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Maier, Deborah (2019). "To Replace or Not to Replace? Replacing Short Peripheral Catheters Based on Clinical Indication." *Journal of Infusion Nursing* 42.3, 143-148.

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To Replace or Not to Replace? Replacing Short Peripheral Catheters Based on Clinical Indication

Abstract

Short peripheral catheters (SPCs) are the most frequently used medical devices in hospital settings. Many hospital policies state that SPCs be replaced at 96 hours, which can be unnecessary and costly. A pre-post quality improvement initiative was implemented following complications surrounding removal of timed SPC catheters compared with those removed by clinical indication, using the Visual Infusion Phlebitis (VIP) scale. Data collected included patient demographics, SPC characteristics, nursing time, and product use. SPCs replaced based on clinical indication remained intact longer and had fewer complications than those in the group with routinely replaced SPCs. Decreasing SPC replacements by use of clinical indication resulted in cost savings of \$7263.60/unit/month.

Disciplines

Nursing

Comments

This is a non-final version of an article published in final form in *Journal of Infusion Nursing* 2019 May/ Jun;42(3):143-148. The article can also be found on the publisher's website: <https://dx.doi.org/10.1097/NAN.0000000000000322>

To Replace or Not to Replace? Replacing Short Peripheral Catheters Based on Clinical Indication

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The author of this article has no conflicts of interest to disclose.

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ABSTRACT

Short peripheral catheters (SPCs) are the most frequently used medical devices in hospital settings. Many hospital policies state that SPCs be replaced at 96 hours which can be unnecessary and costly. A pre-post quality improvement initiative was implemented following complications surrounding removal of timed SPC catheters with those removed by clinical indication using the Visual Infusion Phlebitis (VIP) scale. Data collected included patient demographics, SPC characteristics, nursing time, and product usage. SPCs replaced based on clinical indication remained intact longer and had fewer complications than those in the group with routinely replaced SPCs. Decreasing SPC replacements by use of clinical indication resulted in cost savings of \$7263.60/unit/month.

Key words: clinical indication, dwell time, peripheral intravenous access, phlebitis, replace, short peripheral catheter, SPC

Short peripheral catheter (SPC) use is standard practice in US hospitals in which 90% of all patients have an SPC placed.¹ The current health care climate ties patient care closely with reimbursement and payment for services based on quality measures and patient experience. Limiting the number of SPC insertions and minimizing scheduled replacement of SPCs can potentiate higher patient satisfaction scores related to pain as well as demonstrate a decrease in staff time and equipment dollars.

Average dwell time of SPCs is supported by the Centers for Disease Control and Prevention's (CDC's) recommendation to replace them no more frequently than 72 to 96 hours.² The base cost of insertion ranges from \$28 to \$35 without weighing the need for further equipment or intervention.¹ Catheter placement and frequent replacement can be a painful process for patients. The authors' hospital replaces SPCs at 96 hours to avoid potential complications of phlebitis regardless of patency of the device. Factors such as patient age, number of attempts to place the device, catheter gauge, and anatomical placement position all play a role in the longevity of an SPC, as well as frequency of use. However, with consumers demanding accountability related to affordable health care, every effort should be made to minimize discomfort and reduce costs by avoiding unnecessary procedures.^{3,4}

Accessing and maintaining an SPC, especially in patients with small or fragile veins, can be difficult. SPCs that are used continuously have shorter dwell times, as do those used for antibiotic, emergency, or vasoactive use.⁵ Patients often endure multiple failed placement attempts due to poor vasculature, staff inexperience, or disease process.^{3,6} This can potentiate SPC destabilization, venous depletion, and patient dissatisfaction.⁷ Catheter materials and design have progressed over the last 40 years and now include biocompatible products comprised of silicone and polyurethane.^{8,9} These changes have diminished vascular irritation, and have allowed dwell times to exceed the standard 96-hour guideline, while significantly decreasing catheter-associated complications.¹⁰

Phlebitis and infiltration are frequent complications in determining the need for a catheter replacement. Frequent SPC placement attempts and reattempts have shown less device stability and more chance for development of thrombophlebitis.^{10,11} The Infusion

Nurses Society's *Infusion Therapy Standards of Practice* supports the practice of removing catheters only when clinically necessary.^{1,12} Previous research suggested that SPCs could be kept in place for 96 to 120 hours without increasing infection risk and reducing the need for routine replacement.¹³ Additionally, multiple research studies have found fewer or equal occurrences of phlebitis, infiltration, and extravasation in the SPCs replaced when clinically indicated than with those removed routinely in more than 4000 patients.^{3,5,14,15} These findings are associated with savings in time, supplies, and health care dollars, as well as increased satisfaction by patients and clinicians.

