Centre universitaire de santé McGill
McGill University Health Centre

L'Unité d'évaluation des technologies et des modes d'intervention en santé (UETMIS) du Centre Universitaire de Santé McGill (CUSM)
Health Technology Assessment Unit (TAU) of the MUHC

B. Braun Medical Inc.

December 20, 2024

Ultrasound-Guided Peripheral Intravenous Catheter (USGPIVC) Insertion: Evaluation of a Pilot Program at the MUHC

Health Technology Assessment Report
Evaluation of Current Practice
Report no. 99

Report prepared for the Technology Assessment Unit (TAU) of the McGill University Health Centre (MUHC)

by

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Mission Statement

The MUHC Health Technology Assessment Unit (TAU) advises hospital administrators and clinical teams in difficult resource allocation decisions. Using an approach based on independent, critical evaluations of the available scientific evidence and a transparent, fair decision-making process, novel and existing medical equipment, drugs and procedures used by healthcare professionals are prioritized on a continuous basis ensuring the best care for life with the best use of resources.

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Declaration of Conflicts of Interest

Members of TAU's research staff and policy committee declare no conflicts of interest.

Suggested citation

Almeida N, Suarthana E, Panjwani C. Ultrasound-Guided Peripheral Intra Venous Catheter (USGPIVC) Insertion: Evaluation of A Pilot Program at the MUHC. Montreal (Canada): Technology Assessment Unit (TAU) of the McGill University Health Centre (MUHC); December 20, 2024. Report no.99. 28 pages

Report available from https://muhc.ca/tau

ACKNOWLEDGEMENTS

The expert assistance of the following individuals is gratefully acknowledged for providing background information and for reviewing the final draft of this report:

- Katherine Mohsen, Inf. Clin, MSc (A), Nursing Advisor for Vascular Access, Nursing Directorate, McGill University Health Centre (MUHC)
- Carissa Wong, RN, MSc.(A), CHPCN(C), Nursing Practice Consultant (Interim), Nursing Directorate, MUHC
- Dr. Antony Robert, Emergency Medicine attending physician and Assistant Director of the Emergency Department Information Technology, MUHC

REPORT REQUESTOR

This evaluation was requested by Dr. Antony Robert, Emergency Medicine physician at the McGill University Health Centre (MUHC), on January 29th, 2024 to document the implementation of an ultrasound-guided peripheral intravenous catheter (USGPIVC) insertion training and pilot program in the emergency department (adult sites) of the MUHC.

TYPES OF RECOMMENDATIONS ISSUED BY THE TAU COMMITTEE

Type of recommendation	Explanation
Approved	• Evidence for relevant decision criteria, including efficacy, safety, and cost, as well as context-specific factors such as feasibility, is sufficiently strong to justify a recommendation that the technology be accepted, used and funded through the institutional operating budget
Approved for evaluation	• There is a reasonable *probability* that relevant decision criteria, including efficacy, safety, and cost, as well as context-specific factors such as feasibility, are favorable but the evidence is not yet sufficiently strong to support a recommendation for permanent and routine approval. • The evidence is sufficiently strong to recommend a *temporary* approval in a restricted population for the purposes of evaluation, funded through the institutional operating budget.
Not approved	• There is insufficient evidence for the relevant decision criteria, including efficacy, safety, and cost; • The costs of any use of the technology (e.g. for research purposes) should not normally be covered by the institutional budget.

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LIST OF ABBREVIATIONS

BMI	Body mass index
CVC	Central venous catheter
DIVA	Difficult Intravenous access
IV	Intravenous
i-SIM	Interprofessional Simulation Centre
MUHC	McGill University Health Centre
PIVC	Peripheral intravenous catheter
RVH	Royal Victoria Hospital
TAU	MUHC Technology Assessment Unit
U/S	Ultrasound
USGPIVC	Ultrasound-guided peripheral intravenous catheter

PLAIN LANGUAGE SUMMARY

Training nurses to use ultrasound for difficult intravenous (IV) insertions: what did we learn from a pilot program at the McGill University Health Centre?

KEY MESSAGES

- Ultrasound-guided peripheral IV catheter (USGPIVC) insertion is a technique that uses ultrasound to help guide the needle into the vein. It can make the procedure easier and more comfortable for patients with difficult intravenous access, and may help avoid the need for central lines.
- The pilot program showed that training nurses to perform ultrasound-guided IV insertions is possible: 67% of insertions were successful and nurses considered the theory and supervision strong points.
- To enhance success, future programs should offer more realistic simulations and dedicated practice time.

What is the problem?

When patients come to the emergency department, they often need an intravenous (IV) line to receive fluids or medications. However, some patients have difficult intravenous access and getting an IV line inserted is challenging due to hard-to-find veins. Ultrasound-guided peripheral IV catheter (USGPIVC) insertion is a technique that uses ultrasound to help guide the needle into the vein, potentially preventing the need for multiple insertion attempts or more invasive central lines.

