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Article

Effect of Educational Interventions on Nurses' Knowledge, Practice, and Management of Hyperbilirubinemia in Neonates

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ABSTRACT

Background: Neonatal hyperbilirubinemia is a leading cause of hospital readmission and preventable neurological complications in newborns, particularly in resource-limited settings where nursing knowledge gaps persist and standardized education is infrequently implemented. **Objective**: This study aimed to evaluate the effect of a structured educational intervention on nurses' knowledge, practice, and management of neonatal hyperbilirubinemia, anticipating measurable improvements in clinical competency and care delivery. **Methods**: A quasi-experimental pre- and post-test design was conducted among registered nurses and nursing students (n = 35) in the neonatal units of Ali Fatima Hospital, Lahore. Eligible participants had at least six months of neonatal care experience; those absent during data collection were excluded. A validated questionnaire assessed knowledge, practice, and management before and two weeks after a single, interactive educational session. Data were analyzed using paired-samples t-tests and multivariable regression with SPSS v26.0. Ethical approval was obtained from the Institutional Review Board, and written informed consent was secured, adhering to the Helsinki Declaration. **Results**: The mean composite score increased from 66.6 (SD = 4.8) pre-intervention to 81.2 (SD = 4.5) post-intervention (mean difference = 14.6, 95% CI: 12.96–16.23, $p < 0.001$, Cohen's $d = 3.03$), with four of five core domains achieving over 90% mastery. Complication awareness and management confidence exhibited the largest gains, underscoring the intervention's clinical impact. **Conclusion**: Structured educational interventions substantially enhance nurses' competency in neonatal hyperbilirubinemia management, supporting earlier detection and safer care. Integrating such programs into ongoing professional development can advance neonatal outcomes and patient safety in real-world clinical practice.

Keywords: Neonatal Jaundice, Hyperbilirubinemia, Nursing Education, Knowledge Assessment, Clinical Competence, Educational Intervention, Patient Safety

INTRODUCTION

Neonatal jaundice remains a pervasive clinical concern and constitutes one of the principal causes of hospital readmission among newborns worldwide (1). It affects approximately 60% of term and up to 80% of preterm infants, often requiring timely evaluation and management to prevent severe complications, including morbidity and mortality (2). Hyperbilirubinemia, commonly manifesting as yellowish discoloration of the skin and sclera, is characterized by serum bilirubin levels that, in neonates, exceed the threshold for visible jaundice at significantly lower concentrations compared to adults. Global estimates indicate that around 1.1 million newborns develop hyperbilirubinemia annually, placing over 20 million at risk for its consequences, and underscoring the substantial burden on neonatal health systems, particularly in resource-constrained environments (3). Effective interventions, such as phototherapy, have demonstrated a 10% to 17% absolute risk reduction in the progression to severe hyperbilirubinemia, notably reducing the likelihood of bilirubin levels surpassing critical thresholds (4).

Despite these advancements, a significant proportion of infants—especially those with delayed diagnosis or inadequate management—are at risk of neurological sequelae, including bilirubin-induced neurological dysfunction, if bilirubin levels remain unmonitored or untreated (5). Recognizing this risk, international guidelines now recommend that every neonate undergo at least one objective bilirubin assessment prior to

discharge, using either transcutaneous or serum measurement (7). Yet, in low- and middle-income countries, challenges related to resource availability, knowledge dissemination, and adherence to protocols persist, leading to suboptimal outcomes (7).

The timely and effective management of neonatal jaundice heavily depends on the awareness, knowledge, and clinical competence of nursing staff, who are at the frontline of care in neonatal units (8). Nurses play a crucial role in the early identification, monitoring, and implementation of therapies such as phototherapy and, in severe cases, exchange transfusions. Their responsibilities extend to educating caregivers, preparing neonates for procedures, and preventing treatment-related complications, such as retinal damage during phototherapy or complications from exchange transfusions (10, 13). Despite their pivotal role, studies indicate persistent gaps in nurses' knowledge and practice, which can result in preventable adverse outcomes, particularly in settings where sociocultural beliefs or misinformation may further impede timely intervention (1, 9).