METHODS

Design

The Iowa Model was utilized as the framework to develop this pre-post quality improvement initiative.¹⁶ This pre-post evidenced-based practice (EBP) project compared complication rates surrounding removal of 96-hour timed SPCs with those removed according to clinical indicators over a period of 30 days. Preintervention data were obtained retrospectively.

Setting

A 528-bed, tertiary hospital's medical intensive care unit (MICU), housing 16 critical care beds, a progressive pulmonary care unit housing 8 medical step-down beds, and 18 medical-surgical beds with a pulmonary focus were utilized. Participants were chosen via convenience sampling of those admitted to these designated units at the time of the project.

Ethics

This project was approved through both the academic Institutional Review Board (IRB) and the Committee on Institutional Cooperation (CIC) of the hospital's research and evidence-based practice committee.

Sample

An *a priori* power analysis was utilized to perform the sample size calculation.¹⁷ The criteria for significance was set at a confidence interval of 0.05, utilization of a 2-tailed ANOVA test, and power at 80%. A total sample size of 128 SPCs was determined necessary to yield a significant result in the preintervention group ($n = 64$) as well as in the intervention group ($n = 64$).

Preintervention Group

The preintervention data were collected retrospectively over 30 days between August and September 2017. The preintervention group included randomly selected patients with SPCs chosen by the primary investigator, in the defined investigation areas before the project began. The preintervention group's demographic and variable information was gathered through retrospective chart review via a self-developed data collection tool. Demographic data included age, sex, ethnicity, and admitting diagnoses. Variables examined included the registered nurse's (RN's) years of work experience, number of SPC attempts for successful placement, SPC gauge size, anatomic placement site, days in situ, and reason for SPC removal in relation to a 96-hour timed removal.

Intervention Group Inclusion Criteria

Participants in the intervention group were defined as consenting patients on the MICU, progressive pulmonary care, and medical-surgical unit during a 30-day project period occurring from February 1 to March 2, 2018. Men and women over the age of 18 years were included in this project. Participants were defined as English speaking, able to make independent decisions related to care, and capable of self-consent.

Per hospital policy, the study units' staff RNs evaluated SPC sites every 8 hours for signs of phlebitis using the Visual Infusion Phlebitis (VIP) scale.^{18,19} This scale has been validated and shown to be reliable in previous research, testing the psychometric properties of phlebitis assessment scales using the CONsensus-based Standards for the selection of health Measurement INstruments (COSMIN) guidelines.^{18,19} The staff RN documented the VIP scale value under the SPC assessment in the electronic documentation. VIP scale scores of 0-1 are favorable, meaning the SPC site remains benign. Catheters that had a score greater or equal to 2 per the VIP scale were removed. Within the intervention group, if a catheter remained patent at 96 hours (4 days) with a VIP score less than 2, the RN requested an extension of the dwell time to the provider team to be removed based on VIP scale. Data were kept confidential during the collection process on a designated flash drive located in a locked office offsite and were reviewed on a password-protected computer. Patient medical record numbers were used to identify patients but were removed for anonymity for dissemination purposes.

Exclusion Criteria

Patients consent was obtained upon arrival to the investigation unit. Patients with length of stay (LOS) of 4 days or less were removed from this pilot. Any patient who was unable to self-consent (eg, related to sedative medication or cognitive disorder) was also disqualified from participation. Patients who required central vascular access and no longer needed an SPC were omitted from the study. Patients with SPCs placed by emergency medical services or outside of the hospital were also excluded, since hospital policy requires SPC removal within 24 hours of placement. Patients who moved off the study floor with an SPC in situ for more than 4 days had it removed and replaced when necessary, to comply with current hospital 96-hour dwell time. Those SPCs were removed from the data collection.

