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Implementation of a midline catheter service in a regional setting

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Service de pose d'un cathéter mi-long dans un contexte régional

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Abstract

Introduction: *Midline catheters have been reported to be an effective and safe means of providing patients with intravenous access within the hospital and community setting. With minimal experience in the introduction of a midline service across the local health network, a regional hospital pursued this task. This observational study assesses the provision of a safe clinical framework for midline insertion, and the improvement of patient care and experiences by avoiding treatment interruptions and unnecessary cannulation attempts from failed traditional peripheral vascular access devices.*

Methods: *From the introduction of the midline service in June 2018, outcome measures of all patients who received a midline over the following two-year period were documented including rate of line success, complication rates, dwell time, and the number of insertion attempts.*

Results: *The midline service provided 207 lines over a two-year period with a total dwell time of 1,585 days. Project goals were achieved with 85% (Aim ≥ 85%) of all lines completing treatment prior to removal. First attempt insertion was 86% (Aim ≥ 80%) with a maximum insertion attempt of two. Rates of line-related complications were less than 8%, with five documented cases of phlebitis (2.5%) and one deep vein thrombosis with no infections documented.*

Conclusion: *Despite limited resources, a successful midline service was introduced. Future expansion will see an increase in insertor numbers providing improved access to the service.*

Keywords: midline, ultrasound, nursing, phlebitis, DIVA

Résumé

Introduction : *On a déterminé que les cathéters mi-longs étaient un moyen efficace et sécuritaire offrant aux patients une méthode d'accès intraveineux en milieu hospitalier et communautaire. À cause du peu d'expérience en matière d'insertion des cathéters mi-longs dans l'ensemble du réseau de santé local, un hôpital régional a entrepris la tâche d'explorer le sujet. Cette étude d'observation évalue la mise à disposition d'un cadre clinique sécuritaire pour l'insertion des cathéters mi-longs ainsi que l'amélioration des soins et des expériences des patients, en évitant les interruptions de traitement et les tentatives d'insertion infructueuses à cause des dispositifs traditionnels d'accès vasculaire périphérique défaillants.*

Méthodologie : *Depuis l'introduction du service de pose des cathéters mi-longs en juin 2018, les critères d'évaluation de tous*

les patients chez qui un cathéter mi-long a été inséré au cours des deux années suivantes ont été documentés, y compris le taux de succès de la pose, le taux de complications, la durée de séjour et le nombre de tentatives d'insertion.

Résultats : *Le service de pose des cathéters mi-longs a procédé à l'insertion de 207 cathéters sur une période de deux ans, avec une durée de séjour totale de 1585 jours. Les objectifs du projet ont été atteints : 85 % (l'objectif était de ≥ 85 %) des cathéters ont été retirés après la fin du traitement. Le taux d'insertions à la première tentative a atteint 86 % (l'objectif était de ≥ 80 %) et le nombre maximal de tentatives d'insertion était de deux. Le taux de complications associées à l'insertion des cathéters était de moins de 8 % : cinq cas de phlébite (2,5 %) et un cas de thrombose veineuse profonde sans infection ont été documentés.*

Conclusion : *Malgré des ressources limitées, il a été possible de mettre en place un service efficace de pose de cathéters mi-longs. La future croissance du projet augmentera le nombre de cathéters insérés et améliorera l'accès au service.*

Introduction

Providing a single intravenous access for the course of a patient's admission is a challenging and difficult task. For a large cohort of patients, numerous unsuccessful attempts precede achieving intravenous access (Sabri et al., 2013). Insufficient access to skilled and qualified vascular access specialists, unsuccessful attempts are often repeated throughout a single admission, particularly when prolonged access is required. These costly interruptions to treatment have the potential to lengthen hospital admissions and greatly impact patient and staff satisfaction with a higher risk of vascular access complications, such as infection, phlebitis, and pain (Anderson, 2004; Tagalakis et al., 2002; Uslusoy & Mete, 2008).