What was done?

Between June 2023 and January 2024, a pilot program at the Royal Victoria Hospital (part of the McGill University Health Centre) trained emergency department nurses to perform USGPIVC insertions.

- We evaluated the success rate of each attempt
- We interviewed nurses to understand challenges encountered and strengths of the training program.

What did we find?

- 67% (18 out of 27) of the insertions were successful.
- Success varied depending on nurse experience and how hard it was to access the vein.
- None of the nurses completed enough supervised insertions to become certified during the pilot.
- The most common challenge was seeing the tip of the needle on the ultrasound screen—a skill that takes practice to master.
- Nurses wanted more realistic simulations and more time for hands-on practice.

- The theoretical part of the training and the support from supervisors were considered strong points.
- Nurses were motivated and believed this technique could benefit patients by reducing pain and delays in care.

Bottom line

This pilot program showed that training nurses to perform ultrasound-guided IV insertions is possible and has potential benefits for both patients and staff. However, to be successful, the program needs to offer dedicated hands-on practice time. This is aligned with the MUHC Nursing Directorate's strategic plan of evolving nursing practices with technology, adapting care to the population, and potential for nursing retention.

EXECUTIVE SUMMARY

BACKGROUND

Ultrasound-guided peripheral intravenous catheter (USGPIVC) insertion is a technique that uses ultrasound visualization to guide placement of a catheter into a peripheral vein. This method is particularly beneficial for patients who have difficult intravenous access (DIVA) and aims to improve success rates and reduce complications arising from difficult insertion. A pilot program to train nurses in the USGPIVC procedure was implemented at the emergency department of the Royal Victoria Hospital (RVH) of the McGill University Health Centre (MUHC) between June 2023 and January 2024.

EVALUATION QUESTION (OBJECTIVES OF THIS REPORT)

- To assess the rate of successful USGPIVC line insertions among pilot participants (outcome measure).
- To identify technical, practical, and systemic challenges and suggestions for improvements in the training program (process measures).

METHODS

We conducted a quantitative analysis of data collected during the pilot program to evaluate the rate of successful USGPIVC insertions. A successful insertion was defined as autonomously being able to complete the insertion such that the catheter is patent when flushed, and an individual nurse required 10 supervised successful attempts to obtain certification.

For the qualitative evaluation to assess process measures of implementation, we developed a questionnaire based on the Kirkpatrick Model, which is used to evaluate and analyze the results of educational, training and learning programs. We interviewed two participants of the pilot program. Interviews were transcribed and evaluated for recurring themes and concepts.

RESULTS

Outcome measure: Rates of successful USGPIV insertion in the pilot program

- Four nurses participated in the pilot and attempted 27 USGPIV insertions. Of these, 18 (66.7%) were successful. Success rates varied by nurse experience and level of difficulty in accessing the vein, as indicated by the adult DIVA (A-DIVA) scores. None of the nurses completed the required 10 supervised successful attempts to obtain certification during the pilot.

Process measures: Challenges and facilitators encountered during the pilot

- **Challenges**:
    - The most common challenge, reported in nearly 30% of attempts, was mastering the technique for visualizing the tip of the catheter.
    - A factor affecting success rates was the inability to liberate sufficient time to practice frequently and retain skills.
- **Suggestions for improvement**:
    - Participants noted that theoretical training should include awareness of anticipated challenges such as identifying appropriate veins for cannulation, losing sight of the needle tip and tenting.
    - In terms of simulated training, nurses identified the need for more realistic simulations, including the use of phantom arms at the Interprofessional Simulation Centre (SIM).
    - More frequent opportunities for practice and allocation of sufficient time outside work shifts were suggested to help trainees master and retain skills.
- **Facilitators**:
    - The theoretical training was in-depth and well-received.
    - The USGPIVC insertion protocol was thorough and clear.
    - Supervisors were excellent and nurses were highly motivated.
    - Participants agreed that USGPIVC has the potential to benefit patients by reducing discomfort and length of stay.
    - Nurse confidence in the technique helped ease patient anxiety.

CONCLUSIONS

The implementation of the ultrasound-guided peripheral intravenous catheter (USGPIVC) insertion pilot program at the RVH emergency department demonstrated promising outcomes and revealed several valuable insights into the feasibility and challenges of adopting this technique in clinical nursing practice:

- Implementation of the procedure is feasible with continued support and structured practice because of highly motivated staff and a well-developed training protocol.
- The pilot highlighted critical areas for program refinement, including enhanced simulation and improved access to intensive practice opportunities.
- Given the potential of USGPIVC to reduce reliance on central venous catheters, improve patient comfort, and enhance care efficiency, further scaling of the

program is warranted. Future implementation should integrate the lessons learned from this pilot to optimize training, support skill retention, and maximize the benefits of this innovative technique for both patients and providers. This is aligned with the MUHC Nursing Directorate's strategic plan of evolving nursing practices with technology, adapting care to the population, and potential for nursing retention.