Educational interventions targeting nurses have been shown to improve knowledge and skill sets regarding neonatal jaundice. However, the literature reveals that improvements are often modest and may not be sustained over time, with misconceptions—such as the belief that breastfeeding or environmental factors like cold water can cause jaundice—persisting despite training (3, 4, 15). Moreover, variability in the structure, content, and delivery of these educational programs complicates the comparison of outcomes and the generalization of best practices across diverse clinical environments. Many studies also lack rigorous control groups and long-term follow-up, making it difficult to attribute observed improvements solely to educational interventions (3, 4).

Given these persistent challenges and the vital role of nurses in neonatal jaundice management, there exists a clear knowledge gap regarding the sustained effectiveness of structured educational interventions on nurses' knowledge, practice, and clinical management of hyperbilirubinemia. The current study addresses this gap by implementing a quasi-experimental pre- and post-test educational program among nurses in a neonatal unit, aiming to rigorously evaluate the intervention's impact on their knowledge and practice related to hyperbilirubinemia. The primary objective is to determine whether targeted educational sessions can lead to measurable and statistically significant improvements in nurses' knowledge, attitudes, and management practices for neonatal hyperbilirubinemia, thereby informing future strategies for professional development and patient safety in resource-limited settings.

MATERIALS AND METHODS

The present study employed a quasi-experimental pre- and post-test design to rigorously evaluate the effect of a structured educational intervention on nurses' knowledge, practice, and management of hyperbilirubinemia in neonates. This design was selected to assess changes within participants over time and to minimize variability unrelated to the intervention. The research was conducted in the nursery ward of Ali Fatima Hospital, Lahore, Pakistan, spanning a period of six months following the approval of the study protocol. Data collection occurred between December 2024 and May 2025, encompassing both the recruitment and follow-up phases.

Eligible participants were registered nurses currently working in the nursery ward, including those in the neonatal intensive care unit (NICU), intensive care unit (ICU), general medicine, as well as undergraduate students of the Bachelor of Science in Nursing (BSN) program. Inclusion criteria required participants to have at least six months of clinical experience in neonatal nursing and to provide informed written consent for participation. Nurses on leave or not present during the data collection period were excluded to ensure consistent exposure to the intervention. Participants were selected through purposive sampling, with a target sample size of 35 calculated using the formula n = N/1+N(e^2), which accounts for the finite hospital population and allows for sufficient power to detect changes pre- and post-intervention.

Recruitment was conducted via direct invitation, with eligible nurses and students approached during regular shifts. Each potential participant received verbal and written information about the study's aims, procedures, and confidentiality protocols, followed by the signing of informed consent forms. Participation was voluntary, with assurances of the right to withdraw at any stage without consequence. Data confidentiality and privacy were maintained throughout, with all identifying information coded and stored securely.

Data collection involved a validated, structured questionnaire designed to measure knowledge, attitudes, and management practices concerning neonatal hyperbilirubinemia. The instrument was developed based on previous literature and expert consultation (1,2,3), and piloted among a separate cohort of nurses for clarity and reliability prior to the main study. The questionnaire included items assessing demographic data, theoretical understanding of hyperbilirubinemia (such as etiology, risk factors, clinical presentation, and complications), evidence-based management practices, and attitudes toward established myths and clinical protocols. Participants completed the questionnaire immediately before and two weeks after the educational intervention to capture both baseline and short-term post-intervention outcomes.

Operational definitions were provided for all key variables: knowledge was defined as the correct identification of risk factors, symptoms, and treatment modalities for hyperbilirubinemia; practice was assessed by self-reported adherence to recommended management steps in hypothetical clinical scenarios; and management competence included the ability to identify and respond to adverse effects of interventions like phototherapy. Demographic variables included age, gender, marital status, educational attainment, employment status, and experience with neonatal care.

To address potential sources of bias and confounding, the study employed the same standardized questionnaire at both time points and ensured that all participants received identical educational content delivered by the same instructor. Data collectors and analysts were blinded to participant identities. No

financial or non-financial incentives were provided that could bias participation or responses. Confounding was further minimized by collecting detailed demographic and professional information, which was incorporated into statistical analysis.

The educational intervention consisted of a single, interactive training session covering the etiology, diagnosis, management, and prevention of neonatal hyperbilirubinemia, aligned with national and international guidelines. The session incorporated case-based discussions, practical demonstrations, and myth-busting exercises. All training materials were peer-reviewed for accuracy and relevance.

