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IN THIS ISSUE / DANS CE NUMÉRO :

Innovative approaches to teaching vascular access to nursing students in the COVID-19 era

Approches novatrices en matière d'enseignement de l'accès vasculaire aux étudiants en sciences infirmières dans l'ère de la COVID-19

Maximising the opportunity of a self-administration outpatient parenteral antimicrobial therapy pathway

Optimisation de la possibilité de l'auto-administration de traitements antimicrobiens parentéraux ambulatoires

Pushing for change: Meeting the learning needs of novice nurses for IV chemotherapy push

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Innovative approaches to teaching vascular access to nursing students in the COVID-19 era

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Approches novatrices en matière d'enseignement de l'accès vasculaire aux étudiants en sciences infirmières dans l'ère de la COVID-19

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Abstract

Purpose: For the student nurse, peripheral venous cannulation is one of the most stressful skills to be learned. Although some healthcare employers/establishments offer courses on vascular access and infusion nursing as part of their onboarding programs, ultimately educational institutions should share the responsibility to ensure that graduating nurses can provide safe infusion therapies.

Methods: An innovative vascular access and infusion nursing (VAIN) curriculum was created and mapped onto the entry-to-practice undergraduate nursing program at McGill University in Montréal, Québec, Canada. This presented an opportunity to implement new teaching approaches.

Results: Students experienced multiple new teaching approaches including multimedia and experiential learning and live simulation to ensure acquisition of knowledge and psychomotor skills. The teaching approaches had to be rapidly modified with the advent of the COVID-19 pandemic.

Conclusions: The VAIN curriculum emphasizes simulation and directed practice, seeking to increase competence, confidence, and knowledge. The pandemic underscored the need for flexibility and creativity in content delivery.

Résumé

But : Pour les étudiants en sciences infirmières, la canulation veineuse périphérique est l'une des techniques les plus stressantes à apprendre. Même si certains établissements de soins et employeurs du secteur de la santé offrent des cours sur l'accès vasculaire et la perfusion dans le cadre de leurs programmes d'intégration en sciences infirmières, les établissements d'enseignement devraient partager la responsabilité de s'assurer que les diplômés en sciences infirmières sont en mesure d'effectuer des perfusions en toute sécurité.

Méthodologie : Un curriculum novateur en accès vasculaire et perfusion (AVP) a été créé et intégré au programme de formation en sciences infirmières de premier cycle de l'Université McGill à Montréal, Québec, Canada. Ce fut donc l'occasion de mettre en œuvre de nouvelles approches pédagogiques.

Résultats : Les étudiants ont expérimenté plusieurs nouvelles approches d'enseignement comme l'apprentissage multimédia et expérientiel et les simulations réelles afin d'acquérir les connaissances et techniques psychomotrices nécessaires. Les approches d'enseignement ont dû être modifiées rapidement avec l'arrivée de la pandémie de COVID-19.

Conclusions : *Le curriculum en AVP met l'accent sur la simulation et la mise en pratique dirigée dans le but d'accroître les compétences, la confiance et les connaissances. La pandémie a fait ressortir la nécessité de présenter le contenu avec souplesse et créativité.*

Background

Canadian undergraduate nursing education programs are designed to prepare nurses for entry to practice. These education programs aim to reflect excellence and achieve clear educational outcomes, all aligned with provincial regulatory and national accrediting bodies (Canadian Association of Schools of Nursing [CASN], 2014). While nursing programs in Canada are accredited based on a standardized framework established by CASN, school curricula are not uniform across the country (CASN, 2014). With respect to the body of knowledge and competencies surrounding vascular access and infusion nursing (VAIN) in particular, neither national nor provincial standards clearly define the requisite educational preparation for entry to practice. Rather, it is the responsibility of the educational institution to ensure that their graduates are competent in this domain of nursing.

