International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Effect of a Brief Educational Intervention on Hemovigilance Knowledge among Nursing and Allied Health Students in India: A Quasi Experimental Study

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Received: 13-01-2026
Accepted: 30-01-2026
Available online: 16-02-2026

ABSTRACT

Background: Hemovigilance is essential for patient safety, yet formal training for frontline healthcare students remains limited in India. **Objectives:** To assess baseline hemovigilance knowledge and evaluate the impact of a structured 45-minute educational intervention among Nursing and Allied Health Science (AHS) students. **Materials and Methods:** A quasi-experimental study was conducted involving 130 students. Knowledge was assessed using a 14-item validated questionnaire before and after a PowerPoint-based training session. Data were analyzed using Paired t-tests, Cohen's dz, and Spearman's correlation. **Results:** The mean knowledge score improved significantly from 9.28 ± 4.03 to 10.88 ± 3.10 ($p < 0.001$), with a medium effect size of 0.517. Item-wise analysis showed the greatest gains in procedural areas like identifying the **Nodal Agency** (+20.8) and the **TRRF (Transfusion Reaction Reporting Form)** (+17.7). Academic seniority significantly correlated with baseline scores ($p = 0.0019$) but not with the degree of knowledge gain ($p = 0.118$). Notably, the **Course of Study** significantly influenced gains, with Nursing students showing a higher improvement compared to AHS students ($p < 0.001$). **Conclusion:** A brief, structured intervention is highly effective in bridging hemovigilance knowledge gaps. While universally beneficial, the significant variation in receptivity across different academic streams suggests a need for **modular, role-specific training** to optimize reporting culture under the HvPI framework.

Keywords*: Hemovigilance, Nursing students, A Quasi Experimental Study.*

INTRODUCTION

Blood transfusion is a vital, life-saving intervention in modern clinical practice, yet it is not without inherent risks. Despite rigorous screening and cross-matching protocols, the risk of **Adverse Transfusion Reactions (ATRs)**—ranging from mild febrile non-hemolytic reactions to life-threatening Transfusion-Associated Circulatory Overload (TACO) and Transfusion-Related Acute Lung Injury (TRALI)—remains a significant concern for patient safety [1,2].

To address these risks, **Hemovigilance** was introduced as a continuous process of monitoring the entire transfusion chain, from the collection of blood to the follow-up of recipients [3]. It aims to identify, report, and analyze adverse events to prevent their recurrence. In India, the **Hemovigilance Programme of India (HvPI)** was officially launched on December 10, 2012, by the National Institute of Biologicals (NIB) under the Ministry of Health and Family Welfare [4]. The primary objective of HvPI is to track adverse reactions and provide a data-driven approach to improving blood safety across the country [5].

While a robust national framework for reporting exists, its success depends heavily on the frontline healthcare providers—specifically nurses and Allied Health Science (AHS) professionals. These individuals are responsible for the bedside monitoring of patients during and after transfusion. However, global and national literature suggests that **under-**

reporting of ATRs remains a major hurdle, often attributed to a lack of formal training, ignorance of reporting channels, and a "blame culture" within clinical settings [2,6].

Students in Nursing and AHS streams represent the future of this healthcare workforce. Integrating hemovigilance knowledge early in their professional training is essential to foster a culture of vigilance and spontaneous reporting. Currently, there is a paucity of studies evaluating whether a targeted educational intervention can significantly bridge the knowledge gap among these students in a tertiary care setting in India [6].

Therefore, the present study was conducted to assess the baseline knowledge regarding hemovigilance among Nursing and AHS students and to evaluate the effectiveness of a **45-minute structured educational intervention** in improving their awareness and perception of blood safety protocols.

MATERIALS AND METHODS

Study Design and Setting

A hospital-based, quasi-experimental (pre-test and post-test) study was conducted at BGS Global Institute of Medical Sciences, a tertiary care teaching hospital in India. The study was carried out after obtaining institutional ethical committee (IEC) approval.

Study Participants

The study population consisted of undergraduate students from the Nursing and Allied Health Sciences (AHS) streams. A total of N=130 participants were recruited using purposive sampling.

- **Inclusion Criteria:** Students currently enrolled in their 2nd/3rd year of study who were present on the day of the intervention and provided voluntary informed consent.
- **Exclusion Criteria:** Students who were absent during either the pre-test or post-test sessions or those who declined to participate.