Consent Process

Participation was voluntary and the primary investigator, who was not a member of the health care team assigned to the 2 units, obtained consent. A secondary unit-based clinical nurse specialist (CNS) was used as a consenting resource to provide information/education and allow open communication with participants regarding the project, thereby, removing potential for care bias. The teach back method was used to confirm participant understanding of the project before consent was signed. Patients were initially evaluated on arrival to the study floor, reevaluated daily for their ability to consent, and were then approached to participate when appropriate. Family members or a health care proxy were not utilized in the consent process. Paper consent was scanned into the participant's electronic health record.

Preeducation

The investigator met with the participating unit leadership and RN teams to introduce the project. The investigator reviewed the consent process for those meeting inclusion criteria, the new process of SPC assessment, the documentation of that assessment in the electronic health record, and the request for extended SPC dwell time when an SPC met EBP criteria. A laminated VIP scale poster was placed in each room and on each workstation on wheels (WOW) for staff/participant reference for the duration of the project.

DATA COLLECTION

All preintervention patient demographic and variable information was gathered using a researcher-developed data collection tool. Data collection occurred over 30 days between the months of August and September 2017 via retrospective chart review. Demographic data included age, sex, ethnicity, and admitting diagnoses. Catheter characteristics examined included number of SPC attempts for successful placement, SPC gauge size, anatomic placement site, days in situ, and reason for SPC removal. The RN's years of work experience was also noted in relation to the number of attempts before a successful insertion. The intervention group was evaluated utilizing the same tools in real-time during a 30-day period between February and March 2018.

STATISTICAL ANALYSIS

Analysis of demographic and clinical characteristics were summarized using descriptive statistics. The pre- and intervention groups were compared using the chi-squared tests for nominal data if assumptions of normality were met. The Mann-Whitney U test was used to compare outcome data when those assumptions were not met.

RESULTS

Sixty-four preintervention SPCs were followed. The intervention sampling frame included 217 SPCs. Of those, 115 SPCs were excluded related to exclusion criteria, 6 patients refused to participate (accounting for 9 SPCs), and 28 were lost to attrition leaving 65 SPCs in the sample population (Figure 1). The mean age of the sample was 66 years with a range of 27 to 93 years. The distribution of gender was significantly different from preintervention compared to postintervention. A chi square analysis revealed that there were more females in the pre-intervention group ($n = 42$, 62.7%; $\chi^2_{(1)} = 4.7$, $P = .03$). As shown in Table 1, there was no difference across pre- and postintervention groups related to age or race. On average, across both samples 20-gauge catheters ($n = 40$, 59.7%; $\chi^2_{(131)} = -0.373$, $P = .71$) were predominantly placed in the patient's forearm ($n = 29$, 43.9%; $t_{(125.079)} = -5.12$, $P = .022$) with 1 attempt ($n = 44$, 65.7%) (Table 2). Though gauge size and number of attempts weren't significant, placement in the forearm showed greater SPC stability and therefore potentiated longer days in situ.

As shown in **Table 2**, the intervention group had longer days in situ. A Mann-Whitney U test revealed that the intervention group had significantly longer days in situ ($n = 31$, 46.9%; $U = 951.5$, $P = .001$) and remained in situ less than 120 hours (5 days) in comparison to the pregroup in situ time of 54 hours (2.4 days). There were fewer infiltrations ($n = 6$, 9.1%) and no complications of phlebitis among the intervention group. Among both groups, “per protocol” ($n = 9$, 13.4%; $n = 29$, 43.9%); was the most common reason for SPC removal.

DISCUSSION

The purpose of this investigation was to determine if replacing SPCs by clinical indication would be a safe alternative to current facility practice (routine replacement based on 96-hour dwell time) and appraise any fiscal implications. During this project, SPCs consistently remained intact without complications of phlebitis or infection. These findings are consistent with what has been written in the literature—phlebitis and infiltration are the most common risks of extended dwell times.⁸ There was no evidence of phlebitis in the intervention group, and infiltration was accountable for only a few SPC removals.