BEST PRACTICE RECOMMENDATIONS

Future iterations of the training program for USGPIVC could integrate the following:

- **Didactic training**: Emphasize best practice for identifying the IV needle tip, include instruction on anticipated challenges and incorporate realistic simulations (e.g., curved phantom limb models) during training
- **Supervised practice**: To help trainees master and sustain skills, the program should provide structured, intensive supervised training with sufficient dedicated practice time and program continuity.
- **Outcome evaluation**: To understand downstream clinical impact and benefit of USGPIVC, incorporate evaluation of central venous catheter insertions and associated infection rates, delays in treatment and patient satisfaction.

SOMMAIRE

CONTEXTE

L'insertion d'un cathéter intraveineux périphérique sous échoguidage (CIVPE) est une technique qui utilise la visualisation échographique pour guider la mise en place d'un cathéter dans une veine périphérique. Cette méthode est particulièrement bénéfique pour les patients présentant un accès intraveineux difficile (DIVA) et vise à améliorer les taux de réussite et à réduire les complications liées à une insertion difficile. Afin d'introduire les CIVPE à l'Hôpital Royal Victoria (HRV) du Centre universitaire de santé McGill (CUSM), le service des urgences a mis en œuvre un programme pilote entre juin 2023 et janvier 2024 afin de former les infirmières à cette procédure.

QUESTION D'ÉVALUATION (OBJECTIFS DU PRÉSENT RAPPORT)

- Évaluer le taux de réussite des insertions de CIVPE parmi les participants au projet pilote (mesure des résultats).
- Identifier les défis techniques, pratiques et systémiques et des suggestions d'amélioration du programme de formation (mesures des processus).

MÉTHODES

Nous avons réalisé une analyse quantitative des données recueillies pendant le programme pilote afin d'évaluer le taux de réussite des insertions de CIVPE. Une insertion réussie était définie comme la capacité à terminer l'insertion de manière autonome, de sorte que le cathéter soit perméable après lors du rinçage.

Pour l'évaluation qualitative des mesures de processus de mise en œuvre, nous avons élaboré un questionnaire basé sur le modèle Kirkpatrick, utilisé pour évaluer et analyser les résultats des programmes d'éducation, de formation et d'apprentissage. Nous avons interrogé deux participants au programme pilote, dont les entretiens ont été retranscrits et analysés afin d'en dégager les thèmes et concepts récurrents.

RÉSULTATS

Mesure de résultat : Taux de réussite de l'insertion d'un cathéter intraveineux périphérique sous échoguidage (CIVPE) dans le cadre du programme pilote

- Quatre infirmières ont participé au programme pilote et ont tenté 27 insertions de CIVPE. Parmi celles-ci, 18 (66,7 %) ont été réussies. Les taux de réussite variaient selon l'expérience de l'infirmière et le niveau de difficulté d'accès à la veine, comme l'indiquent les scores A-DIVA.

Mesures de processus : Défis et facteurs facilitants rencontrés pendant le programme pilote

- **Défis :**
    - La difficulté la plus fréquente, signalée dans près de 30 % des tentatives, était la maîtrise de la technique de visualisation de l'extrémité du cathéter.
    - Un facteur affectant les taux de réussite était l'incapacité à dégager suffisamment de temps pour pratiquer fréquemment et maintenir les compétences.
- **Suggestions d'amélioration :**
    - Les participants ont souligné que la formation théorique devrait inclure une sensibilisation aux difficultés anticipées.
    - Concernant la formation par simulation, les infirmières ont identifié le besoin de simulations plus réalistes, notamment l'utilisation de bras fantômes.
    - Des occasions de pratique plus fréquentes et un temps suffisant en dehors des quarts de travail ont été suggérés pour aider les participants à maîtriser et à maintenir leurs compétences.
- **Facteurs facilitants :**
    - La formation théorique était approfondie et bien accueillie.
    - Le protocole était complet et clair.
    - Les superviseurs étaient excellents et les infirmières très motivées.
    - Les participants ont convenu que les CIVPE pouvait être bénéfique pour les patients en réduisant l'inconfort et la durée du séjour.
    - Avoir un inséreur confiant a aidé à apaiser l'anxiété des patients.

CONCLUSIONS

La mise en œuvre du programme pilote d'insertion de cathéter intraveineux périphérique sous échoguidage (CIVPE) au service des urgences de l'HRV a montré des résultats prometteurs et a révélé plusieurs informations précieuses sur la faisabilité et les défis liés à l'adoption de cette technique en pratique infirmière clinique :

- La mise en œuvre de la procédure est réalisable avec un soutien continu et une pratique structurée, grâce à un personnel hautement motivé et à un protocole de formation bien développé.
- Le projet pilote a mis en évidence des points critiques à améliorer, notamment l'amélioration de la simulation et l'accès à des possibilités de pratique intensive.