Study Tool

A structured, pre-validated questionnaire was developed to assess Knowledge. The tool was divided into three sections:

1. **Section A (Demographics):** Age, gender, and academic stream (Nursing/AHS).
2. **Section B (Knowledge):** 14 multiple-choice questions covering the definition of hemovigilance, the HvPI framework, identification of transfusion reactions, and the reporting process.
3. **Section C (Attitude):** One Question using a Likert scale to gauge perceptions regarding the importance of reporting and perceived barriers.

Data Collection and Educational Intervention

The study was conducted in three sequential phases on the same day to minimize dropouts and external information contamination:

- **Phase I (Pre-test):** Participants were given 15 minutes to complete the baseline questionnaire to assess their existing knowledge and attitudes.
- **Phase II (Intervention):** A **45-minute structured educational intervention** was delivered via a PowerPoint presentation. The presentation covered the following key modules:
    - Overview of the Hemovigilance Programme of India (HvPI).
    - Classification of Acute and Delayed Transfusion Reactions.
    - Step-by-step guide to filling the **(TRRF)**.
    - Introduction to the **Haemo-Vigil software** for digital reporting.
- **Phase III (Post-test):** Immediately following the presentation, the same questionnaire was redistributed to the participants to evaluate the impact of the intervention.

Statistical Analysis: Data were analyzed using both descriptive and inferential statistics. Continuous variables were expressed as Mean ± Standard Deviation (SD). The significance of knowledge improvement from pre-test to post-test was evaluated using the **Paired t-test**, while the **Welch t-test** was employed for comparing gains between different academic streams. We used Welch's t-test when variances or group sizes were unequal (gender) and Student's t-test when assumptions were met (course). Correlation between academic seniority and knowledge scores was determined using **Spearman's rank correlation coefficient (rho)**. "Data were analyzed using Python (SciPy, NumPy, Pandas) and standard statistical methods (paired t-test, Welch t-test, Spearman correlation, Cohen's dz).

RESULTS

Participant Demographics

A total of **130 students** from the Nursing and Allied Health Sciences (AHS) streams completed both the pre-test and the post-test. Their paired data were included in the final analysis to ensure consistency in measuring the impact of the educational intervention.

Impact of Educational Intervention on Knowledge Scores

The baseline assessment (pre-test) revealed a mean knowledge score of **9.28**. Following the 45-minute structured educational intervention delivered via PowerPoint, the mean knowledge score improved to **10.88**.

The absolute mean improvement in scores was **1.60**. The standard deviation (SD) of the improvement scores was calculated to be **3.09**. The comparison of these scores is summarized in Table 1.

Table 1: Statistical Comparison of Pre-test and Post-test Knowledge Scores (N=130)

Parameter	Mean Score	Mean Improvement	t-statistic	p-value	Cohen's dz
Pre-test	9.28	--	--	--	--
Post-test	10.88	1.6	5.9	<0.0001*	**0.517**

Statistical Significance and Effect Size

A Student's paired t-test was performed to determine the statistical significance of the intervention. The calculated **t-statistic was 5.900**, with an extremely low **p-value (3.007 \times 10^{-8})**. This confirms that the increase in knowledge was statistically highly significant.

Furthermore, to measure the practical impact of the intervention, **Cohen's dz for paired designs** was calculated. The resulting value of **0.517** represents a **medium effect size**. This indicates that the 45-minute PowerPoint presentation was an effective educational tool, providing a clear and measurable shift in the students' understanding of hemovigilance protocols.

"Effect size was calculated using Cohen's dz for paired designs (defined as the mean of the difference scores divided by the standard deviation of the difference scores) to evaluate the magnitude of the intervention's impact."