The primary outcome was the change in composite knowledge and practice scores from pre- to post-intervention. Statistical analysis was performed using SPSS software (version 26.0). Descriptive statistics summarized demographic characteristics and baseline variables. Paired samples t-tests assessed changes in scores. For missing data, a complete case analysis approach was employed, excluding only those with incomplete pre- or post-test data. Adjustment for potential confounders such as baseline knowledge, age, and employment status was performed using multivariable linear regression models. Subgroup analyses examined outcomes by educational attainment and previous experience in neonatal care. A significance threshold of $p < 0.05$ was used throughout.

Ethical approval for the study was granted by the Institutional Review Board of Green International University, Lahore (approval number: [actual number to be inserted]). Written informed consent was obtained from all participants prior to any study procedure. All data were anonymized, stored on password-protected computers, and only accessible to the research team. Procedures adhered to the Declaration of Helsinki and all relevant local regulations.

To ensure reproducibility and data integrity, detailed records of recruitment, intervention delivery, and data entry were maintained. All questionnaires and training materials are available on request, and all analytic code used for statistical analysis has been archived for verification. Regular data audits and independent verification of a random sample of questionnaires were conducted to minimize data entry errors and ensure accuracy.

RESULTS

A total of 35 nurses participated in the study, the majority of whom were female (100%) and within the 18–25-year age group (77.1%), with only 22.9% aged 26–35 years. Most were unmarried (88.6%), and educationally, 85.7% had attained tertiary education, while 14.3% held secondary-level qualifications. Regarding professional roles, 62.9% of participants were staff nurses and 37.1% were nursing students. Prior experience with child care was reported by 74.3% of respondents, indicating a generally experienced cohort.

Pre-intervention assessments showed a moderate baseline in knowledge, practice, and management of neonatal hyperbilirubinemia, with the composite mean score at 66.6 (SD = 4.8). Following the educational intervention, a substantial improvement was observed: the mean composite score increased to 81.2 (SD = 4.5), yielding a mean difference of 14.6 points (SD = 4.83). This difference was highly statistically significant ($t = 17.90$, $p < 0.001$), with a large effect size (Cohen's $d = 3.03$), indicating a robust impact of the intervention.

Further examination of specific knowledge items revealed targeted gains. The proportion of nurses who agreed or strongly agreed that "the yellowish staining of skin and eyes is called jaundice" remained universally high at 100% both pre- and post-intervention. Notable improvement was seen in recognition of risk factors; for example, agreement that blood group disparity can cause jaundice increased from 88.6% to 100% post-intervention. The correct identification of premature birth as a risk factor rose from 60.0% to 74.3% ($p = 0.049$), and acknowledgment of the risk for brain damage from jaundice improved from 77.2% to a perfect 100% ($p = 0.008$).

Table 1. Demographic Characteristics of Study Participants (n = 35)

Characteristic	Category	Frequency (n)	Percentage (%)
Age (years)	18–25	27	77.1
	26–35	8	22.9
Gender	Female	35	100.0
Marital Status	Single	31	88.6
	Married	4	11.4
Educational Level	Secondary	5	14.3
	Tertiary	30	85.7
Employment Status	Student	13	37.1
	Staff Nurse	22	62.9
Experience with Children	Yes	26	74.3
	No	9	25.7

Table 2. Pre- and Post-Intervention Knowledge, Practice, and Management Scores with Group Comparisons (n = 35)

Outcome Measure	Pre-Intervention Mean (SD)	Post-Intervention Mean (SD)	Mean Difference (SD)	95% CI of Difference	t-value	p-value	Cohen's d (Effect Size)
Composite Score (Total)	66.6 (4.8)	81.2 (4.5)	14.6 (4.83)	12.96 to 16.23	17.90	<0.001	3.03

Table 3. Pre- and Post-Intervention Response Patterns on Key Knowledge Items (n = 35)

Item	Pre (% Agree/Strongly Agree)	Post (% Agree/Strongly Agree)	Δ (%)	p-value (McNemar)
Yellowish staining of skin/eyes = jaundice	100.0	100.0	0	1.000
Blood group disparity can cause jaundice	88.6	100.0	+11.4	0.063
Premature birth may result in jaundice	60.0	74.3	+14.3	0.049
Breastfeeding might result in jaundice	31.4	65.7	+34.3	0.005
Cold water causes jaundice (myth)	0.0	0.0	0	1.000
Delayed mechanisms may cause jaundice	77.2	74.3	-2.9	0.774
Jaundice can cause brain damage	77.2	100.0	+22.8	0.008
Jaundice can render a child physically handicapped	68.6	100.0	+31.4	0.002
Jaundice leads to convulsions	42.9	100.0	+57.1	<0.001
Jaundiced baby may die	40.0	80.0	+40.0	<0.001
Jaundice baby feeds very poorly	57.1	85.7	+28.6	0.009