The introduction of midlines has provided vascular access teams with a safe, efficient and reliable means of establishing access in a population where central access is not indicated and traditional peripheral intravenous cannulation (PIVC) is difficult to establish, unreliable, or will require multiple insertions to achieve treatment goals (Anderson, 2004; Alexandrou et al., 2011; Moreau et al., 2015; Cummings et al., 2011). Midlines are recognized as an option to reduce the incidence of phlebitis, a substantial contributor to PIVC failure, and catheter-associated blood stream infections (Anderson, 2004; O'Grady et al., 2011; Salgueiro-Oliveira et al., 2013; Warrington et al., 2012).

Incorporating midlines into hospital vascular access options can be successfully achieved, delivering an opportunity to provide a single line for the entirety of treatment from the hospital and into the community setting (Owen, 2014).

Objective

The study aims to assess the safe, effective, and efficient introduction of a midline insertion team in regions without dedicated vascular access specialists, targeting one attempt per line with low rates of complications.

Methods

Study design

The introduction of the midline service was developed as a quality improvement project. The framework consisted of specialized training in midline insertion for a cohort of staff, the referral pathway, the documentation, and a set of parameters or goals against which to assess the safe clinical implementation.

A retrospective observational study of all adult patients who had a midline inserted during the study period, from June 2018 to June 2020, was undertaken.

Setting

Northeast Health Wangaratta is a 228-bed, rural regional hospital with approximately 20,000 admissions per year. Without a designated vascular access team, the task of obtaining peripheral vascular access in challenging situations across the organization lies with ultrasound-trained critical care nurses. Anecdotal evidence suggested an increase in complications prior to referral, including multiple failed access attempts, premature PIVC failure, inappropriate site and vessel selection, and multiple PIVC referrals per patients. This was particularly the case for patients identified as difficult intravenous access (DIVA). The introduction of a midline service planned to address these issues, while aiming to provide one line per referral from a single attempt early in the admission process.

Three Critical Care Unit (CCU) nurses, an effective full-time (EFT) equivalent of 2.4 (96 nursing hours per week), with expertise in the use of ultrasound-guided PIVC insertion were trained by BARD Access Specialists (Becton-Dickson, BD [the supplier]) using Powerglide Pro midlines. It was estimated that an EFT of 2.4 would be sufficient to provide the health service with access to the midline team within 24–48 hours from referral,

while providing sufficient exposure to insertion practice to maintain a high level of competence. Insertor training included ultrasound theory, best practice for insertion, care, troubleshooting and maintenance of midlines, and insertion practice utilizing phantom limbs and ultrasound. Once the BARD Access Specialists were confident with the insertor's technique, supervised practice was commenced on patients throughout the organization. Medical physicians with high expertise in ultrasound-guided central line insertion, in addition to the BARD Specialists, supervised insertions until competence and independent practice was awarded. This was achieved through a minimum of five successful insertions with minimal assistance and prompting from supervisors.

The supplier's specialists provided the organization's nurses with initial care, maintenance and troubleshooting, education, and training. To ensure line success and high rates of referrals, the primary midline team member provided multiple education sessions across the organization over the study period. Nursing staff were encouraged to communicate with members of the midline team should a complication arise or assistance be required.

Participants

All adult patients who consented to a midline insertion were included in the study. Due to the retrospective design, ethics approval was gained to permit data collection. No patients for whom a midline was inserted were excluded or removed. For the first six months of the midline service, no lines were inserted into Hospital in the Home (HITH) patients, while baseline safety and effectiveness were established.

Any clinician, nurse or doctor, could refer to the midline team. At the earliest opportunity, a member of the midline team undertook a vascular assessment to ensure appropriateness of midline insertion. Assessment included indication and estimated length of treatment for intravenous access, vascular access history – previous lines and attempts, relevant medical history (e.g., chemotherapy, steroid use), and vessel integrity – size, depth, options for site rotation, and presence of contraindications for insertion.

