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Research Brief

# Simulation-Based Mastery Learning for Central Venous Line Dressing Changes

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## KEYWORDS

simulation-based  
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simulation mastery;  
nursing;  
central line  
maintenance;  
competency training;  
pediatric

## Abstract

**Background:** The aim of this study was to determine the effectiveness of simulation-based mastery learning (SBML) for competency training with pediatric cardiac intensive care (CVICU) nurses in central venous line (CVL) dressing changes.

**Sample:** Convenience sample of 20 CVICU nurses at a freestanding Midwestern pediatric hospital.

**Method:** Content experts developed curricula, created checklists and set a minimum passing score (MPS) for CVL dressing procedure. Participants were scored via direct observation by two trained raters and were tested before SBML intervention to measure pretest score. Debriefing was provided after attempts until mastery was achieved.

**Results:** None of the participants achieved MPS in the pretest. Common missteps include maintaining sterile protocol and masking the patient. MPS was achieved by 55% in the second attempt and 89% in the third attempt.

**Conclusion:** The SBML intervention was effective in achieving a predetermined mastery level in CVL dressing changes with pediatric CVICU nurses.

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A 2014 review of simulation-based mastery learning (SBML) suggests that this teaching approach is widely used in medical education for training students and providers in procedural skills (McGaghie, Issenberg, Barsuk, & Wayne, 2014). However, the evidence base on the use of SBML by

nurses is more limited (Barsuk et al., 2015; Gerolemou et al., 2014; Scholtz, Monachino, Nichisaki, Nadkarni, & Lengetti, 2013). Simulation is a training technique born from the aviation field and adopted by the medical field, facilitating skill acquisition without endangering patient safety (Gaba, 2004). Mastery learning theory was proposed by Bloom in 1971, outlining a strategy to incorporate feedback and corrective procedures into the learning process, allowing all learners to meet uniform standards with varying time (Bloom, 1971). In contrast to SBML, the

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traditional apprenticeship model of “see one, do one, teach one” may lead to uneven skill acquisition because it does not require a standard benchmark that all participants must meet before performing the skill on a patient (Barsuk et al., 2015).

### Key Points

- Simulation-based mastery learning (SBML) may lead to improved nurse performance on central line dressing changes.
- Self-rated confidence is not predictive of performance in central line dressing changes.
- SBML is underutilized in nursing education and more research is needed to determine its efficacy on improving nurse performance and patient outcomes.

SBML combines the idea of a safe learning environment with the ability to produce uniform outcomes across learners (Barsuk, Cohen, Wayne, Siddall, & McGaghie, 2016). This technique has been used extensively for procedural skill training in medical residents, leading to improved patient outcomes and improved knowledge of the resident (Griswold-Theodorson et al., 2015; McGaghie et al., 2014). Generalizability of these outcomes is limited to the medical profession as different content and logistical challenges arise in continuing education for nursing staff.

The premise of SBML is that any participant can achieve mastery when provided with adequate support, opportunity for repetitions, and time (McGaghie et al., 2014). SBML provides the participant with an individualized amount of simulation sessions. The participant is silently observed by the educator while performing a task, and then feedback and debriefing are provided after each simulation attempt is completed. The participant repeats simulation and feedback cycles, with opportunities for deliberate practice, until mastery level (designated by a minimum passing score [MPS]) is achieved (Barsuk et al., 2016).

Central line-associated bloodstream infection (CLABSI) reduction is an opportune target for the application of SBML. Reducing CLABSI is a national focus, with a 58% reduction in intensive care unit patients in the United States between 2001 and 2009 attributing to increased adherence to best practices and practice bundles for insertion and maintenance care (Srinivasan et al., 2011). Practice bundles or care bundles are a collection of evidence-based guidelines outlining the care of patients with central venous lines (CVLs). CLABSIs continue to occur in approximately 41,000 inpatients each year in the United States with a mean attributable cost per pediatric patient of \$55,646 (Goudie, Dynan, Brady, & Rettiganti, 2014; Srinivasan et al., 2011). Further reductions in hospital-acquired infections are necessary because of the high mortality rate, which is currently estimated at 12 to

25% by the CDC (Srinivasan et al., 2011). The use of SBML among residents and nurses using CVL-insertion bundles and maintenance bundles has led to increased compliance rates and infection rate decreases (Barsuk, Cohen, Feinglass, McGaghie, & Wayne, 2009; Barsuk et al., 2015; Gerole mou et al., 2014; Scholtz et al., 2013).

The aim of this study was to determine the effectiveness of SBML for competency training of pediatric cardiovascular intensive care unit (CVICU) nurses in CVL dressing changes.

## Sample

A convenience sample of 20 CVICU nurses at a free-standing Midwestern pediatric hospital was recruited from both night and day shifts in September 2016. Participants were diverse in experience (0-1 years to over 16 years as a nurse), in years of experience as a critical care nurse (0-1 years to over 16 years), and highest degree obtained (Associate to Master's degree). Inclusion criteria consisted of being employed as a CVICU nurse and completion of institutional and unit-based orientation. Unit-based orientation includes the use of an apprenticeship model for central line maintenance skills education. Agency/travel nurses or critical care float team nurses were excluded due to variation in their orientation training compared with CVICU staff nurses. None of the participants had experienced SBML during prior education. The CVICU holds monthly simulation sessions, which participants are welcome to attend but not compulsory.