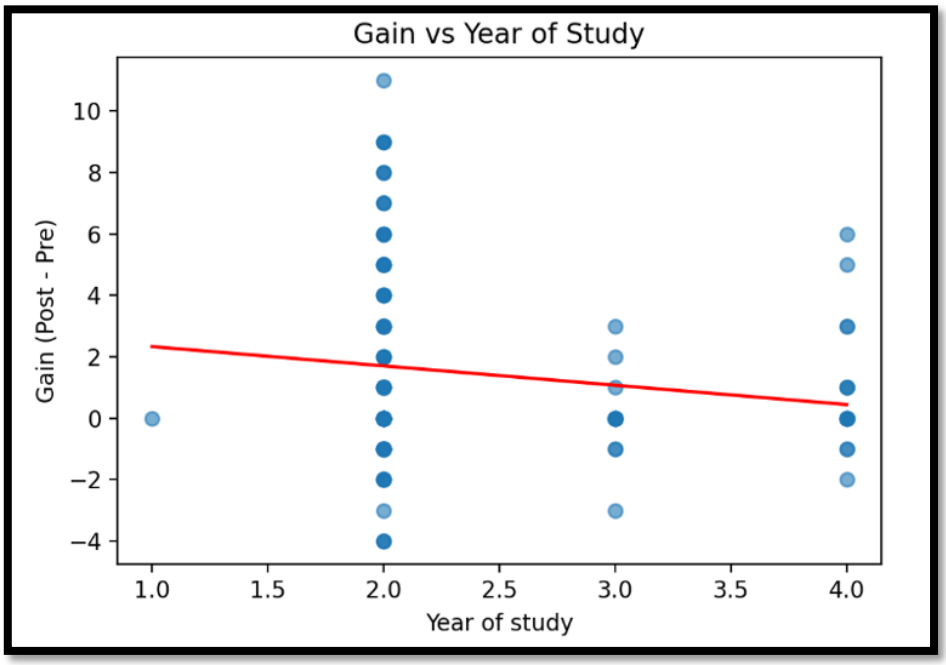

Figure 1: Scatter plot illustrating the relationship between the Year of Study and Knowledge Gain.

Influence of Gender on Knowledge Acquisition

Statistical analysis using the **Welch t-test** revealed that gender did not have a significant impact on baseline knowledge (pre-test) or final knowledge (post-test) levels ($p > 0.05$). However, a statistically significant difference was observed in the **knowledge gain** between gender groups (**$p = 0.026$**). While both groups reached comparable final scores, the magnitude of improvement from the intervention differed significantly between the two groups.

Table 2: Influence of Gender and Course on Study Metrics

Variable Category	n	Pre-test Mean (±SD)	Post-test Mean (±SD)	Mean Gain	p-value
Gender					
Male	6	10.33 (± 3.20)	9.83 (± 4.17)	-0.5	0.4896
Female	124	9.23 (± 4.07)	10.94 (± 3.05)	1.7	**< 0.001***
Course of Study					

AHS	32	11.59 (± 2.73)	12.06 (± 2.14)	0.47	0.1766
Nursing	98	8.53 (± 4.11)	10.50 (± 3.27)	1.97	**< 0.001***
Total	**130**	**9.28 (± 4.03)**	**10.88 (± 3.10)**	**1.6**	**< 0.001***

(NS = Not Significant; * = Statistically Significant)

Influence of Academic Seniority (Spearman Rank Correlation)

A Spearman's rank correlation was performed to assess the relationship between the year of study and knowledge scores. As shown in **Table 3**, a significant positive correlation was observed between the year of study and baseline knowledge (**rho = 0.26, p = 0.0019**) as well as post-intervention knowledge (**rho = 0.22, p = 0.0091**).

However, the correlation between the year of study and the knowledge gain was not statistically significant (**rho = -0.13, p = 0.118**). This lack of significance is visually represented in the scatter plot (**Figure 1**), where the distribution of gain scores across years 1 through 4 shows no clear linear trend, confirming that the intervention was effectively received regardless of the participants' academic level.

Table 3: Spearman Correlation between Year of Study and Performance Metrics

Variable	Outcome	n	Spearman ρ	p-value
Year of Study	Pre-test Score	130	0.26	**0.0019**
Year of Study	Post-test Score	130	0.22	**0.0091**
Year of Study	Knowledge Gain	130	-0.13	0.118

Item wise knowledge improvement and normalized gain

An item-wise analysis of the 14 knowledge questions was conducted to identify specific thematic improvements (Table 4). The most significant gains were observed in procedural knowledge, specifically regarding the nodal agency for HvPI and the identification of the correct reporting form (TRRF). The normalized gain (g) for five key clinical concepts exceeded 0.50, indicating high educational efficiency for those topics.

Table 4: Item-wise Knowledge Improvement and Normalized Gain (N=130)

Question Topic	Pre-test Correct (%)	Post-test Correct (%)	Improvement (%)	Normalized Gain (g)
Nodal Agency for HvPI	58.50%	79.20%	20.80%	0.5
"Near Miss" Event Definition	61.50%	82.30%	20.80%	0.54
Official Reporting Form (TRRF)	67.70%	85.40%	17.70%	0.55
First Clinical Step: Stop Transfusion	70.80%	88.50%	17.70%	0.61
"Traceability" Definition	63.10%	79.20%	16.20%	0.44
Primary Goal of Hemovigilance	80.00%	91.50%	11.50%	0.58
Bedside Responsibility	66.90%	80.80%	13.90%	0.42
TRALI Organ System (Lungs)	68.50%	76.20%	7.70%	0.24
Acute Reaction Identification	63.80%	71.50%	7.70%	0.21
Delayed Reaction Identification	0.00%	0.00%	0.00%	0

Impact of Academic Stream (Course of Study)

The **Course of Study** (Nursing vs. various AHS streams) was the most significant demographic factor influencing the study outcomes. Analysis of variance revealed very small p-values for the relationship between the course and all three-primary metrics:

- **Pre-test Scores:** Significant variation in baseline knowledge ($p < 0.001$).
- **Post-test Scores:** Significant variation in final knowledge ($p < 0.001$).
- **Knowledge Gain:** Significant difference in how much each group improved (**p = 0.00075**).