All midlines were inserted using ultrasound via the cephalic, basilic, or brachial veins above the antecubital fossa. Lines were 20-gauge with either 8 or 10cm length and utilized based on vessel depth and anatomical features.

Indications for midline insertion according to best practice recommendations included the following:

- intravenous access required for 5 to 30 days;
- identified as a difficult intravenous access (DIVA), as locally defined by greater than or equal to two attempts, a history of difficult access and/or requiring ultrasound guidance;
- insufficient options for intravenous site rotation; and
- pH range of medication 5–9 and osmolality < 600mOsmol/L

(Anderson, 2004, 2005; Alexandrou et al., 2011; Gorski et al., 2016; Griffiths, 2007; Moreau et al., 2015; Moreau & Chopra, 2016; Warrington et al., 2012).

To optimize the early identification (within 48hr of admission) of patients for referral by nursing or medical staff, admission diagnosis was included in the indications for midline insertion. Diagnosis-related group (DRG) codes, combined with electronic medication dispensing, provided a list of diagnoses that frequently require intravenous access for greater than five days. The top five diagnoses were pneumonia, cellulitis, exacerbation of congestive cardiac failure, sepsis, and exacerbation of chronic obstructive pulmonary disease. The presence of the diagnosis was used to identify potential patients, while insertion remained at the discretion of the midline team member following assessment.

Indications for midline insertion and the referral process were included in organization-wide education, including posters, prior to service commencement.

Outcome variables

Prior to the commencement of the midline service, primary goals were established to ensure patient safety, risk reduction, and appropriate quality control practice. Complications were referred back to the midline team for investigation and recommendation.

Goals included the following and reflect targets and results from previous successful studies:

- successful treatment ≥ 85%, as defined by intravenous access no longer required at time of removal;
- first attempt insertion success ≥ 80% to ensure patient safety and satisfaction, while preserving vessel integrity and midline rate of success;
- a rate of phlebitis of ≤ 2%; and
- rate of infection ≤1 per 1,000 line-days

(Anderson, 2004; Moreau & Chopra, 2016; Warrington et al., 2012).

Data sources

Data were collected through the use of a midline insertion and care document commenced by a member of the midline team at insertion. The document served as a tool for medical and nursing staff to monitor the midline including the organization's visual infusion phlebitis (VIP) scores (see Table 1), dressing changes, and line health, and as an aid to prompt allied health staff to its presence. This form was photocopied and returned to the Critical Care Unit to facilitate the tracking of patients with ward staff encouraged to supply documentation on the removal of the midline. If insufficient information was provided, patient histories were audited.

Time required to insert, including time out of CCU, was documented and served to track midline team demand for potential future expansion.

Collected data were collated and analyzed in a Microsoft Excel spreadsheet. Statistical analysis comprised descriptive statistics with categorical variables summarized using number (count) and percentage, and continuous variables summarized using mean. There was no pre-determined sample size, as the sampling was determined by the number of eligible cases presenting over the study period. To promote integrity, a consultant physician who was not a member of the midline team reviewed the data.

Table 1

Organisation Visual Infusion Phlebitis Score (VIP)

No pain, heat, redness or swelling	**0**	Remove cannula if not required. Monitor cannula site every shift and when accessing line.
Slight pain, light redness (<2cm) at cannula site	**1**	Remove cannula if not required or consider replacement. Monitor cannula site every shift and when accessing site.
Pain and redness, heat or swelling at cannula site	**2**	PHLEBITIS Remove cannula. Notify Medical team.
Pain, redness, heat or swelling with exudate, hardening, a palpable venous cord or tissue damage at cannula site	**3**	SEVERE PHLEBITIS Remove cannula. Notify Medical Team. Send swab of exudate & blood cultures, if febrile.

Results

During the two-year study period, 207 midlines were placed, delivering 1,585 dwell days. Table 2 highlights the primary study goals and the outcomes. For one line, the removal date was not recorded. The average dwell time was eight days with a maximum of 38 days.