It was interesting to note, on average, the SPCs in the intervention group, though anticipated to remain a minimum of 5 or more days, lasted only 4.5 days. The mean in situ time of the preintervention group was less than 2 days. This can be associated with a number of factors: 1) this study was conducted primarily in a critical care setting and an acute medical-surgical floor during the winter months; 2) the most common patient diagnosis across the study was respiratory disorders, kidney disease, and cancer; and 3) higher patient acuity, vascular frailty, and frequency and type of intravenous (IV) medications may have played a role in a more accelerated SPC mortality in both groups.

Previous research has also investigated many aspects associated with catheter failure rates, including the experience and skill of clinicians placing and maintaining the devices.^{6,8,13} There were many novice nurses practicing in these study units, and although a self-assessment of their individual skills was not examined in this study, it should be considered in future investigations.

Equipment cost for this health system was \$3.50 per IV-start package including 1 SPC catheter, a 10-mL pre-filled normal saline flush, 1 alcohol pad, tourniquet, 1 sterile 2×2 gauze, 1 windowed dressing, and 1 extension set. RN time was evaluated based on experience level and average pay rate of a new graduate/novice nurse (≤ 2.9 years of experience) and experienced RN (≥ 3 years' experience). The average base pay of an experienced RN at this facility was \$31.75/hour. It was deemed to take 5 to 7 minutes (\$3.70) to place an SPC with an average of ≤ 1 to 2 attempts (\$7.20/attempt). The average base pay of a new graduate RN at this facility was \$26.00/hour. Placement was deemed to take 10 to 15 minutes (\$6.50/attempt) with an average of 2 attempts (\$10/attempt). Patient LOS on the study units was 6 to 8 days. Since there was no need to replace some SPCs at day 4, many stayed in situ until discharge.

Through the project duration, unit SPC equipment need and staff time decreased by 40%, resulting in a unit equipment savings of \$52.50/unit/month and \$552.80/unit/month in nursing time saving. With 28 inpatient units within the facility, the yearly-extrapolated hospital savings for introducing this initiative would yield \$7,263.60/unit/year or \$203,380.80 in annual savings.

LIMITATIONS

Limitations of this study included a small convenience sample size within a single center. Surgical patients were not included, so conclusions cannot be inferred across the adult hospital population. A new brand of SPC was introduced to the facility during the preintervention group in August 2017 that may have accounted for the lower mean days in situ and frequency of failed attempts.

CONCLUSION

Although patient satisfaction was not evaluated in this study, considerable health care dollars are tied to that metric. Through the Hospital Consumer Assessment of Healthcare Providers and Systems survey, patients rate their inpatient stay on many care aspects from pain management to quietness. Low scores can mean loss of reimbursement dollars as high as 2%, noted during the 2017 fiscal year.²⁰ Limiting patient venipunctures

while allowing longer dwell times can both increase nurse and patient satisfaction and limit replacement time and waste.

Studies have concluded that better education, annual competence, and mentorship of novice nurses improved skill prowess resulting in fewer instances of SPC-associated complications and catheter failure.^{11,21,22,23} There is agreement among the research that utilizing an objective SPC assessment tool, rather than clinical judgment, aids in the appropriate timing of SPC removal that is supported by this study.^{15,17}

The inability to obtain and maintain vascular access has significant negative consequences, including delay in treatment, complications leading to prolonged LOS, and costly subsequent medical intervention; whereas maintenance of vascular access can lead to increased nurse time to focus on more acute issues and, most important, improving the patient outcome and experience.²² Recent studies have evaluated the current placement and maintenance guidelines with regard to prolonging dwell time of an SPC, removing them only when clinically necessary.^{1,3,14,15} The findings presented in this article are encouraging, indicating that with careful observation, SPCs can dwell longer than the current CDC recommendation of replacement no more frequently than 72 to 96 hours.

Further research is needed on nursing responsibilities in SPC placement and maintenance practices. The goal of this research builds towards strengthening nursing practice to include a nurse-driven, evidence-based placement and removal protocol that is patient focused. The hope is that this will continue to bolster patient care, staff and patient satisfaction, and fiscally responsibility.

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Figure 1 Sample distribution of the intervention group

Abbreviations: 5400, medical-surgical unit; MAT, medical assessment and treatment (progressive care unit); MICU, medical intensive care unit.