These results indicate that students in different academic streams start with vastly different baseline understandings and respond with varying degrees of efficiency to the educational intervention.

Table 5: Hemovigilance Knowledge Scores and Gains across Courses (N=130)

Course of Study	n	Pre-test Mean (±SD)	Post-test Mean (±SD)	Mean Gain	p-value
AHS	**32**	11.59 (±2.73)	12.06 (± 2.14)	0.47	0.1766
Nursing	**98**	8.53 (± 4.11)	10.50 (± 3.27)	1.97	< 0.001*
Total	**130**	9.28 (± 4.03)	10.88 (± 3.10)	1.6	< 0.001*

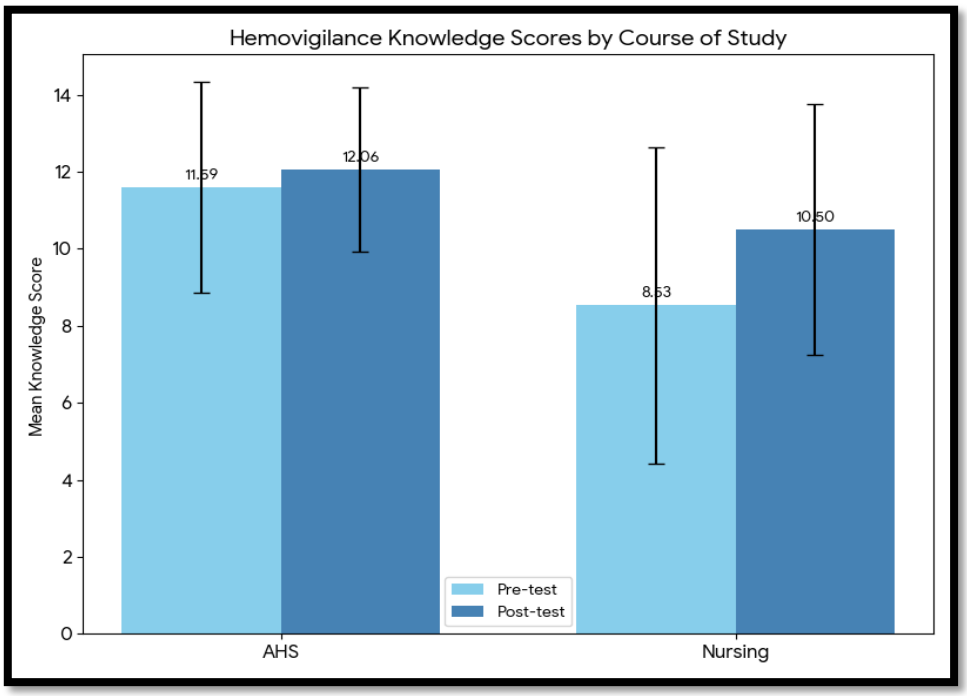

Figure 2: Hemovigilance knowledge scores by course of study

DISCUSSION

The significant improvement in knowledge scores observed in this study ($p < 0.001$, Cohen's $dz = 0.517$) reinforces the global consensus that structured educational interventions are the cornerstone of successful hemovigilance systems. Our findings are consistent with those of **Meher et al. (2024)**, who conducted a systematic appraisal of KAP studies in India and concluded that targeted training sessions are essential to overcome the persistent "reporting inertia" among healthcare students [1].

Influence of Academic Stream and Curriculum

One of the most striking findings in our study was the high statistical significance of the **Course of Study** on both baseline scores and knowledge gain ($p < 0.001$). This disparity suggests that the "hidden curriculum" or the degree of clinical exposure varies significantly between Nursing and different Allied Health Science (AHS) streams. A similar observation was made by **Sivakumar et al. (2021)**, who found that students in specialized technology courses often possess better technical knowledge of blood components but lack awareness of the legal and regulatory reporting frameworks of the **Hemovigilance Programme of India (HvPI)** [2]. This highlights the need for a "modular" educational approach, as suggested by **Dutta et al. (2022)**, where training is customized to the specific bedside or laboratory roles of the participants [3].