The primary study goals were attained with the exception of the rate of phlebitis. Eighty-five percent ($n = 178$) of inserted midlines completed treatment successfully, while first attempt insertion was 89% (207 midlines, 232 attempts). Only one catheter required more than the recommended two attempts.

The rate of phlebitis was slightly higher than the pre-established goal at 2.5% ($n = 5$). Two catheters were removed due to chemical phlebitis with VIP scores greater than or equal to two. Remaining catheter VIP scores did not progress and treatment was completed prior to removal.

Thirteen midlines were removed prior to treatment completion when a change in patient condition required an escalation of care. These were not listed as failed due to the requirements for infusions outside the accepted indications for peripheral administration (e.g., total parenteral nutrition or inotropic/vasopressor support). Central venous access was established and the midline removed.

Table 2

The Primary Study Goals and Results

Results	N (%)
Total midlines inserted	207
Total dwell days	1585
Average dwell time – days	8
Maximum dwell time – days	38
Primary goals	
Successful treatment ≥ 85%	178 (85%)
First attempt success ≥ 80%	207/232 (89%)*
Phlebitis ≤ 2.0%	5 (2.5%)
Infection 0%	0%
Vessel accessed	
Basilic	108 (52%)
Cephalic	58 (28%)
Brachial	41 (20%)
Midline length	
8 Centimetre	110 (53%)
10 Centimetre	97 (47)

*207 midlines inserted from 232 attempts.

The most common indication for insertion (see Table 3) was intravenous access required for less than two weeks (47%, *n* = 97), followed by patients identified as DIVA (36%, *n* = 75) and intravenous access required for greater than two weeks (16%, *n* = 32).

Incorporating a diagnosis for improved identification of patients for midline insertion, highlighted an accurate prediction. The top five diagnoses of patients who received a midline are shown in Table 4. However, with a higher than desired average of approximately 4.7 days to insertion, it is unclear if the predicted diagnosis improved the time to identification and referral.

Hospital in the Home patients received 6% (*n* = 13) of midlines, allowing treatment to be completed in the community. Two lines failed, one a result of accidental removal, the other through kinking. The line accidentally removed was replaced and community treatment completed.

Table 3

Indications for Midline Insertion

Indication	No. (%)
IVA <2/52	97 (47%)
DIVA	75 (36%)
IVA >2/52	35 (17%)
Total	**207**

IVA < 2/52 = Intravenous access required less than two weeks.
DIVA = Difficult Intravenous Access and/or insufficient sites for rotation.
IVA >2/52 = Intravenous access required for greater than two weeks.

Table 4

Number of Midlines Inserted per Diagnosis

Predicted Diagnosis Requiring Midline	Actual Diagnosis with Midline Insertion	No. Midlines per Diagnosis
Pneumonia	Pneumonia	32
Cellulitis	Sepsis	31
Congestive cardiac failure	Cellulitis	24
Sepsis	Bacteraemia	16
Exacerbation COPD	Congestive cardiac failure	12
Exacerbation COPD	(8^{th})	7

Complications occurred in 14% (*n* = 29) of midlines, which failed the primary study goal and were removed prior to completion of treatment (see Table 5). Adjusting for insertor and patient error, i.e., failure to insert (improper insertion technique leading to failure) and accidental patient removal, reduces the complication rate to 9% (*n* = 18).

Two cases of catheter migration were observed, where the cannula migrated out of the vessel leading to failure. This complication was not able to be explained by patient factors, e.g., excessive movement.

One deep vein thrombosis (DVT) was diagnosed sonographically, following the development of localized upper-limb edema post-midline failure.

No infections were attributed to midlines during the study period. This was supported through independent local infection control auditing practices, including *Staphlococcus aureus bacteremia* (SAB) monitoring.