- Compte tenu du potentiel des CIVPE pour réduire le recours aux cathéters veineux centraux, améliorer le confort des patients et optimiser l'efficacité des soins, une extension du programme est justifiée. La mise en œuvre future devrait intégrer les enseignements tirés de ce projet pilote afin d'optimiser la formation, de favoriser le maintien des compétences et de maximiser les avantages de cette technique innovante pour les patients et les soignants. Cela s'inscrit dans le plan stratégique de la Direction des soins infirmiers du CUSM qui vise à faire évoluer les pratiques infirmières grâce à la technologie, à adapter les soins à la population et à favoriser la rétention du personnel infirmier.

RECOMMANDATIONS DE BONNES PRATIQUES

Les futures versions du programme de formation d'insertion de CIVPE pourraient intégrer les éléments suivants :

- Formation didactique : Mettre l'accent sur les bonnes pratiques d'identification de l'extrémité de l'aiguille IV, inclure des instructions sur les difficultés anticipées et intégrer des simulations réalistes (par exemple, des modèles de membres fantômes courbés pendant la formation).
- Pratique supervisée : Pour aider les participants à maîtriser et à maintenir leurs compétences, le programme devrait proposer une formation supervisée structurée et intensive, avec suffisamment de temps de pratique dédié et une continuité du programme.
- Évaluation des résultats : Pour comprendre l'impact clinique et les avantages des CIVPE en aval, intégrer l'évaluation des insertions de cathéters veineux centraux et les taux d'infection associés, les retards de traitement et la satisfaction des patients.

Ultrasound-Guided Peripheral Intravenous Catheter (USGPIVC) Insertion: Evaluation of a Pilot Program at the MUHC

BACKGROUND

The placement of peripheral intravenous catheters (PIVC) is a very common hospital procedure, with up to 70% of patients receiving a PIVC during their hospital stay (1). However, an estimated quarter of patients in the emergency department have difficult intravenous access (DIVA) due to a variety of factors such as obesity, edema or chronic medical conditions (2, 3).

Ultrasound-guided peripheral intravenous catheter (USGPIVC) insertion is a technique that uses ultrasound to guide the placement of the catheter, and is particularly beneficial in patients with difficult IV access (4, 5). Previously, insertion of a central venous catheter (CVC) was indicated when PIVC insertion failed multiple times. However, compared to PIVC, CVC may cause more serious complications such as infections, hemothorax, pneumothorax, arterial puncture, and hematoma formation (6). Studies have demonstrated that USGPIVC can improve the success rate of catheter insertions compared to traditional visualization and palpation, reduce CVC insertion by 85%, decrease medical care delays and patient throughput time, and improve patient satisfaction (7-9).

REASON FOR REQUEST

To introduce USGPIVC at the adult sites of the McGill University Health Centre (MUHC), the Royal Victoria Hospital (RVH) emergency department implemented a pilot program between June 2023 and January 2024 to train nurses in the procedure. In January 2024, TAU received a request from Dr. Antony Robert to evaluate the implementation of the USGPIVC insertion training and pilot program.

EVALUATION QUESTIONS

1. To assess the rate of successful USGPIVC insertions among pilot participants (outcome measure).
2. To identify technical, practical, and systemic challenges and suggestions for improvements in the training program (process measures).

METHODS

We conducted a quantitative analysis of data collected during the pilot program to evaluate the rate of successful USGPIVC insertions. A successful insertion was defined as autonomously being able to complete the insertion such that the catheter was patent when flushed. We conducted descriptive analyses using the IBM Statistical Software for Social Sciences (SPSS) version 29.0.

For the qualitative evaluation to assess process measures of implementation, we developed a questionnaire based on the Kirkpatrick Model (10). It is a tool to evaluate and analyze the results of educational, training and learning programs. The questionnaire items are displayed in the Appendix. We interviewed two of the four nurses who participated in the pilot program. Interviews were recorded with permission via Zoom or Microsoft Teams. The recordings were transcribed using Otter.ai (2024), and the transcriptions were evaluated for recurring themes and concepts.

RESULTS

Outcome: Rates of successful USGPIVC insertion in the pilot program

- Of 27 insertions attempted by four nurses over the course of the pilot, 18 (66.7%) were successful. Success rates varied between nurses and by A-DIVA score (Figure 1).
- The total number of insertion attempts per nurse ranged from 2 to 9; therefore, none of the nurses completed the required 10 supervised successful attempts to obtain certification during the pilot.

