

A Brief Multimodal Simulation Bundle for Peripheral Intravenous Catheter Competency: A Practical Educational Innovation for Infusion Nursing

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ABSTRACT

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Peripheral intravenous catheter (PIVC) insertion and management are fundamental nursing responsibilities that require psychomotor skill, clinical judgment, communication, and timely recognition of complications. Although simulation is increasingly used in nursing education, competency development may be strengthened when different learning modalities are deliberately combined rather than used in isolation. This article proposes a brief, multimodal simulation bundle for PIVC competency that integrates task-trainer practice, scenario-based learning, optional peer role-play, virtual or branching clinical cases, structured feedback, and competency verification. The proposed model is informed by existing evidence supporting simulation and blended learning in PIVC and nursing education; however, the complete bundle has not been evaluated as a single intervention. The approach is designed to be resource-conscious and adaptable to orientation, continuing education, and competency programs. It offers infusion nurse educators a practical framework for connecting technical skills with clinical reasoning and patient-centered communication while maintaining alignment with current infusion therapy standards.

Keywords:

Peripheral intravenous catheter, Pivc, Simulation, Infusion nursing, Clinical competency, Educational innovation

Introduction

Peripheral intravenous catheter insertion and management are among the most common technical responsibilities encountered in nursing practice. Competent PIVC care extends beyond successful catheter insertion. Nurses must select and assess the site appropriately, maintain the device, administer therapy safely, identify complications, communicate with patients, and determine when escalation or device removal is required. The Infusion Therapy Standards of Practice, 9th Edition provide an evidence-based framework for infusion and vascular access practice and emphasize the importance of competency in safe infusion care.^[1]

Clinical experience alone should not be assumed to guarantee competency. In a simulated assessment of licensed practical nurses with several years of reported PIVC experience, de Souza and colleagues identified gaps in performance across components of PIVC insertion, highlighting the potential value of continuing competency assessment and education.^[2] Similarly, Jacobs demonstrated that a blended program incorporating online learning and live simulation could be used to support PIVC insertion confidence and competence among practicing medical-surgical nurses.^[3]

These findings suggest an opportunity for infusion nurse educators to move beyond education based predominantly on demon-

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stration, observation, or periodic skills validation. A brief multimodal simulation bundle may provide a practical method of bringing technical performance, clinical reasoning, communication, and feedback into the same educational experience.

Why a Multimodal Approach?

Simulation-based education allows learners to practice skills and respond to clinical situations without exposing patients to unnecessary risk. PIVC-specific educational programs have combined e-learning, deliberate practice, and simulation to address gaps in continuing education for practicing nurses.^[4] Simulation-based learning has also been associated with improved vascular access skills among nursing students.^[5]

Evidence from broader nursing education provides additional support for scenario-based simulation. A systematic review and meta-analysis reported improvements in nursing students' knowledge, clinical practice skills, and self-confidence following scenario-based simulation, although heterogeneity among studies should be considered when applying these findings to specific clinical populations.^[6]

Technology can add another dimension. In PIVC education, virtual simulation has been compared with video-assisted instruction, with evidence suggesting potential benefit for psychomotor skill development.^[7] Virtual learning should not, however, be regarded as a replacement for hands-on practice. Rather, it can provide an additional opportunity for learners to rehearse clinical decisions, particularly when access to simulation laboratories, faculty, or equipment is limited.

Importantly, much of the simulation literature involves undergraduate nursing students. Evidence should therefore be extrapolated cautiously to experienced nurses and infusion specialists. The rationale for a multimodal PIVC bundle is not that every component has been independently demonstrated to improve clinical outcomes in practicing infusion nurses, but that complementary educational strategies may address different dimensions of competency.

The Proposed Multimodal PIVC Simulation Bundle

The proposed bundle combines several brief educational activities around a common PIVC scenario. It is intended as a flexible framework rather than a prescriptive curriculum.

The complete bundle represents a proposed educational model; it should not be interpreted as an intervention whose effectiveness has already been established. (Table 1)

Table 1: Proposed components of a brief multimodal PIVC simulation bundle.

Component	Educational purpose	Proposed approach
Task-trainer practice	Psychomotor competency	Learner performs PIVC insertion and related procedures using a task trainer, with attention to evidence-based technique
Scenario-based simulation	Integration of skill and clinical judgment	Learner responds to a realistic PIVC situation requiring assessment and appropriate action
Peer role-play	Patient communication	Learner explains the procedure, responds to patient concerns, or communicates findings requiring escalation
Virtual or branching case	Clinical reasoning	Learner makes sequential decisions in a PIVC scenario and receives consequences or feedback based on choices
Structured debriefing and feedback	Reflection and correction	Educator facilitates focused discussion of performance, decisions, and opportunities for improvement
Competency verification	Demonstration of learning	Learner completes a structured checklist or competency assessment aligned with organizational policy and current standards

Task-Trainer Practice

The task trainer provides a controlled environment in which the learner can rehearse technical elements of PIVC insertion and management. The objective is not simply repeated cannulation but deliberate practice with feedback. Depending on the educational objective, practice may include site preparation, insertion, stabilization, dressing application, flushing, connection management, site assessment, and device removal.

Importantly, sophisticated equipment is not necessarily required for every learning objective. A systematic review examining manikin fidelity found that higher fidelity did not consistently produce superior outcomes across all educational measures, suggesting that educators should match simulation fidelity to the competency being taught rather than assume that greater technological complexity is always necessary.^[8] This supports a resource-conscious approach in which existing task trainers may remain useful when paired with well-designed scenarios and feedback.