Discussion

The aim of the study, through a retrospective observation model, was to establish a safe and effective midline service in an institution without a specialist vascular access team. The midline service was able to achieve a total of 207 lines during the study period with near complete achievement in the pre-established goals. Eighty-nine percent of lines were inserted from a single attempt with 85% achieving treatment goals. No infections were recorded and rates of phlebitis were mildly higher than the goal, 2.5% vs. 2%. Adjusting for patient and insertor factor, the rate of total line-related

Table 5

Type and Number of Midline Complications

Midline Complications	No. (%)
Accidental removal by patient	9 (4.3%)
Kinked catheter	6 (2.8%)
Phlebitis	5 (2.4%)
Infiltration	3 (1.4%)
Failed insertion *	2 (1%)
Catheter migration**	2 (1%)
DVT	1 (0.5%)
Blocked catheter	1 (0.5%)
Total	**29**

*Failed insertion – improper insertion technique or tip location resulting in line failure in less than 24hr
**Catheter migration – migration of the catheter extraluminaly, leading to line failure.

complications was less than 10%. The progression of treatment to the community setting was achieved in a less-than-expected number of patients. This was largely attributed to understandable safety concerns surrounding elastomeric infusion devices use with midlines in the community setting and the initial six-month delay.

It was reassuring that the results of the study are reflective of the literature, particularly those where the goals and objectives were established (Anderson, 2004; Alexandrou et al., 2011; Cummings et al., 2011; Moreau et al., 2015). The implementation of the midline service was safe, effective, and provided uninterrupted treatment with low rates of complications seen more commonly with traditional peripheral access devices (Salgueiro-Oliveira et al., 2013). Allowing for a dwell time of approximately 3 and 14 days respectively, it is estimated that a total 519 PIVCs and 34 PICCs were potentially prevented through the implementation of the midline service (Moreau & Chopra, 2016; O'Grady et al., 2011). With up to 26% of PIVC first attempts failing, the removal of these traditional short-term devices has significant implications for patient safety, comfort and satisfaction in addition to the potential reduction in central line-associated complications (Fields et al., 2014; Maki et al., 2006; Pathak et al., 2015; Sabri et al., 2013).

A major strength to this model was the use of nurses well experienced in the use of ultrasound for peripheral access. This was noted by the BARD team in the quick progression of the nurses in their training. The high rate of first-time success was largely attributed to this and may highlight the importance of establishing systems that promote skill attainment and development prior to progression, including competence in PIVC insertion using ultrasound prior to midline insertion requiring ultrasound.

Limitations

The identification of patients and the referral process was a noted limitation within this model. Using a modified version of a system presented within the literature, the predicted diagnosis appeared an accurate means for early identification (Anderson, 2004). However, it is estimated, through the monitoring of the DRG system, that approximately 30% of patients meeting criteria for potential insertion were not referred. In addition, an average delay of 4.7 days to insertion highlights an area for development, with this population likely undergoing unnecessary PIVCs and attempts prior to midline placement.

The small team size with an EFT of 2.4 and the competing responsibilities of insertors, due to an increase in CCU acuity, was insufficient and contributed to delays.

It is considered possible that assessment of phlebitis may have been inaccurate. Due to the insufficient resources and competing commitments of the midline team, VIP monitoring of individual lines on removal relied on general clinical staff. If concerns were raised, midline team members would investigate with recommendation for practice, if required. However, it was reassuring that the auditing of patient records failed to identify any documentation or escalation in treatment for phlebitis for midlines not previously recording a complication.

At commencement of the midline service, we had planned to include the number of PIVCs and attempts prior to midline insertion referral in the data collection. However, due to time limitations on insertors, the team elected to focus on the pre-established goals. Adoption of these factors into future works could provide valuable insight into vascular access practice and complications.

Noting these limitations, a number of forthcoming advances are currently being developed and implemented. No longer hindered by the global pandemic, the expansion of the team is underway and includes ultrasound-trained emergency department nurses. This expansion aims to reduce delays to insertion by promoting early patient identification at the point of admission and greater availability to insertors.