## Methods

We used a pre-post test design in which participants completed a pretest and subsequent posttests until demonstrating mastery. The organization's institutional review board approved the study. Verbal consent was obtained from all participants. An assessment tool was developed by content experts, including clinical nurse specialists, infection prevention and control, quality and safety, and clinical educators. Institutional policy, based on the Center for Disease Control and Prevention (CDC) recommendations for central line maintenance, was used in development of the central line dressing change—assessment tool development. The assessment tool was piloted by multiple clinical educators and content experts before beginning the study. An MPS of 100% was set by the study's content experts to match organization expectations of compliance with institutional policy and procedures. The study team and content experts created a rater handbook for the assessment tool to promote interrater agreement on each step. Cohen's kappa was 1.0 for interrater reliability between the two raters. Clinical educators involved in the study completed a 2-hour

training session that included review of the rater handbook and practice using the assessment tool.

Participants completed a pretest questionnaire to report demographic characteristics and perceived barriers to completing a CVL dressing change. Using a Likert scale, each participant rated their confidence in completing the dressing change. The pretest questionnaire also gathered information on perceived barriers to completing a CVL dressing change in the CVICU.

Immediately after the questionnaire completion, each participant entered the simulation laboratory where two educators led the simulation and a third educator served as a confederate available to assist the participant with the dressing change if requested. Consistent with the 2016 International Nursing Association for Clinical Simulation and Learning guidelines for simulation, a prebriefing script was read by the same educator (Christine Willett) to each participant, providing an orientation to the simulation environment, manikin, and the available equipment (INACSL Standards Committee, 2016).

The first attempt, or pretest, measured the participant's retained knowledge from their institution and unit-based orientation and clinical experience as a CVICU nurse. Participants were not given any additional information or education before their first simulation other than the briefing information described previously.

Both clinical educators silently observed the participant conducting a CVL dressing change, marking incomplete or complete for each step on the CVL dressing procedure assessment tool as the participant proceeded. After the participant stated they were finished with the dressing change, the educators debriefed the participant, offering feedback on their first attempt. If the participant achieved mastery, the simulation was completed. If mastery was not demonstrated, the process of attempts and debriefing continued until the participant reached mastery. Each participant was limited to three attempts to meet mastery because of time constraints of the study.

After completion of the simulation and feedback process, the participant completed a postsimulation evaluation questionnaire to rate their confidence (on a Likert scale) in this procedural skill and to rate their desire to use SBML for other procedural skill training.

After completion of the postsimulation questionnaire, participants were instructed not to discuss the study until all 20 subjects had completed the study. The proportion of participants reaching a passing score at each testing was computed.

## Results

The more commonly identified barriers in the pretest questionnaire included “sedation and hemodynamic stability concerns,” “difficulty finding a second person,” and

“skin integrity/diaphoresis.” Despite self-reporting of high confidence in the pretest questionnaire, there was no correlation (Fischer's exact test  $p = .160$ ) between achieving mastery and pretest self-reported confidence in the ability to execute a dressing change, with none of the 20 participants achieving mastery in the first attempt. Common missteps included maintaining sterile protocol and masking the patient. Mastery level was achieved by 11 of 20 participants (55%) in the second attempt and 8 of 9 (89%) of the remaining participants in the third attempt.

## Discussion

Poor performance on the pretest highlights a need for continuing education in central line dressing change skills and contests the commonly held belief that experience equates mastery of practice.

Similarities with other studies include low pre-test scores, high level of nurse reported self-confidence despite poor performance in the pretest, and improvement in posttest scores. The lack of correlation between reported self-confidence and pretest scores indicates that self-confidence is not an adequate measurement for competence. Education during unit orientation and exposure to central lines during clinical practice is not sufficient for maintaining performance of central line maintenance skills. Continuing education is necessary for nurses of all experience levels and self-reported confidence in the skill in order to achieve mastery.

The SBML intervention was effective in helping pediatric CVICU nurses to achieve a predetermined mastery level in CVL dressing changes. Since this intervention was tested, all CVICU and hematology/oncology inpatient nurses have completed central line maintenance skills training with SBML. Expansion into other preventable harm-reduction measures is ongoing. This education has been possible due to the ability to conduct short educational sessions in the unit during the staff member's scheduled shift and the addition of 1.0 full-time equivalent Clinical Education Specialist for the implementation of SBML in the organization.

This study was limited by its small sample size, the setting of a single institution and department, and the lack of retention or skill decay data. This study differed slightly from SBML principles due to resource constraints. However, the only substantial deviation from SBML principles was allowing participants to conduct their posttest on the same day as their pretest. This deviation did not likely impact the results as the participants still received key SBML components, including deliberate practice between attempts and feedback from content experts. Participants were limited to three attempts, with deliberate practice and feedback provided between attempts. One participant was unable to obtain MPS in three attempts. This participant

was able to meet MPS after the end of the study. The Hawthorne effect is also a possible limitation due to observation from raters; however, institutional policy requires a second person to be present during dressing changes, which minimizes this limitation.

## Conclusion

The results of this study, combined with the results from previous SBML studies, suggest that SBML is an effective technique for central line maintenance skills training for nurses. Further research is needed to understand skill decay and drift after SBML intervention, as well as other applications for SBML in nursing continuing education.

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