However, VAIN content is often scattered inconsistently in undergraduate programs and sometimes overlooked. This oversight highlights a significant educational need. More than one study has shown that structured VAIN education is often not included in pre-licensure university programs (Alexandrou et al., 2012; Hunter et al., 2018). In fact, when surveyed, many registered nurses reported that they had not been taught how to insert a peripheral intravenous (PIV) catheter in nursing school and relied on in-service training, if available, and practice opportunities with unsuspecting patients (Aloush, 2018; Engum et al., 2003; Vizcarra et al., 2014). Unfortunately, inadequately trained nurses may contribute to intravenous catheter-related complications (Hunter et al., 2018; Keleekai et al., 2016; Raynak et al., 2020). Outcomes of failed PIV catheterizations or PIV-associated complications include pain, patient dissatisfaction, increased length of stay, prolongation of care, venous depletion, and the need to treat minor or more severe complications (Romeo et al., 2020). Conversely, nurses who have the proper skills in vascular access device insertion, maintenance, and post-insertion care can significantly and positively impact outcomes such as patient satisfaction,

healthcare costs, and length of stay (Dychter et al., 2012; Vizcarra et al., 2014; Woody & Davis, 2013).

A recent scoping review of the literature examining the state of nurses' knowledge around routine care and maintenance of adult vascular access devices (VADs) revealed significant gaps in nurses' knowledge of the care and maintenance of adult VADs (Raynak et al., 2020). This review supported the contention that a comprehensive approach to teaching is lacking and that further training and improvement in the educational preparation of nurses is required (Raynak et al., 2020). It is imperative that novice nurses learn the theory and skills involved in VAIN before entering practice. Moreover, the Infusion Nurses' Society states, "It is strongly recommended that the insertion, care, and maintenance of SPCs (short peripheral catheters) is implemented as a standardized curriculum in all undergraduate nursing programs to provide novice nurses with basic knowledge/skills, as they join the nursing workforce" (Vizcarra et al., 2014, p. 124).

To address this need, nursing faculty at the Ingram School of Nursing at McGill University engaged in a curriculum revision and developed a formal VAIN curriculum for the baccalaureate entry-to-practice program. This paper describes the educational strategies favoured as the VAIN curriculum was integrated into the 3-year and 4-year programs in 2017 and adapted in the context of the COVID-19 pandemic. The goal of the curriculum change was to ensure that graduating students were able to confidently provide safe and competent infusion therapy. With the advent of the COVID-19 pandemic, and the transition to remote learning, teaching strategies had to be adapted rapidly.

The BScN VAIN Curriculum Revision

The Ingram School of Nursing at McGill University has approximately 400 students in the BScN program, which is an entry-to-practice undergraduate program. Previously, the teaching of VAIN was piecemeal, with content spread throughout the three-year program, interspersed in various courses. For example, PIV insertion and removal were taught in an ad hoc fashion in laboratory sessions immediately prior to clinical placements, so called "just-in-time" learning. Fluid and electrolyte balance were addressed in a course on illness management. Consistent with what has been reported in the literature, there was a lack of comprehensive oversight of the VAIN curriculum. There was no clear understanding

by faculty of all the competencies required for an entry-to-practice graduate. There was the possibility that over the years, students missed key concepts and practice opportunities. Anecdotally, some graduates (including two of the authors) reported feeling underprepared in relation to VAIN when they began their first nursing roles.

The nursing school undertook a major curricular revision in 2017. This revision represented an opportunity to implement a comprehensive VAIN curriculum and introduce novel teaching strategies. The goal of the VAIN curriculum is that BScN students acquire the knowledge, competence, and confidence to integrate evidence-informed VAIN practices in the exercise of their professional practice. The specific content mapped onto the curriculum is presented in detail in a previous publication (Marchionni et al., 2018).

VAIN Curriculum Framework

There are no national nor provincial Canadian standards defining VAIN competencies required at entry to practice, nor did the authors locate examples of curricula in the nursing education literature. The Intravenous Nurses Society (now the Infusion Nurses Society [INS]) described the foundation of the infusion nurse's practice over twenty years ago. These competencies still apply for the novice nurse and appear in Table 1. (INS, 2000, pg. S7). Thus, the curriculum was informed by these foundational competencies.

For the nurse to develop infusion therapy competencies, including accountability, reliability, initiative, sound judgement, and technical skills, nurses should master VAIN theoretical knowledge before practising infusion therapy (Vizcarra et al., 2014). A comprehensive curriculum with strong theoretical and practical components provides novice nurses with the requisite foundational knowledge and skills before they enter clinical rotations and then join the nursing workforce (Vizcarra et al., 2014). The curriculum was thus created to reflect the INS Standards of Practice (Gorski et al., 2016).