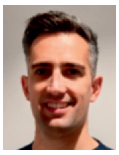
Anecdotal evidence, provided by the midline team and nurses caring for patients, suggested that the patient experience was enhanced with the inclusion of a midline into their care delivery when compared to traditional PIVCs. In addition, medical and nursing staff reported reduced frustration and greater satisfaction. With a larger sample size, future qualitative research to include these experiences would be an area of interest.

Conclusion

The aim of this study was to assess the provision of a safe framework for midline insertion, in regions with limited resources. Despite limitations in early identification and delays to insertion, a successful service was introduced. The introduction of the midline team enabled the achievement of one line per referral, providing successful treatment, with low rates of complications, within its pre-established goals. Expansion of the team is underway in an attempt to improve

early recognition and reduce delays to insertion. Aiming to remove unnecessary cannulations and their attempts, the organization endeavours to improve its service and patient care delivery.

About the author



Paul Jones, NP, BN, MN, is currently an Associate Nurse Unit Manager of the Intensive Care Unit at Northeast Health Wangaratta, a regional 220-bed hospital in Victoria, the Southeast of Australia. With 17 years of ICU experience, he accomplished a Masters of Advanced Nursing Practice and in 2020 was successfully endorsed as a Nurse Practitioner.

A strong passion in vascular access has led him to the implementation of numerous quality improvement initiatives across the organization; most recently, the development of a midline service and formal peripheral intravenous cannulation insertion using ultrasound training for medical and nursing colleagues.

Professional undertakings have included working with Victoria's healthcare and safety regulators – Safer Care Victoria – in the research and development of guidelines and recommendations to improve the provision of care including, pain agitation and delirium in ICU, the statewide standardization of inotropes, and the improvement of the local recognition and response team.

Since 2020, he has held the position of National Safety and Quality Health Service – Recognizing and Responding to Acute Deterioration Standard lead for the organization.

À propos de l'auteur

Paul Jones, IPS, B. Sc. inf., M. Sc. inf. : Il est actuellement infirmier et gestionnaire associé de l'unité de soins intensifs du Northeast Health Wangaratta, un hôpital régional de 220 lits à Victoria, dans le sud-est de l'Australie. Riche de 17 ans d'expérience au sein de l'unité de soins intensifs, il a obtenu une maîtrise en pratiques infirmières avancées et il a obtenu avec succès son titre d'infirmier praticien en 2020.

Sa grande passion pour l'accès vasculaire l'a motivé à mettre en œuvre de nombreuses initiatives d'amélioration de la qualité dans toute l'organisation, la plus récente étant l'introduction d'un service de pose de cathéters mi-longs et d'insertion normalisée de cathéters intraveineux périphériques, en formant les collègues du personnel médical et infirmier sur les techniques d'échographie.

Parmi ses projets professionnels figurent son travail avec Safer Care Victoria, un organisme de réglementation en soins de santé et en sécurité à Victoria, en matière de recherche et d'élaboration de lignes directrices et de recommandations visant à améliorer la prestation de soins, y compris la prise en charge de l'agitation et du delirium causés par la douleur au sein de l'unité de soins intensifs, la normalisation du recours aux inotropes à l'échelle de l'état et l'amélioration de l'équipe locale de reconnaissance des risques et d'intervention.

Disclosure

BARD Medical was selected for its comprehensive training, support and education assistance package for insertors and the organization. BARD Medical supplied no financial assistance to the organization, midline team members, or project and were not involved in the audit process nor have been provided with the results. Purchase of the Powerglide midline and disposables was at the sole expense of the organization.

References

Alexandrou, E., Ramjan, L., Spencer, T., Frost, S., Salamonson, Y., & Davidson, P. (2011). The use of midline catheters in the adult acute care setting – Clinical implications and recommendations for practice. *The Journal of the Association for Vascular Access (JAVA)*, *16*(1), 35–41.

