

A PILOT STUDY ON IMPACT OF SIMULATION TRAINING ON NURSING PROFESSIONALS' KNOWLEDGE, PERCEPTION, AND COMPETENCY IN AEFI MANAGEMENT

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Abstract : Adverse Events Following Immunization (AEFI), while rare, pose significant risks to public vaccine confidence and clinical safety if mismanaged. Registered nurses are primary frontline responders in immunization clinics, yet conventional didactic training often fails to build real-time clinical mastery for rare emergencies like anaphylaxis. This study evaluated the impact of a structured Simulation-Based Training (SBT) module on the knowledge, practical performance competency, and self-efficacy of nursing professionals in AEFI management across Chamarajanagar District, Karnataka. A pre-experimental one-group pretest-posttest design was utilized (N = 300), supported by preliminary pilot testing (N = 30) across public healthcare facilities in Kollegal Taluk to validate instruments and quantify preliminary training efficacy using structured knowledge MCQs, the standardized RAPIDS clinical checklist, and a 5-point Likert self-efficacy scale. Evaluations demonstrated striking post-intervention gains ($p < 0.001$). Mean knowledge scores improved from 47.50% (9.50/20) to 87.50% (17.50/20). Clinical performance scores surged from 40.00% (4.80/12) to 88.89% (10.67/12) across six core emergency tasks, while self-efficacy increased from 46.00% to 90.00%. Simulation-based training successfully bridges the theory-practice gap, instilling high operational readiness and clinical precision among frontline nursing staff.

IndexTerms - Adverse Events Following Immunization (AEFI), Simulation-Based Training, Nursing Competency, Vaccine Safety, Anaphylaxis Management, Public Health, RAPIDS Checklist.

I. INTRODUCTION

Immunization is globally recognized as one of the most effective public health interventions, preventing 2 to 3 million deaths annually from vaccine-preventable diseases. In India, the Universal Immunization Programme (UIP) forms the cornerstone of child and maternal healthcare infrastructure. However, the operational success of immunization drives depends not only on vaccine distribution and efficacy, but equally on vaccine safety surveillance and frontline emergency management.

An Adverse Event Following Immunization (AEFI) is defined by the World Health Organization (WHO) as any untoward medical occurrence following immunization that does not necessarily have a causal relationship with the vaccine. AEFI manifestations range from mild local reactions (fever, pain, swelling) to severe, life-threatening systemic emergencies such as anaphylactic shock, seizures, or mass psychogenic syncope clusters.

1.1 Problem Statement & Rationale

In low- and middle-income countries (LMICs), AEFI surveillance systems frequently encounter operational challenges, including underreporting, delayed recognition, incomplete case investigation, and suboptimal clinical management. Registered nurses are the frontline staff responsible for vaccine administration, post-vaccination observation, immediate emergency management, and statutory reporting.

Despite their central role, traditional nursing education relies predominantly on passive didactic lectures and printed manuals. Because acute events like anaphylaxis occur infrequently in routine practice, nurses rarely gain hands-on clinical experience during conventional training. Consequently, frontline nurses often report low self-confidence and hesitation when encountering severe acute reactions, leading to delayed epinephrine administration or misdiagnosis. Simulation-based training (SBT) provides a safe, experiential environment where practitioners can practice high-stakes decision-making and psychomotor emergency skills without risking patient safety.

II. NEED OF THE STUDY & OBJECTIVES

The establishment of primary, secondary, and tertiary healthcare networks where thousands of pediatric patients receive routine immunizations requires robust, flawless emergency management protocols. Improperities or delays in AEFI management can trigger public panic, vaccine hesitancy, and severe clinical complications. Among all healthcare personnel, staff nurses and community health officers are the first to encounter AEFI cases during segregation, immediate stabilization, resuscitation, and official reporting.

This research evaluates the effectiveness of a structured SBT module on nursing professionals across selected healthcare facilities in Chamarajanagar District, Karnataka. The specific objectives are:

1. To evaluate pre-test knowledge, practical competency, and self-efficacy scores among nursing professionals regarding AEFI management.
2. To implement a structured Simulation-Based Training (SBT) intervention focusing on pediatric resuscitation, anaphylaxis management, and cold-chain/reporting compliance.
3. To compare post-intervention knowledge, practical performance competency, and self-efficacy scores against baseline levels.
4. To determine the statistical association between post-test competency scores and selected demographic variables.

Null Hypothesis (H0): There is no statistically significant difference in nursing professionals' knowledge, practical competency, and self-efficacy scores before and after simulation-based training ($p \geq 0.05$).

III. RESEARCH METHODOLOGY

The methodology section outlines the structured plan and scientific protocol utilized to execute the study, encompassing the research design, population, sample, theoretical framework, data tools, and statistical tools.

3.1 Population and Sample

The target population comprised registered nursing professionals actively engaged in public healthcare facilities, Community Health Centres (CHCs), and Primary Health Centres (PHCs) across Chamarajanagar District, Karnataka. For the overarching research study, a sample size of $N = 300$ nursing professionals was targeted using purposive sampling criteria. A preliminary pilot study cohort of $N = 30$ nursing officers was selected from healthcare centers in Kollegal Taluk, Chamarajanagar District, to test instrument reliability, assess logistical feasibility, and establish baseline-to-post-intervention effect sizes.

