The Impact of High-Fidelity Simulation on Student Registered Nurse Anesthetists’ Knowledge Acquisition and Long-term Pharmacologic Knowledge Retention

Alexis McHale, BSN, RN, DNAP Candidate
Max Rozenberg, BSN, RN, DNAP Candidate
Carrie Bowman-Dalley, PhD, CRNA
Megan McAuliffe, DNP, CRNA
Carter Gisriel, DNAP, CRNA
Nancy A. Crowell, PhD
Presentation Outline

Background
Problem
Review of Literature
Purpose Statement
Research Questions
Methodology
Results
Discussion
Limitations
Future Research
References

GEORGETOWN UNIVERSITY
Background

- SRNAs receive an immense volume of information through didactic pharmacology lectures and are expected to retain this information throughout their training and beyond graduation.

- Acquiring and retaining in-depth knowledge of pharmacological principles is essential for SRNAs to provide safe and effective anesthesia to patients as well as successfully pass the National Certification Exam (NCE)\(^1\).
Background

• An educational model that promotes long-term knowledge retention of pharmacology material presented in the curriculum would benefit students and educators alike.

• Improved pharmacological detail retention throughout SRNA training could inform clinical decision making and optimize anesthesia training outcomes.
Problem

- For students in front-loaded nurse anesthesia programs, there can be a 2- to 3- year gap between receiving didactic pharmacology lectures and taking the NCE.

- Pharmacology-specific objectives are traditionally taught in a **didactic format**.\(^2^\)-\(^4\) This method of teaching **can result in knowledge decay without continual recall**.\(^5\)
Review of the Literature

• **High-fidelity simulation (HFS)** is an educational technique that realistically replicates a clinical event to allow participants to practice how they would respond in real-life, high-risk scenarios.⁶

• **Systematic review and meta-analysis (N=609 studies) (Roizen et al.)⁷**
  – Examined effects of HFS on knowledge and skill retention in **healthcare professions**.
  – Findings: *Simulation improves outcomes in knowledge level* compared with didactic instruction alone.

• **Systematic review and meta-analysis (N=77 studies) (Lorello et al.)⁸**
  – Examined simulation-based **anesthesia training**
  – Findings: *Simulation to teach anesthesia students is more effective* in obtaining new clinical skills compared with lectures alone.
Review of the Literature

- Many nurse anesthesia programs currently incorporate HFS into their curriculums to emphasize technical skills and critical event management, but **do not use HFS to meet program objectives related to** the basic sciences, such as pharmacology.

- **Pilot Study (N=15 participants) (Gisriel et al.)**
  - A didactic nurse anesthesia pharmacology curriculum was supplemented with a simulation-based learning experience.
  - On the pre-test, **baseline knowledge was equal** between 2 sets of medications that were taught in the same 4-week time period through formal lectures.
  - **Initial post-test** immediately following the simulation intervention:
    - Scores were 20% higher on content supplemented with simulation.
    - Scores were 1% lower on material taught through didactic lectures alone.
  - **30-day post-test**
    - Scores were the same as initial post-test on content supplemented with simulation.
    - Scores were 15% lower on material taught through didactic lectures alone.
  - Limitations: Under-powered and measured knowledge retention after 30 days.
The purpose of this study is to determine the effectiveness of supplementing didactic lectures with HFS in order to improve pharmacologic knowledge acquisition and long-term knowledge retention in Student Registered Nurse Anesthetists.
Research Questions

1. Does incorporating a HFS intervention, specifically focused on pharmacology concepts, provide an advantage over didactic instruction alone in **short-term knowledge acquisition** of pharmacology?

2. Does incorporating a HFS intervention, specifically focused on pharmacology concepts, provide an advantage over didactic instruction alone in **long-term knowledge retention** of pharmacology?
## Methodology

### Design
- Quantitative, quasi-experimental, one-group, pre- and post-test

### Setting
- Private Mid-Atlantic University School of Nursing simulation laboratory
- Simulated OR equipped with an anesthesia machine, high-fidelity mannequin, and anesthesia cart with medications and endotracheal intubation equipment

### Participants
- Convenience sample of 36 first-year SRNA's enrolled in a front-loaded DNAP program
- Participants had not yet entered clinical rotations

### Protection of Human Subjects
- Exempted by Georgetown University Institutional Review Board
- Collaborative Institutional Training Initiative Human Research Curriculum completion
- Informed Consent
Methodology: Data Collection Tool