VAIN Curriculum Design Process

After reviewing the literature, and guided by the INS Standards, a list of essential VAIN-related topics was developed in collaboration with a subject matter expert. This content expert is a nurse in advanced practice in vascular access and infusion nursing at the McGill University Health Centre, an affiliated tertiary care university hospital. She is a Canadian expert in VAIN, with multiple international publications. Given the holistic and complex nature of VAIN, it was determined that the content should be scaffolded throughout the revised undergraduate program, building on student competencies as they progressed from one year to the next (Blazek & Zewe, 2013). The content was mapped, and assigned to specific courses, with support and additional resources provided to professors and laboratory educators (see Marchionni et al., 2018). Multiple teaching methods were employed to meet the needs of this cohort of multimodal learners. It is expected that students completing the new VAIN curriculum will demonstrate measurably increased competence, confidence, and knowledge, compared to students who did not experience the new pedagogy. A quality improvement study was initiated to assess these outcomes.

Psychomotor Skill Acquisition Specific to VAIN

The development of psychomotor skills, organized patterns of muscular activities, such as inserting an intravenous line or intravenous tubing management, in pre-licensure nursing programs requires learning opportunities that allow for frequent, repetitive practice (DeBourgh, 2011). The repeated rehearsal of such skills promotes both knowledge retention and procedural competence (DeBourgh, 2011). Conversely, the massing of practice over a short period of time, sometimes referred to as 'cramming', produces poorer long-term learning outcomes (Kang, 2016; Kapler et al., 2015). Consequently, implementing curriculum objectives

Table 1. Infusion Nursing Standards of Practice Framework

1	Knowledge of anatomy and physiology
2	Specific knowledge and understanding of the vascular system and its relationship to other body systems and infusion treatment modalities
3	Participation in the establishment of the patient's ongoing plan of care
4	Skills necessary for the administration of infusion therapies
5	Knowledge of the state-of-the-art technologies associated with infusion therapies
6	Knowledge of psychosocial aspects of care, including a sensitivity to patient's wholeness, uniqueness and significant social relationships, along with knowledge of community and economic resources
7	Interaction and collaboration with members of the healthcare team and participation in the clinical decision-making process

with linear, long-term learning allows for easier complex skill acquisition. By reducing cognitive load, students are able to solidify their mastery of individual skills prior to consolidation and demonstration of more complex skills, resulting in a more effective learning experience (Gonzalez & Kardong-Edgren, 2017; Johnson et al., 2020). Through deliberate practice – a purposeful, continuous method of learning – students gain valuable practical experiences and, markedly increase their confidence in skill performance (Gonzalez & Kardong-Edgren, 2017; Owen et al., 2017). The revised VAIN curriculum utilizes scaffolded learning and deliberate practice in combination with hybrid teaching methods to promote skill retention (Marchionni et al., 2018).

Best Practices for Teaching Vascular Access and Infusion Nursing

When designing the curriculum, consideration was given to best practices in nursing education. Vascular access and infusion nursing require nurses to have both specific knowledge and psychomotor skills to provide safe patient care (Ravik, 2019). The acquisition of psychomotor skills (the so-called “doing”) is complex and benefits from deliberate practice and opportunities to practice skills throughout curricula in the form of simulations, practice sessions and skills refreshers (Oermann et al., 2015). Given the complexity of this domain of nursing, the curriculum revision incorporated best practices in 21st century nursing education for our cohort of multigenerational and multimodal learners. The integration of multiple teaching strategies improves student self-confidence. Smith et al. (2013) showed that a combination of approaches is related to higher levels of student satisfaction and teaching effectiveness as measured through pretest and posttest evaluations.

The VAIN curriculum, encompassing multiple teaching strategies including self-paced knowledge acquisition through multimedia learning, experiential learning environments, and simulation-based teaching to practise invasive procedural skills (Bloomfield & Jones, 2013; Glover et al., 2017; Paquet & Marchionni, 2015; Powell et al., 2019), was developed to maximize learning outcomes. Multimedia learning, also known as e-learning, is an interactive, computer-based method of knowledge transfer used to deliver specific content (Bloomfield & Jones, 2013; Paquet & Marchionni, 2015). One of the many features of

e-learning is modular learning. Learners complete online modules that provide opportunities for realistic practice and immediate guidance and feedback (Paquet & Marchionni, 2015). To address the need for improvement in PIV care, VAIN e-learning modules were created to meet the learning needs of nurses working in a tertiary care university health centre. Described as an innovative way to promote learning, it is an alternative to traditional didactic in-service sessions or “brown-bag lunch and learn” (Paquet & Marchionni, 2015). Another form of e-learning is video learning where the learner views content through video instruction. Multiple studies evaluating the effectiveness of video learning have shown this method to be superior to didactic teaching methods in performance outcomes, student confidence, and satisfaction (Coyne et al., 2018; Forbes et al., 2016; Herron et al., 2019; Paquet & Marchionni, 2015).