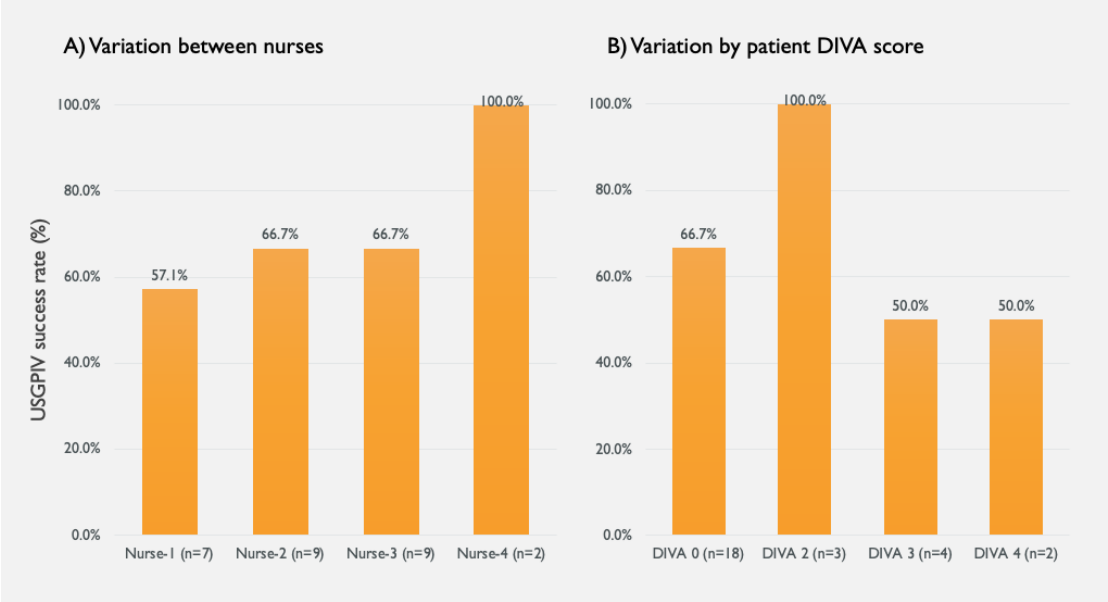

Figure 1. Ultrasound-guided peripheral intravenous catheter insertion success rate by nurse (A) and A-DIVA score (B)

- For training purposes, the procedure was mainly performed in patients with an A-DIVA score of 0 (18/27). Yet, there was a 33% failure rate in this category (Figure 1).
- Overall, 13/18 (72%) of the successful USGPIVC were done in 15 minutes or less.
- The most common procedural challenge, reported in nearly 30% of attempts, was mastering the technique for visualizing the tip of the catheter.

Process measures: Challenges and facilitators during the pilot

We interviewed two of the four nurses who participated in the pilot, each with variable experience using the USGPIVC insertion technique.

In our qualitative analysis of the interview transcriptions, we categorized challenges and facilitators according to the following themes: theoretical instruction; practical training (systemic, technical, and procedural aspects); supervision; safety; and training protocol. The full results are displayed in Table 1 and the questionnaire is included in the Appendix.

- **Challenges**:
    - During practice on patients, the hardest technical aspect was visualization of the tip of the catheter.
    - Factors affecting success rates included the inability to liberate sufficient time to practice frequently and retain skills, and low number of eligible patients to practice on in a day. This was attributed to the need for practice attempts to be made during work hours within the emergency department, where there were many competing patient care priorities for both nurses and supervisors.
- **Suggestions for improvement**:
    - Theoretical training should include awareness of the expected challenges, such as identifying appropriate veins for cannulation, losing sight of the needle tip and tenting.
    - In terms of simulated training, the nurses identified the need for more realistic simulations, including the use of phantom arms at the MUHC Interprofessional Simulation Center (MUHC-i-SIM).
    - Nurses also identified the need for appropriate distribution of training across theory, simulated practice and supervised practice on patients.

  - More frequent opportunities for practice and allocation of sufficient time outside work shifts were suggested to help trainees master the skills and avoid loss of momentum.

- **Facilitators**:
  - The theoretical training was in-depth (topics covered included identification of vein vs. artery, depth and direction of veins, safety issues, sterile technique, protocol, and technique for visualizing the tip of the catheter) and well received.
  - Supervisors were excellent and nurses were highly motivated.
  - The USGPIVC insertion protocol was thorough and clear.
  - Training participants agreed that USGPIVC has the potential to benefit patients by reducing discomfort and length of stay.
  - Nurse confidence in the technique helped ease patient anxiety.

DISCUSSION

Summary of findings

The implementation of the ultrasound-guided peripheral intravenous catheter (USGPIVC) insertion pilot program at the MUHC emergency department demonstrated promising outcomes and revealed several valuable insights into the feasibility and challenges of adopting this technique in clinical nursing practice.

