-referenced with monthly infection prevention and microbiology records against all facility reported CLABSI during the study period. Data was analyzed for variables of

CLABSI in patients with a PICC and securement device as either a SESD versus an AESD. Analysis was conducted using Microsoft Excel 2019 (Microsoft Inc., USA, 2019). The non-parametric statistical tools, relative risk ratio and percent relative effect, were calculated to investigate the sample data and potential difference in risk between the primary variables.

Results

The facility's two primary vascular services (VAT and IR) placed 7779 PICCs within the study period. Forty-seven (47) PICC-specific CLABSIs were diagnosed and reported for CLABSI during the same period. Both securement devices were utilized among the VAT and IR as illustrated in Table 1.

YEAR	SESD (VAT)	%	AESD (IR)	%
2015	1827	87.04	272	12.96
2016	1795	89.30	215	10.70
2017	1688	89.26	203	10.74
2018	1631	91.68	148	8.32

Table 1. Securement choice by service type.

Descriptive data collected were patient demographic information, laterality of device placement, device type, number of lumens, dwell time, organisms grown, and securement device type. Demographic and insertion related data yielded expected findings. Only single lumen (SL) and double lumen (DL) configurations of PICCs were placed at UAMS. A minimal number of TL PICCs were from patients transferred into the facility from other acute care hospitals, highlighting UAMS non-utilization of this type of device, however have been included in the overall numerator to differentiate the CLABSIs related to insertion or care and maintenance. The greatest number of reported CLABSIs were from DLs (36, 76.6%) catheters. The remainder of

CLABSIs reported were comprised of single lumens and triple lumen (TL) catheters (11, 23.4%) as shown in Table 2.

YEAR	TOTAL PICCs PLACED	SL	DL	TL	DWELL DAYS	CLABSI	AESD	SESD	Cancer	Non-Cancer	Right Side	Left Side
2015	2099	2	9	1	714	12	4	8	3	9	4	8
2016	2010	0	8	1	190	9	3	6	5	4	5	4
2017	1891	2	15	0	460	17	4	13	9	8	7	10
2018	1779	4	4	1	151	9	4	5	7	2	5	4
TOTAL	7779	8	36	3	1515	47	15	32	24	23	21	26

Table 2. Demographic and PICC insertion data. SL – single lumen. DL – double lumen, TL – triple lumen.

There was no noticeable difference between cancer (24/47, 51.1%) and non-cancer (23/47, 48.9%) patients or PICC laterality.

The primary endpoint in the study selected for analysis was the type of securement device applied, AESD or SESD. Risk ratio is an intuitive way to compare risks for two groups. The study found a cumulative incidence for each group (AESD, 1.79%, SESD, 0.46%) and a risk ratio of 3.88 (n=47). For this setting, this may be interpreted as those with an AESD had 3.88 times the risk for a CLABSI than those with a SESD. An additional representation is Percent Relative Effect and is calculated as 288% (n=47). Thus, those who had an AESD had a 288% increase in risk of CLABSI compared to those who had an SESD.

Device	**CLABSI** (n=47)	**No CLABSI** (n=7732)	**Total**	**Cumulative Incidence**
AESD	15	823	838	1.79%
SESD	32	6909	6941	0.46%
			Risk Ratio	**3.88**
			Percent Relative Effect	**288%**

Table 3. CLABSI by stabilization device.

Discussion

Securement for various intravascular devices has gained much attention recently with vascular access as an essential component of providing quality patient healthcare and outcomes. Up to 90% or more of all patients admitted to hospital require insertion of an intravascular device to enable the administration of required therapies, hemodynamic monitoring and diagnostic processes.[29] The findings of this study are significant to the securement of PICCs relevant to patients' overall risk for CLABSIs. Going forward, the choice of securement device process has

opportunity to consider product design and use elements. The collaborative team considered various product-related questions when reviewing the data as possible differences impactful towards CLABSI. While these represented expert opinion questions only, the majority of these attributes were not known, therefore no data was able to draw conclusion – however, these points are worthy of future investigation. Some of these questions included;

- Vulnerable to movement & catheter loss?
- Risks for infection?
- Associated with safety issues, skin tears?
- Hinders care and maintenance?
- Evidence suggests frequent migration & dislodgement?
- Adhesive related skin injury?
- Replacement regimen or stability throughout therapy?
- Inconsistency of care with patient transitions?
- Are they being replaced?
- Are they available in community care?
- Material costs over time?
- Are the costs covered for the patient after insertion?
- Learning curve?

The occurrence of CLABSIs yield tremendous negative consequences affecting patients and health care facilities associated with morbidity, mortality, and financial burdens. The potential implications of this study serve to improve patient outcomes in this population. This

research related to securement devices should be furthered to add to the literature as it relates to risks for CLABSI. Its discovery of potential reductions in morbidity and mortality are worthwhile to assist in the creation of evidence-based practice. A study by McParlan found the use of SESDs provided an average cost savings per patient (€81.92/US$93.41), lower complications, and served as a safe and affordable alternative to PICC securement.[30] Financial savings by mitigating the risks of CLABSIs are additionally a benefit to the economic health care burden. Performing CER at all levels benefit the patient population for increasing transferability of practice with theoretical, practical, and future implications to practice.

Conclusions

Investigational analysis of patient data can yield valuable insight into quality outcomes related to nursing practice. This retrospective, observational quality review found a substantial difference in relative risk among securement devices utilized in their population. The difference in practice demonstrated direct positive impact on patient outcomes when using SESDs verses AESDs. The relative risk for CLABSI as related to securement device applied may have a substantial impact within other patient populations. The quality review study has helped further the research in evaluating risks factors for CLABSI throughout the continuum of care. The results suggest the use of a SESDs in a setting can be beneficial by potentially decreasing the risks of CLABSIs. Further ongoing research is required to evaluate the impact of securement devices on CLABSI rates.

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