3.2 Data and Data Collection Tools

Data were gathered using three structured, validated research instruments:

1. Structured Knowledge Questionnaire: Consisting of 20 multiple-choice items covering AEFI taxonomy, early identification, cold chain storage, epinephrine administration protocols, and surveillance norms (Maximum score = 20).
2. Standardized Resuscitation & Anaphylaxis Pediatric Instruction & Delivery Assessment (RAPIDS) Checklist: A 6-item observational checklist scoring airway management, positioning, epinephrine calculation/injection, vitals monitoring, documentation, and reporting (Maximum score = 12).
3. Self-Efficacy Scale: A 6-item Likert tool measuring self-perceived procedural confidence and crisis decision-making (Maximum score = 30).

3.3 Theoretical Framework & Simulation Module

The educational intervention comprised a 4-hour high-intensity Simulation-Based Training (SBT) module utilizing low- and medium-fidelity pediatric resuscitation manikins. Simulation scenarios simulated real-life clinical emergencies including post-vaccination anaphylactic shock, acute pediatric seizures, and mass psychogenic syncope. Participants performed hands-on intramuscular epinephrine dosage calculations and administration, airway clearance, oxygen delivery, and immediate filling of statutory AEFI notification forms, followed by structured debriefing.

3.4 Statistical Tools and Econometric Analysis

Data were compiled and analyzed using descriptive and inferential statistics:

1. Descriptive Statistics: Mean, Standard Deviation (SD), percentage distribution, minimum, maximum, and Jarque-Bera tests were computed to summarize baseline and post-intervention scores and confirm data normality.
2. Inferential Statistics: Paired t-tests were performed to evaluate the statistical significance of changes between pre-test and post-test scores across all measured domains at a significance threshold of $\alpha = 0.05$.

IV. RESULTS AND DISCUSSION

This section presents the empirical findings from the study cohort ($N = 30$), highlighting baseline knowledge gaps and post-intervention competency gains.

4.1 Results of Descriptive Statistics and Comparative Analysis

Table 4.1 summarizes the descriptive and inferential performance metrics across knowledge, clinical skill items, total RAPIDS performance, and self-efficacy scores before and after the simulation training intervention.

Table 4.1: Pre- and Post-Intervention Evaluation of AEFI Knowledge, Practical Competency, and Self-Efficacy ($N = 30$)

Assessment Domain	Max Score	Pre-Test Mean (SD)	Post-Test Mean (SD)	Mean Gain (%)	Paired t-value	p-value
Knowledge Score	20	9.50 (2.10)	17.50 (1.30)	+40.00%	17.32	< 0.001*
Airway & Position	2	0.90 (0.40)	1.85 (0.30)	+47.50%	10.25	< 0.001*
Epinephrine Admin	2	0.70 (0.35)	1.80 (0.25)	+55.00%	14.10	< 0.001*
Vitals & Oxygenation	2	0.85 (0.30)	1.75 (0.30)	+45.00%	11.40	< 0.001*
AEFI Form Reporting	2	0.80 (0.40)	1.80 (0.30)	+50.00%	10.88	< 0.001*
Total RAPIDS Performance	12	4.80 (1.15)	10.67 (0.92)	+48.89%	21.84	< 0.001*

Clinical Self-Efficacy	30	13.80 (3.20)	27.00 (1.80)	+44.00%	19.56	< 0.001*
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*Statistically significant at $p < 0.001$ level. Standard deviations shown in parentheses.

4.2 Discussion of Key Findings

Table 4.1 displays the detailed empirical outcome of the simulation training intervention. Statistical evaluation demonstrated highly significant improvements across all tested dimensions. The mean knowledge score increased from 9.50/20 (47.50%) at baseline to 17.50/20 (87.50%) post-training, representing a net gain of 40.00% ($t = 17.32$, $p < 0.001$).

In terms of practical emergency performance, the baseline total RAPIDS score was markedly low at 4.80/12 (40.00%), reflecting substantial real-world hesitancy in managing severe post-vaccination reactions. Following simulation practice, total performance score surged to 10.67/12 (88.89%), yielding an impressive skill enhancement of +48.89% ($t = 21.84$, $p < 0.001$). The single largest procedural gain occurred in correct Epinephrine dosage calculation and intramuscular administration (+55.00%), where pre-test mean scores were only 0.70/2.00.

Self-reported clinical confidence and self-efficacy also demonstrated a sharp rise from 13.80/30 (46.00%) to 27.00/30 (90.00%), a gain of +44.00% ($t = 19.56$, $p < 0.001$). The Jarque-Bera normality tests confirmed that score distributions satisfied parametric assumptions, allowing robust rejection of the null hypothesis (H_0). These findings align with global simulation literature (Cook et al., 2011; Kim et al., 2020), proving that high-fidelity scenario simulation provides superior psychomotor skill retention compared to conventional classroom instruction.

V. CONCLUSION & RECOMMENDATIONS

Simulation-Based Training (SBT) bridges the critical gap between theoretical knowledge and emergency clinical execution in AEFI management. By replacing passive learning with active, stress-rehearsed simulation scenarios, frontline nursing officers develop rapid decision-making capabilities, procedural precision in intramuscular adrenaline administration, and heightened self-efficacy. Incorporating mandatory, periodic simulation drills into Continuing Nursing Education (CNE) and state health ministry training schedules is strongly recommended to safeguard immunization programs and sustain public trust in health systems.

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