The overall success rate of USGPIVC insertions among nurses during the pilot was 66.7%, which was mainly impacted by systemic issues such as limited time to practice during shifts and the scarcity of eligible patients with high A-DIVA scores. The fact that one-third of attempts failed even in patients with an A-DIVA score of 0 suggests a learning curve that must be acknowledged and supported. Encouragingly, 72% of successful insertions were completed in 15 minutes or less, indicating that with increased proficiency, USGPIVC has the potential to be an efficient alternative to more invasive procedures.

Qualitative findings further clarified the primary barriers to successful implementation. Nurses identified technical challenges, particularly with visualizing the catheter tip via ultrasound, as the most frequent source of difficulty. This was compounded by insufficient and infrequent practice, which hindered skill acquisition and retention. These issues echo concerns in the literature about sustaining

competency in advanced procedures when exposure is low (11, 12).

Strengths of the program

Despite the above challenges, the program was well-received. Theoretical training was described as comprehensive and engaging, and participants felt well supported by their supervisors. The program is in line with effective teaching methods for USGPIVC identified in the literature, which include a combination of didactic and simulation training (13). Nurses expressed strong motivation to learn and apply USGPIVC and identified clear patient benefits, including reduced discomfort and a lower likelihood of requiring central catheter insertion.

Future direction

Although our analysis included only four pilot participants and two interviewees, respondents provided thoughtful and actionable suggestions for improving the program. These included incorporating more realistic simulation tools such as phantom arms and allowing for extended practice under supervision. These recommendations are consistent with best practices in procedural skill development, which emphasize the importance of deliberate practice, feedback, and simulation (13).

Future evaluation should incorporate the impact of USGPIVC on clinical outcomes such as reduction in central venous catheter insertion rates and associated bloodstream infections, therapy delays and patient satisfaction.

CONCLUSIONS

The implementation of the ultrasound-guided peripheral intravenous catheter (USGPIVC) insertion pilot program at the MUHC emergency department demonstrated promising outcomes and revealed several valuable insights into the feasibility and challenges of adopting this technique in clinical nursing practice:

- Implementation of the procedure is feasible with continued support and structured practice because of highly motivated staff and a well-developed training protocol.
- The pilot highlighted critical areas for program refinement, including enhanced simulation and improved access to intensive practice opportunities.
- Given the potential of USGPIVC to reduce reliance on central venous catheters, improve patient comfort, and enhance care efficiency, further scaling of the

program is warranted. Future implementation should integrate the lessons learned from this pilot to optimize training, support skill retention, and maximize the benefits of this innovative technique for both patients and providers. This is aligned with the MUHC Nursing Directorate's strategic plan of evolving nursing practices with technology, adapting care to the population, and potential for nursing retention.

BEST PRACTICE RECOMMENDATIONS

Future iterations of the training program for USGPIVC could integrate the following:

- **Didactic training**: Emphasize best practice for identifying the IV needle tip, include instruction on anticipated challenges (such as identifying appropriate veins for cannulation, losing sight of the needle tip and tenting), and incorporate realistic simulations (e.g., curved phantom limb models) during training.
- **Supervised practice**: To help trainees master and sustain skills, the program should provide structured, intensive supervised training with sufficient dedicated practice time and program continuity.
- **Outcome evaluation**: To understand downstream clinical impact and benefit of USGPIVC, incorporate evaluation of pertinent outcomes such as central venous catheter insertions and associated infection rates, delays in treatment and patient satisfaction.

TABLES

Table 1. Qualitative analysis of nurse interviews

Themes	General Comments	Positive aspects	Challenges Encountered	Suggestions for Improvement
General experience with USGPIVC	Only 1 of the 2 nurses had previous experience with USGPIVC dating to 2019 where she achieved 80% success rate following 40-50 insertions.			
Training				
Didactic training				

	• Theory presented at the MUHC Interprofessional Simulation Center (MUHC-i-SIM) (unclear how long the theoretical part was in terms of hours, but not a lot of theory).
	• Topics covered:
	  ○ Identification of vein vs. artery;
	  ○ depth and direction of veins;
	  ○ safety issues;
	  ○ sterile technique;
	  ○ protocol;
	  ○ technique for visualizing tip of catheter
		• The theory was very well done
		• The consensus was that the theory was straightforward
			None	Include instruction about:
				• Potential for clot formation that impedes blood flow, which is hard to differentiate from failure to insert in the vein;
				• Amount of possible tenting;
				• Hardest aspect: visualization of the tip of the catheter

Simulated training				
	Training consisted of: • Practice on dummy arms at i-SIM	Phantom arms at i-SIM: more realistic due to the curvature of the arm, than jelly pad arms	Lack of practice time	• Need for more realistic simulations, including the use of phantom arms at the i-SIM • More time at the i-SIM centre on the Phantom arms (mandatory practice time)