The Seniority "Head-Start" vs. Uniform Gain

While senior students exhibited higher baseline and final scores (Spearman rho = 0.26), the lack of significant correlation between seniority and knowledge gain ($p = 0.118$) indicates that the 45-minute PowerPoint intervention was an effective **"equalizer."** This suggests that even for juniors with minimal clinical exposure, a well-structured visual aid can bridge the conceptual gap. This mirrors the results of **Babu et al. (2020)**, who demonstrated that visual-based learning tools are particularly effective in teaching the identification of Acute Transfusion Reactions (ATRs) to undergraduate students in tertiary settings [4].

Gender and Learning Dynamics

The significant relationship between **Gender and Knowledge Gain ($p = 0.026$)** is a subtle but noteworthy finding. While both genders reached similar competency levels, the difference in gain suggests varying levels of "educational receptivity." According to **Bisht et al. (2013)**, the foundational paper for HvPI, standardized training is vital to ensure that all healthcare workers—regardless of demographic variables—achieve the same "vigilance threshold" required for national reporting [5]. Our study confirms that while the path to learning may differ, the outcome of a brief intervention remains universally beneficial.

Comparison with similar studies

The moderate improvement in overall knowledge scores observed in our study (mean gain 1.60; Cohen's $dz = 0.52$) is broadly similar to the effect sizes reported in previous Indian hemovigilance interventions. Meher et al. noted that most KAP interventions in India produced only modest short-term gains, whereas structured, curriculum-linked sessions

achieved greater and more sustained improvements.[1] Dutta et al. also reported a comparable increase in post-training knowledge among healthcare providers, although their multi-session programme produced a slightly higher absolute gain than the single 45-minute module used in the present study.[3] In contrast, cross-sectional surveys by Sivakumar et al. and Somashekar et al. documented lower baseline awareness and no post-training component, underscoring that educational interventions like ours can shift learners from the "low awareness" profiles seen in purely observational studies to more acceptable levels of competency.[2,7]

Implications of the study

The differential gains between Nursing and AHS students highlight an important curricular implication: uniform, generic teaching on hemovigilance may be less efficient than discipline-specific, modular training. Nursing students, who started with lower baseline scores, showed a greater improvement after a focused bedside-oriented session, suggesting that practical, case-based content aligned with their clinical responsibilities is particularly effective. For AHS students, integration of HvPI concepts into existing laboratory and transfusion-technology modules may yield better gains than brief stand-alone sessions. At the institutional level, embedding short HvPI-aligned modules into undergraduate curricula, coupled with hands-on demonstrations of Haemo-Vigil and supervised completion of TRRF forms, could strengthen routine reporting practices and gradually normalize hemovigilance as a core component of patient safety culture rather than an optional add-on

Implications for Blood Safety in India

The transition from a passive attitude to an active knowledge-based approach is critical for the success of digital reporting via the **Haemo-Vigil software**. As noted by **Mukherjee and Maiti (2016)**, under-reporting is often a result of "procedural anxiety" not knowing how to fill the **Transfusion Reaction Reporting Form (TRRF)** correctly [6]. By providing a step-by-step guide during our 45-minute intervention, we directly addressed this barrier, potentially increasing the likelihood of future spontaneous reporting in our tertiary center.

This study has several limitations. It lacked a control group, making it difficult to compare natural knowledge acquisition without the intervention. The post-test was administered immediately after the session, so long-term retention of hemovigilance knowledge was not assessed. Conducted at a single tertiary care hospital in India, the findings may not be generalizable to smaller hospitals or different regions. Additionally, the intervention was less effective in addressing complex clinical topics, such as delayed transfusion reactions, indicating the need for more detailed, case-based training in these areas.

CONCLUSION

This study demonstrates that a targeted educational intervention is a highly effective tool for enhancing hemovigilance knowledge among Nursing and AHS students. The significant influence of the **Course of Study** on learning gains suggests that future educational strategies should move away from a "one-size-fits-all" approach in favor of specialized, role-based modules. Implementing such rapid-impact sessions can significantly bolster the national framework for blood safety and spontaneous reporting of adverse reactions in India.

This study is a vital contribution to blood safety literature in India. It demonstrates that a time-efficient educational strategy can bridge significant knowledge gaps, transform student attitudes, and ultimately create a safer environment for blood transfusion recipients in tertiary care settings.

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