Pharmacology Pre- and Post-Simulation Knowledge Assessment

5 Demographic Questions
10 Simulation-Reinforced Questions
10 Control Questions

ANS Pharmacology
LA Pharmacology

ANS = Autonomic Nervous System
LA = Local Anesthetic

GEORGETOWN UNIVERSITY
**Methodology: Timeline**

Didactic Lectures

- **October 2021**
  - Didactic Lectures

Pre-Simulation Test

- **First**
  - Knowledge assessment taken prior to simulation

Simulation Intervention

- **Second**
  - Knowledge assessment taken after debriefing

Post-Simulation Test

- **Third**
  - Knowledge assessment taken 60 days following simulation

60-Day Post-Simulation Test

Participants receive 2 lectures over ANS and LA pharmacology in the same 1-month time frame.
## Results: Sample Demographics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample (n=26)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Female (n)</td>
<td>18 (69.2%)</td>
</tr>
<tr>
<td>Male (n)</td>
<td>8 (30.8%)</td>
</tr>
<tr>
<td><strong>Age (mean ± SD)</strong></td>
<td>28.4 ± 3.5 years</td>
</tr>
<tr>
<td><strong>RN Experience (mean ± SD)</strong></td>
<td>4.1 ± 2.0 years</td>
</tr>
<tr>
<td><strong>ICU Experience (mean ± SD)</strong></td>
<td>3.6 ± 1.8 years</td>
</tr>
<tr>
<td><strong>ICU Worked Prior to CRNA Program</strong></td>
<td></td>
</tr>
<tr>
<td>Medical (n)</td>
<td>8 (30.8%)</td>
</tr>
<tr>
<td>Cardiac (n)</td>
<td>6 (23.1%)</td>
</tr>
<tr>
<td>Surgical (n)</td>
<td>5 (19.2%)</td>
</tr>
<tr>
<td>General/Mixed (n)</td>
<td>2 (7.7%)</td>
</tr>
<tr>
<td>Neuro (n)</td>
<td>2 (7.7%)</td>
</tr>
<tr>
<td>Pediatric (n)</td>
<td>2 (7.7%)</td>
</tr>
<tr>
<td>Neonatal (n)</td>
<td>1 (3.8%)</td>
</tr>
</tbody>
</table>
Baseline knowledge was equivalent between ANS and LA pharmacology.
Results:
Initial Post-Simulation Knowledge Assessment

HFS improved **short-term knowledge acquisition** of pharmacology.
Results:
60-Day Post-Simulation Knowledge Assessment

HFS improved long-term knowledge retention of pharmacology.
Results: Overview

- Pre-Sim Test: LA Questions (50%) vs. ANS Questions (75%)
- Initial Post-Sim Test: LA Questions (50%) vs. ANS Questions (75%)
- 60-Day Post-Sim Test: LA Questions (50%) vs. ANS Questions (75%)
**Discussion: Knowledge Acquisition of Pharmacology**

Current Study: **HFS enhances knowledge acquisition of pharmacology.** This is consistent with findings related to undergraduate nursing students\(^\text{12}\) and graduate nurse anesthesia students\(^\text{11}\).

- **Systematic review and meta-analysis (N=20 studies) (Gill et al.)\(^\text{12}\)**
  - Compared teaching strategies in undergraduate nursing pharmacology courses
  - Findings:
    - Simulation was one of the most beneficial methods for pharmacology knowledge acquisition
    - Traditional lectures were among the least effective strategies for teaching pharmacology to undergraduate nursing students.

- **Pilot Study (N=15 participants) (Gisriel et al.)\(^\text{11}\)**
  - A didactic nurse anesthesia pharmacology curriculum was supplemented with a simulation-based learning experience
  - **Initial post-simulation test** scores were 20% higher on content supplemented with the simulation intervention. Scores were 1% lower on material taught through didactic lectures alone.
  - Findings:
    - HFS supplementation improves knowledge acquisition of pharmacology over traditional lectures alone in SRNAs.
Discussion: Knowledge Retention of Pharmacology

Current Study: **HFS enhances knowledge retention of pharmacology.**
This positive impact of HFS is consistent with the findings of undergraduate medical students\(^1\) and nurse anesthesia students\(^1\).

- Parallel group randomized study (N=90 participants) (Arcoraci et al.\(^1\))
  - Compared simulation compared to lecture alone in undergraduate medical students.
  - Findings:
    - Simulation applied to pharmacology is associated with **more effective learning and long-lasting retention** compared to lecture alone.

- Pilot Study (N=15 participants) (Gisriel et al.\(^1\))
  - A didactic nurse anesthesia pharmacology curriculum was supplemented with a simulation-based learning experience
  - **30-day post-simulation test** scores were the same as the initial post-test on content supplemented with the simulation intervention. Scores were 15% lower on material taught through **didactic lectures alone**.
  - Findings:
    - HFS supplementation improves knowledge retention of pharmacology and protects against knowledge decay over traditional lectures alone in SRNAs.
Discussion: Barriers to Implementing HFS

• Simulation education and high-fidelity simulators are expensive.\textsuperscript{14-16}

• High running costs linked to human and capital resource allocation.\textsuperscript{15}
  – Program budget constraints
  – Time to learn equipment and tailor curriculum
  – Potential repairs

• Lack of economic evaluation on return of investment in simulation education leaves reported expenses without proper context.\textsuperscript{16,17}
  – If HFS increases clinical competency, then potential costs may be outweighed by patient safety benefits.
Discussion: Implications

Current Study: Supplementing didactic nurse anesthesia pharmacology lectures with an educational simulation-based intervention enhances short-term knowledge acquisition and prevents knowledge decay of pharmacology for at least 60 days.

- HFS is already a well-established supplement for developing clinical skills in anesthesia.⁹
- Pharmacology is an essential component to clinical education. Investing additional resources into HFS to supplement traditional pharmacology lectures may be worth the associated costs.
- Important implications extending beyond nurse anesthesia curriculums and into other healthcare disciplines.

Increasing pharmacologic knowledge retention will provide a strong basis for optimal clinical decision-making, which may mitigate the potential for medication errors and improve patient safety.
Limitations

• Potential for increased familiarity with questions due to several exposures to the same knowledge assessments.
  – Answer choice selection based on recalling and selecting previous answers versus remembering what was learned.

• Discussing questions or looking up answers in time period between simulation intervention and 60-day post-simulation knowledge assessment.
  – Unlikely to have occurred.

• 5-month gap between students receiving the 2 pharmacology lectures and taking the first knowledge assessment.
  – Decay of knowledge during this period produced “failing” baseline scores.
Future Recommendations

• Randomized control groups
  – Different instructional methods with same class of medications.
    • Compare group that receives an additional traditional lecture to a group that receives a simulation intervention.
  – Recruit participants from multiple nurse anesthesia programs

• Extend time period of testing knowledge retention
References

1. NBCRNA - Item Development Guidelines. NBCRNA. Accessed June 1, 2021. nbcrna.com


References