Table 1. Demographic Description of Study Sample

Table 2. Catheter Characteristics (N=132)

Figure 1 Sample distribution of the intervention group. Abbreviations: 5400, medical-surgical unit; MAT, medical assessment and treatment (progressive care unit); MICU, medical intensive care unit.

Table 1. Demographic Description of Study Sample

Patient Demographics (N=132)	Preintervention n= 67	Intervention n= 66	P Value
	n (%)	n (%)	
Age in Years (m,sd)	67 (13.67)	66 (14.25)	0.94
Race			0.08
African American	13 (19.4)	16 (24.2)	
Caucasian	54 (80.6)	46 (69.7)	
Hispanic	0 (0.0)	4 (6.1)	
Gender			0.03
Male	25 (37.3)	37 (56.1)	
Female	42 (62.7)	29 (43.9)	
Diagnosis			0.001
AKI/ESRD/dehydration	4 (6.0)	13 (19.7)	
Anemia	NA	5 (7.6)	
Respiratory failure	22 (35.9)	14 (19.7)	
Cancer	11 (16.5)	2 (3.0)	
CAD	NA	2 (3.0)	
CHF	6 (9.0)	1 (1.5)	
Cholangitis	NA	2 (3.0)	
COPD	1 (1.5)	2 (3.0)	
DKA	NA	1 (1.5)	
Pneumonia	3 (4.5)	NA	
Pulmonary embolus	NA	2 (3.0)	
Pulmonary hypertension	NA	2 (3.0)	
Pylonephritis	NA	4 (6.1)	
SIRS/sepsis/shock	10(13.5)	9 (13.6)	
GI disorders	10 (13.5)	7 (10.6)	

Abbreviations: Acute Kidney Injury (AKI); Coronary Artery Disease (CAD); Congestive Heart Failure (CHF); Chronic Obstructive Pulmonary Disease COPD; Diabetic Ketoacidosis (DKA); End-Stage Renal Disease(ESRD); Gastrointestinal (GI); Systemic Inflammatory Response Syndrome (SIRS);

Table 2. Catheter Characteristics (N=132)

Variable	Pre-intervention n= 67 n (%)	Post-intervention n=66 n (%)	P Value
Number of Attempts			0.45
1	44 (65.7)	47 (71.2)	
2	6 (9.0)	5 (7.6)	
3	3 (4.5)	1 (1.5)	
Not documented	14 (20.9)	13 (19.7)	
Placement Site			0.02
Left Antecubital		9 (13.6)	
Left forearm	13 (21.5)	16 (24.2)	
Left hand	9 (13.4)	4 (6.1)	
Left wrist	10 (10.5)	5 (7.6)	
Not documented	2 (3.0)	NA	
Right Antecubital	1 (1.5)	12 (18.2)	
Right forearm	6 (9.0)	13 (19.7)	
Right hand	13 (21.7)	3 (4.5)	
Right wrist	4 (6.0)	4 (6.1)	
SPC Gauge Size	9 (13.4)		0.71
(m,sd)		20 (1.37)	
16		1 (1.5)	
18	20 (1.32)	15 (22.7)	
20	1 (1.5)	38 (57.6)	
22	16 (23.9)	12 (18.2)	
*Days in Situ^a	40 (59.7)		0.001
(m,sd)	10 (14.9)	4.59 (2.4)	
0-4		35 (53.1)	
5	2.54 (1.7)	8 (12.1)	
6	61 (91.1)	2 (3.0)	
7	4 (6)	13 (19.7)	
8-10	1 (1.5)	8 (12.1)	
Reason For Removal	1 (1.5)		0.001
Catheter damage	NA	4 (6.1)	
Replaced by central access		1 (1.5)	
Discharge home	4 (6.0)	9 (13.6)	
Drainage/leaking	1 (1.5)	4 (6.1)	
Infiltration	NA	6 (9.1)	
Not documented	1 (1.5)	6 (9.1)	
Occlusion	12 (17.9)	5 (7.6)	
Per family request	10 (14.9)	1 (1.5)	
Per hospital protocol	4 (6.0)	29 (43.9)	
Phlebitis	2 (3.0)	NA	
Removed by patient	23 (34.3)	1 (1.5)	
	1 (1.5)		
	9 (13.4)		

^aMann-Whitney U test performed.