Scenario-Based Learning

Technical performance can be placed within a short clinical scenario rather than taught as an isolated procedure. For example, the learner might encounter a patient whose PIVC site has become painful during an infusion. The learner must assess the device and patient, recognize abnormal findings, determine the appropriate immediate response, communicate with the patient, and escalate according to organizational policy.

Such scenarios shift the educational focus from “Can the nurse insert a catheter?” toward the broader question, “Can the nurse make safe decisions while caring for a patient with a PIVC?” This distinction is particularly relevant to infusion nursing, where ongoing assessment and device management are as important as insertion itself.

Peer Role-Play and Patient Communication

A brief role-play can incorporate communication into the simulation. One participant may assume the role of a patient who is anxious about insertion, reports discomfort at the catheter site, or asks why the catheter needs to be removed or replaced. The nurse must provide an understandable explanation while simultaneously demonstrating appropriate clinical judgment.

The evidence supporting role-play in this proposed bundle is more indirect than that supporting PIVC task training or simulation. It should therefore be viewed as a pragmatic strategy for rehearsing patient-centered communication rather than as a PIVC-specific intervention with independently demonstrated clinical effectiveness.

Virtual or Branching Clinical Cases

A virtual or branching case can extend the educational experience beyond the physical simulation laboratory. Learners may be presented with a sequence of findings and asked to choose an assessment or management action. Each choice leads to additional information and another decision.

This format is particularly suitable for complications and clinical situations that may be difficult to reproduce repeatedly in a physical simulation. It can also be completed individually before or after hands-on practice. Evidence comparing virtual simulation with other educational approaches in intravenous catheter education suggests that virtual methods can contribute to skill development, although they should complement rather than replace physical practice.^[7]

Debriefing and Competency Verification

Simulation is most useful when performance is followed by an opportunity to reflect on what occurred. Structured debriefing allows learners to identify why a particular decision was made, what went well, and what should

be changed in future practice. Evidence from nursing simulation supports the educational role of debriefing, although no single debriefing approach has been established as universally superior.^[9]

The session should conclude with competency verification appropriate to the learner’s role and institutional requirements. A checklist aligned with current infusion standards and organizational policies can be used to evaluate observable technical and decision-making behaviors. The purpose is not merely to document attendance but to establish that the learner can demonstrate the expected competency.

Implementing the Bundle in Infusion Nursing Education

The model can be incorporated into existing educational structures rather than requiring development of a separate simulation program. It may be adapted for new-nurse orientation, annual or periodic competency assessment, remediation, vascular access education, or continuing professional development.

Implementation can begin by identifying a small number of competencies that are clinically important within the organization. Educators can then construct one PIVC scenario that incorporates those competencies and use available task trainers, clinical equipment, and digital learning resources.

A practical sequence could include a brief prebrief, focused task-trainer practice, a clinical scenario or branching case, communication rehearsal when relevant, structured debriefing, and competency verification. The exact duration and configuration should be adapted to learner experience, institutional resources, and the educational objective.

The content should also remain consistent with the current *Infusion Therapy Standards of Practice* and local policies.^[4] As standards and organizational procedures change, the scenarios and competency checklists should be reviewed and updated accordingly.

Potential Benefits and Important Limitations

The primary educational advantage of the proposed bundle is its integration of multiple dimensions of PIVC competency. Task trainers address psychomotor performance; scenarios and branching cases encourage clinical reasoning; role-play provides an opportunity to rehearse communication; debriefing promotes reflection; and structured verification provides a mechanism for demonstrating competency.

The model is also intended to be resource-conscious. Existing simulation equipment and educational resources can be used, and not every institution requires high-fidelity technology to create a meaningful learning experience.

The emphasis is on purposeful instructional design rather than technological complexity.

Several limitations should be recognized. First, this exact multimodal bundle has not been evaluated as an integrated intervention. Evidence supporting individual components should not be interpreted as evidence that the complete bundle reduces PIVC complications or improves patient outcomes. Such outcomes would require prospective evaluation.

Second, a substantial portion of published simulation research has been conducted among nursing students rather than experienced infusion nurses. Although these findings provide an educational rationale, their applicability to practicing clinicians requires further evaluation.

Third, the strength of evidence varies among individual components. PIVC-specific evidence is available for simulation, blended education, and virtual approaches, whereas the rationale for peer role-play is more indirect. Finally, simulation should complement—not replace—supervised clinical experience, institutional competency requirements, and continuing assessment of actual practice.

Future evaluation of the proposed bundle could examine learner knowledge, observed competency, confidence, skill retention, and feasibility. More rigorous studies would be needed before associating the educational model with clinical outcomes such as insertion success or complication reduction.

Conclusion

Maintaining PIVC competency requires more than teaching a technical procedure. Nurses must integrate psychomotor skill with assessment, clinical reasoning, communication, and evidence-based decision-making. A brief multimodal simulation bundle offers a practical framework for bringing these competencies together.

By combining task-trainer practice, scenario-based learning, optional peer role-play, virtual or branching cases, structured debriefing, and competency verification, infusion nurse educators can create a learning experience that more closely reflects the complexity of clinical PIVC care. The proposed model is supported by evidence relating to its individual educational components but has not yet been validated as a complete intervention. It should therefore be considered a practical educational innovation for implementation and future evaluation, rather than an established method for improving clinical outcomes.

For infusion nursing education, its principal value lies in providing a flexible, resource-conscious framework that connects evidence, simulation, and competency assessment while remaining adaptable to local practice environments.

Declaration

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Conflict of interest

The available study record did not report any competing interests.

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