Anderson, R. (2004). Midline catheters: The middle ground for intravenous therapy administration. *Journal of Infusion Nursing*, *25*(5), 313–321.

Anderson, R. (2005). When to use a midline catheter. *Nursing*, *35*(4), 68.

Cummings, M., Hears, N., McCuthcheon, H., & Deuter, K. (2011). Improving antibiotic treatment outcomes through the implementation of a midline: Piloting a change in practice for cystic fibrosis patients. *Journal of Vascular Nursing*, *29*(1), 11–15.

Fields, J. M., Piela, N. E., & Ku, B. S. (2014). Association between multiple IV attempts and perceived pain levels in the emergency department. *Journal of Vascualr Access*, *15*(6), 514–518.

Gorski, L. Hadaway, L. Hagle, M. E. McGoldrick, M. Orr, M. Doellman, D. (2016). Infusion therapy standard of practice – Revised 2016. *Journal of Infusion Nursing*, (39) 1S.

Griffiths, V. (2007). Midline catheters: Indications, complications and maintenance. *Nursing Standard*, *22*(11), 48–57.

Maki, D. G., Kluger, D. M., & Crnich, C. J. (2006). The risk of bloodstream infection in adults with different intravascular devices: A systematic review of 200 published prospective studies. Mayo Clinic Proceedings, 81(9), 1159–1171

Moureau, N., & Chopra, V. (2016). Indications for peripheral, midline and central catheters: Summary of the MAGIC recommendations. *British Journal of Nursing*, *25*(8), S15–S24.

Moureau, N., Sigl, G., & HIll, M. (2015). How to establish an effective midline service: A case study of 2 hospitals. *JAVA, 20*(3), 179–188.

O'Grady, N. P., Alexander, M., Burns, L. A., Delligen, P., Garland, J., Heard, S. O., Lipsett, P. A., Masur, H., Mermel, L. A., Pearson, M. L., Raad, I. I., Randolph, A., Rupp, M. E., Saint, S., & Healthcare Infection Control Practices Advisory Committee (HICPAC). (2011). *Guidlines for the prevention of intravascular catheter-related infections.* Centre for Disease Control. https://www.cdc.gov/infectioncontrol/pdf/guidelines/bsi-guidelines-H.pdf

Owen, K. (2014). The use of 8cm midlines in community IV therapy. *British Journal of Nursing*, 23(19), S18–S20.

Pathak, R., Patel, A., Enuh, H., Adekunle, O., Shrisgantharajah, V., & Diaz, K. (2015) The incidence of central line–associated bacteremia after the introduction of midline catheters in a ventilator unit population. Infectious Diseases in Clinical Practice, 23(3), 131–134.

Sabri, A., Sizalas, J., Holmes, K. S., Labib, L., & Musslvand, T. (2013). Failed attempts and improvement strategies in peripheral intravenous catheterization. *Biomedical Materials and Engineering, 23*(1–2), 93–108.

Salgueiro-Oliveira, A., Veiga, P., & Parreira, P. (2013). Incidence of phlebitis in patients with peripheral intravenous catheters: The influence of some risk factors. *Australian Journal of Advanced Nursing, 30*(2), 32–39.

Tagalakis, V., Kahn, S., Libman, M., & Blostein, M. (2002). The epidemiology of peripheral vein infusion thrombophlebitis: A critical review. *The American Journal of Medicine, 113*(2), 146 –151.

Uslusoy, E., & Mete, S. (2008). Predisposing factors to phlebitis in patients with peripheral intravenous catheters: A descriptive study. *Journal of the American Academy of Nurse Practitioners, 20*(4), 172–180.

Warrington, W., Jr., Penoyer, D., Kamps, T., & Van Hoeck, E. (2012). Outcomes for using a Modified Seldinger Technique for long term intravenous therapy in hospitalised patients with difficult venous access. JAVA, 17(1), 24–31.