Supervised insertions				
General	• 10 supervised successful attempts to obtain certification			
Technical aspects	• Poor ultrasound image quality made tip visualization difficult (poor contrast, only black and white) • Sometimes used doctors' personal ultrasound machine which has better image quality		The quality of the current available ultrasound machine available on the unit is poorer than the one used in training (low clarity of image)	• Special IVs for ultrasound: Catheters with tips specifically for ultrasound for better visualization • Include nurse rep from ultrasound company as potential supervisor who understands how ultrasound machine works
Procedural aspects	• Position: ○ Supine patient position was best ○ Stretcher best, not chair. Placement of material, positioning of the ultrasound machine in front so no need to turn head. • Patient cooperation: ○ Always ethically difficult to use patients as practice, especially when it takes longer on low A-DIVA score patients ○ Most patients were cooperative and consented • Patient clinical characteristics: ○ Characteristics of patients with difficult access: BMI, sepsis, hypotensive veins hard to visualize, scar tissue in high A-DIVA patients, fluid retention	• Patients were generally cooperative and understood it was necessary; for low A-DIVA score patients, they were a little nervous • Chose patients who were stable and able to consent • Having a confident inserter helped ease anxiety		
Systemic aspects			• Not enough eligible patients to practice on in a day	• Need sufficient time outside work shifts allotted for practical experience

			• Finding time to practice and synchronize schedules with the supervisor: one nurse was able to complete only 5 insertions over 15 months	• Liberating nurses' time to do insertions or scheduling blocks outside of regular shifts
Supervision	Supervision and coaching were excellent	Expert instructors and their ability to troubleshoot difficulties	Sometimes felt like they would be imposing on the supervisors' time and regular workload, which made them feel rushed	
Protocol		• No changes needed to protocol; it was clear • Nurses took time to explain procedure and get patient consent		
Safety issues	• Nothing specific; just being careful to differentiate between a vein and an artery during insertion			
	•			
Nurse self-assessment				
Benefits on efficiency & workflow	• Agreed that successful use of this technique could: ○ Reduce delays to pain control, medications etc. since patients wouldn't have to wait for interventional radiology to insert a PICC line, which in turn would reduce wait times and length of stay; ○ Benefit patients who would get faster pain relief			
Confidence level with insertions	Varied based on prior experience: one very confident while the other felt they needed more practice			
Motivation to learn	Nurses are very motivated but systemic factors, such as finding time, finding an available supervisor, finding an empty room etc., are challenging			
Confidence to teach	Varied based on experience; one ready to teach while the other wasn't			

APPENDIX

APPENDIX A: INTERVIEW QUESTIONS

Objective of the interview

- To better understand nurses' experience with training and use of USGPIVC during the pilot program
- Explore challenges encountered and opportunities for improving the training program

Scope of the interview

- Focussed on the pilot program that took place between June 2023 and January 2024 and included questions on the training received and experience using USGPIVC.

Section 1: Demographic and previous experience

QUESTIONS

- How long have you been working as a nurse? … (years)
- Did you have any previous experience using USGPIV prior to the pilot? (Yes/No)
    - If YES, please answer the following
    - Do you know what U/S machine you used?
    - If it was different from what you were using in the pilot, was it easier or more difficult to work with?
- How many insertions did you attempt? (approximate number)
- How many successful insertions did you have? (approximate %)
- On which patients did you use the USGPIV?
    - Children (yes/no)
    - Adult (yes/no)
    - Pregnant (yes/no)
    - ICU (yes/no)

Section 2: Training

THE FOLLOWING QUESTIONS RELATE TO TRAINING RECEIVED FOR THE LATEST PILOT PROGRAM AT THE MUHC.

QUESTIONS

- Did you get any training on how to use the device before (yes/no)? If YES, please answer the following
    - How long did it last? (weeks)

- How long did each session last? (hours)
- What did the training consist of? (procedure description)

Theoretical part of the training:

- What topics covered in the theoretical training did you find most helpful?
- Are there any areas of the theoretical training that you think need improvement or further clarification?

For the non-theoretical part:

- What apparatus did you use for the training? (e.g. dummies, U/S machine type)
- Did you practise on patients with varying DIVA scores? (yes/no)
- How many successful insertions did you get in the training? (number)
- At the end of the training, did you feel adequately trained to use the U/S machine? (yes/no)
- What were the biggest strengths of the training?
- What were the biggest weaknesses of the training?
- What do you think you didn't learn in the training?
- Are there any specific elements you think should be added to the training procedure?
- Are there any aspects of training that should be emphasised?
- What aspects of the theory training did you find most challenging?
- Now that the pilot study has been completed, in hindsight, how often should the training have been? (hours/sessions)

Section 3: Experience with supervised insertions

THE FOLLOWING QUESTIONS RELATE TO YOUR EXPERIENCE WITH SUPERVISED INSERTIONS.