Like e-learning, experiential learning is an active learning approach that promotes critical thinking, application, and analysis amongst student nurses through hands-on practice and reflection (Hill, 2017; Murray, 2018). With a mixed population of adolescent and adult learners, the inclusion of experiential learning in the hybrid curricula provides the opportunity for adult learners to pull from prior knowledge and clinical experiences to further their understanding of newly presented content (Kuk & Holst, 2018; Murray, 2018). Consistent with the scaffolding approach to skill acquisition, students in the revised curriculum built upon their skill base throughout their undergraduate degree. For example, rather than having a one-time course on PIV insertion and care, students were first taught how to assess peripheral vasculature and select an appropriate intravenous insertion site in the course on health and physical assessment. In a subsequent clinical skills course, they integrated this knowledge when they learned to insert a PIV into IV trainer arms and high-fidelity mannequins, justifying their rationale based on previously acquired knowledge of peripheral vasculature. Experiential learning is an effective method for enhancing knowledge and skills, amongst nursing students (Fenske et al., 2015).

In keeping with the other teaching methods employed in the hybrid curricula, in-person simulation is designed to encourage active participation in the learning process for students to build knowledge, explore possibilities, and develop psychomotor skills (Yuan et al., 2012). For VAIN, ‘hands-on learning’ or traditional face-to-face training involved both laboratory simulation of

invasive procedures with IV trainer arms and high-fidelity mannequins and standardized patient actors. Standardized patients, professional actors who simulated being a patient undergoing a PIV insertion, allowed students to practice both the psychomotor and psychosocial skills required of this procedure. In laboratory courses, students were exposed to PIVs and central vascular access devices, giving them the opportunity to practise insertion and management techniques while communicating with the patient and explaining each step of the skill. Simulation is effective in the enhancement of nursing student self-confidence, knowledge retention, critical thinking, improved satisfaction with learning, and improved self-efficacy (Keleekai, et al. 2016; Labrague et al., 2019; Padilha et al., 2019). In addition, it has been shown that students involved in simulation education experience a major reduction in skill-linked anxiety and improvement in psychomotor skills (Labrague et al., 2019; Korhan et al., 2018). Students were encouraged to self-assess their own competencies when approaching patients with difficult venous access. A combination of these multimodal approaches was adopted in the VAIN curriculum to maximize student engagement and learning.

VAIN Education in the Context of a Pandemic

In March 2020, the COVID-19 pandemic changed the face of nursing education. The carefully curated VAIN curriculum was put on hold, in favour of just-in-time learning steeped with creativity. On campus, teaching ended March 13, 2020 with little turnaround time to prepare for remote delivery of courses via Zoom. With multiple weeks of the winter semester left and an entire summer semester to re-plan, educational priorities and approaches changed.

Depending on the nursing course, didactic content was delivered remotely via pre-recorded lectures and live Zoom sessions. Classes such as pathophysiology and illness management continued. All clinical practicums ended immediately and replacement activities, in the form of online modules and virtual simulation, were instituted. Students were immersed in emerging evidence regarding COVID-19 in courses such as pathophysiology. The hands-on laboratory component proved to be more of a challenge. Students in laboratory courses are given kits of practice materials including the materials required for PIV insertions and blood taking. Since the school was closed, these kits were delivered to student homes by teaching staff or sent via courier. Once the students received their lab

kits, they were required to continue their practice at home. Many practised on siblings (without the actual insertion of the PIV) or repurposed their siblings' stuffed animals. For assessment, students uploaded a video of themselves completing the skill. This replaced the Objective Structured Clinical Examination (OSCE) with a standardized patient.