QUESTIONS

- What were the challenges for insertion?
  - Technical challenges:
    - What was your experience with finding the tip of the needle?
    - What was your experience with maintaining the 90-degree angle?
    - How did you typically resolve the above challenges?
  - Procedural challenges:
    - What was your experience with patient position (supine/sitting/other)?
    - What was your experience with patients' cooperation (was it important for a successful insertion)?
    - What were patients' clinical characteristics that impacted successful insertion?

        - What are your thoughts on the quality and ease of use of the ultrasound equipment you used?
        - Others, please elaborate…
- What were important factors to have successful insertion
    - Protocol
        - Were there any steps that were unclear or difficult to follow? (yes/no, if yes which ones?)
        - Was there anything lacking from the protocol that should be added? (yes/no, if yes please elaborate)
        - Was there anything from the protocol that should be emphasized? (yes/no, if yes please elaborate)
        - Were there any situations where you had to adapt or modify the protocol? (yes/no, if yes please elaborate)
        - The pilot protocol didn't include explaining steps to the patient. Do you think this should be added because the patient being prepared and less scared could help? (yes/no, if yes please elaborate)
    - Patient cooperation
        - How do patients typically respond to ultrasound guided IV insertion? Are they anxious?
        - How do you communicate the process and its benefits to patients?
        - Besides explaining the steps to the patient, what other measures could improve patient comfort and reduce anxiety?
- Supervision
    - On a scale from 0 to 10, what was the quality of the supervision?
- Others, please elaborate…
- Are there specific safety concerns you have with this technique?

Section 4: Nurse self-assessment

QUESTIONS

- Do you think regular use of USGPIV will have an impact on your workflow and efficiency?
- On a scale from 0 to 10, how confident are you to use USGPIV?
- On a scale from 0 to 10, how motivated are you to learn/ask for help?
- On a scale from 0 to 10, how confident are you to teach your USGPIV skills to other people
- Are there any best practices or tips you've developed that you would like to share?

REFERENCES

1. Zingg W, Pittet D. Peripheral venous catheters: an under-evaluated problem. Int J Antimicrob Agents. 2009;34 Suppl 4:S38-42.

2. Jacobson AF, Winslow EH. Variables influencing intravenous catheter insertion difficulty and failure: an analysis of 339 intravenous catheter insertions. Heart Lung. 2005;34(5):345-59.

3. Fields JM, Piela NE, Au AK, Ku BS. Risk factors associated with difficult venous access in adult ED patients. Am J Emerg Med. 2014;32(10):1179-82.

4. Joing S, Strote S, Caroon L, Wall C, Hess J, Roline C, et al. Ultrasound-Guided Peripheral IV Placement. N Engl J Med 2012;366(25):e38.

5. Gottlieb M, Sundaram T, Holladay D, Nakitende D. Ultrasound-Guided Peripheral Intravenous Line Placement: A Narrative Review of Evidence-based Best Practices. West J Emerg Med. 2017;18(6):1047-54.

6. McGee DC, Gould MK. Preventing complications of central venous catheterization. N Engl J Med. 2003;348(12):1123-33.

7. van Loon FHJ, van Hooff LWE, de Boer HD, Koopman S, Buise MP, Korsten HHM, et al. The Modified A-DIVA Scale as a Predictive Tool for Prospective Identification of Adult Patients at Risk of a Difficult Intravenous Access: A Multicenter Validation Study. J Clin Med. 2019;8(2).

8. Au A, MJ Rotte, RJ Grzybowski, BS K, JM F. Decrease in central venous catheter placement due to use of ultrasound guidance for peripheral intravenous catheters. Am J Emerg Med. 2012;30(9):1950-4.

9. Edwards C, Jones J. Development and Implementation of an Ultrasound-Guided Peripheral Intravenous Catheter Program for Emergency Nurses. J Emerg Nurs. 2018;44(1):33-6.

10. Khurt S. Kirkpatrick Model: Four Levels of Learning Evaluation: Educational Technology Network; 2018 [Available from: https://educationaltechnology.net/kirkpatrick-model-four-levels-learning-evaluation/.

11. Anderson AP, Taroc AM, Wang X, Beardsley E, Solari P, Klein EJ. Ultrasound guided peripheral IV placement: An observational study of the learning curve in pediatric patients. J Vasc Access. 2022;23(2):250-6.

12. Mark J. Ault RT, Bradley T. Rosen,. Peripheral Intravenous Access Using Ultrasound Guidance: Defining the Learning Curve. J Assoc Vasc. 2015;20(1):32–6.

13. Hoskins MJ, Nolan BC, Evans KL, Phillips B. Educating health professionals in ultrasound guided peripheral intravenous cannulation: A systematic review of teaching methods, competence assessment, and patient outcomes. Medicine (Baltimore). 2023;102(16):e33624.