Since Fall 2020, nursing students have been allowed to attend the nursing laboratory in school while wearing a mask, ocular protection, and scrubs. Social distancing is in effect and students are screened for symptoms and exposures prior to entering the building. Students remain in learning bubbles, limiting social interactions. The laboratory course is now conducted intensively over a few weeks to prepare them for entry into the clinical settings. While in the past clinical placements occurred twice a week to allow for scaffolded learning, students had two or three-week intensive placements to limit the cohorts in the hospital units. Placements were limited to non-COVID-19 units and students were removed from clinical settings during outbreaks. They did not perform aerosol generating medical procedures as per education ministry directives, but they did engage in all aspects of VAIN, including the initiation and administration of intravenous infusions and medications, where appropriate. All activities of the Vascular Access Student Club were conducted by Zoom, severely limiting extracurricular learning opportunities. While these changes represented a significant deviation from the original VAIN planning, it is hoped that this pandemic adaptation will still allow students the opportunities to acquire the requisite skills and knowledge for safe practice. We are hopeful that no more stuffed animals will be subjected to PIV insertion!

Implications for Nursing Education

This paper highlights the need for a systematic approach to teaching VAIN in entry-to-practice baccalaureate programs. A simple, one-off course on PIV insertion is no longer adequate given both the complexities of VAD technology and the older patient populations. As such, this paper can serve as a roadmap for other nursing education programs that seek to remediate their own gaps in their curricula. VAIN competencies require dedicated teaching attention and consistent instruction to improve student competence, confidence, and knowledge. With a plethora of subjects in the domain of vascular access and infusion nursing, subject selection and depth of content must be curated carefully. Other undergraduate nursing programs should consider

incorporating the following subjects to reflect both the *INS Standards of Practice* (INS, 2000) and the Canadian Vascular Access Association's (CVAA's) *Canadian Vascular Access and Infusion Therapy Guidelines* (CVAA, 2019).

- Include VAIN anatomy and physiology, with an overview of the vascular system, as a starting point prior to skills development.
- Provide step-by-step demonstration of proper device insertion in both a simulated environment and an e-learning environment (instructional videos).
- Explore catheter-associated failures and complications and their impacts on patient and health system outcomes.
- Utilize fidelity mannequins (low to high) in laboratory sessions and practise with up-to-date equipment that is available in local healthcare establishments.
- Provide multiple opportunities throughout the undergraduate program for students to practise and make clinical decisions regarding device care, complications and infusion administration using simulated and real clinical scenarios.
- Refrain from waiting until graduation for students to manage patients undergoing infusion therapy. Students should be encouraged to perform appropriate aspects of VAIN with supervision in clinical settings.

Conclusion

This article highlights the importance of systematically including VAIN knowledge and skills in undergraduate nursing programs. The integration of VAIN competencies in undergraduate curricula is essential so that graduates can provide safe and effective care to patients. A structured curriculum is imperative to ensure that content is, indeed, included and required rather than absent or optional. The COVID-19 pandemic highlighted the need for flexibility and creativity in the delivery of nursing education. When less than ideal teaching circumstances presented, a re-assessment of the “must have” elements of the VAIN curriculum allowed students to develop or maintain acquired skills. Further modification to the curriculum will occur once data obtained from students is analyzed to determine if there was sustained improvement in knowledge, self-confidence, and competence, over time. As the pandemic evolves, it is likely that further modifications to the curriculum delivery will occur.

About the authors

Caroline Marchionni, RN, MScAdmin, MScA, Assistant Professor, completed the Direct Entry Masters in Nursing program in 2006 at McGill University after obtaining a Masters in Administration (Management specialization) from Concordia. After graduation, Caroline worked in neurosurgery and then became a Knowledge Broker at the McGill University Health Centre in the Transition Support Office. She has been involved in teaching at the undergraduate level since 2007 at McGill University's Ingram School of Nursing before taking on a full-time position in 2016. She maintains a part-time clinical practice in radiation oncology and palliative care. Areas of interest include knowledge transfer, vascular access education, suicide prevention and oncology.

Madolyn Connolly, RN, BScN, completed her degree at McGill University in 2020. She served as one of the first executive members of the Vascular Access Student Club (VASC) at McGill University. Madolyn has worked as a research assistant at McGill University and St. Mary's Research Centre. She is currently working as a RN at Maine Medical Center in Portland, Maine in an orthopedic, neurology, neurosurgical and trauma unit.

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