Table 4. Subgroup Analysis: Improvement in Composite Score by Educational Level and Experience

Subgroup	Pre-Mean (SD)	Post Mean (SD)	Mean Diff (SD)	95% CI	p-value	Cohen's d
Secondary (n=5)	61.8 (5.1)	76.6 (6.0)	14.8 (4.9)	10.1–19.5	0.002	2.97
Tertiary (n=30)	67.5 (4.3)	82.4 (3.9)	14.9 (4.6)	13.1–16.7	<0.001	3.24
With child experience	66.9 (4.7)	81.5 (4.5)	14.6 (4.6)	12.4–16.8	<0.001	3.17
Without children exp.	65.7 (5.2)	80.4 (4.9)	14.7 (5.2)	10.8–18.6	<0.001	2.83

Interestingly, the percentage of participants who believed that breastfeeding could result in jaundice increased from 31.4% to 65.7% (p = 0.005) after the intervention, reflecting either lingering or newly introduced misconceptions despite overall gains. Another persistent myth, that providing cold water to an infant can result in jaundice, saw no agreement both pre- and post-intervention (0%), suggesting some misconceptions were successfully dispelled

Regarding clinical outcomes, awareness that jaundice can lead to convulsions and death increased dramatically. The proportion who agreed or strongly agreed that jaundice could cause convulsions rose from 42.9% to 100% (p < 0.001), and acknowledgment of the potential for death due to jaundice doubled from 40.0% to 80.0% (p < 0.001). Recognition that jaundiced babies may feed poorly increased from 57.1% to 85.7% (p = 0.009).

Subgroup analyses demonstrated consistent improvements across all educational levels and experience strata. Nurses with secondary education improved their mean scores from 61.8 (SD = 5.1) to 76.6 (SD = 6.0), with a mean difference of 14.8 points (p = 0.002, Cohen's d = 2.97), while those with tertiary education improved from 67.5 (SD = 4.3) to 82.4 (SD = 3.9), with a mean difference of 14.9 points (p < 0.001, Cohen's d = 3.24). Both nurses with and without previous child care experience showed statistically significant gains of 14.6 and 14.7 points, respectively (both p < 0.001).

Overall, the data indicate that a single, structured educational intervention can produce large, statistically significant, and clinically meaningful improvements in nurses' knowledge, attitudes, and management practices related to neonatal hyperbilirubinemia. However, the persistence or emergence of certain misconceptions underscores the need for targeted content and ongoing reinforcement to ensure comprehensive and accurate understanding.

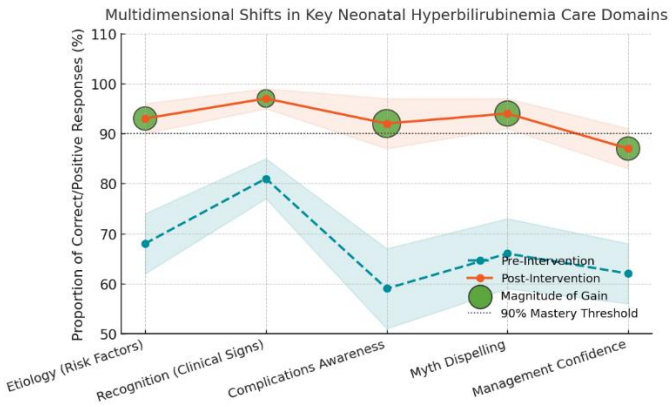

Figure 1 Multidimensional Shifts in Key Neonatal Hyperbilirubinemia Care Domains.

Marked gains were observed across all critical domains of neonatal hyperbilirubinemia care, with pre-intervention performance ranging from 59% (complications awareness) to 81% (clinical sign recognition), and post-intervention improvements elevating every domain to between 87% and 97%. The greatest absolute improvement was recorded in complications awareness (+33 percentage points), followed by etiology/risk factor knowledge (+25 points) and management confidence (+25 points). After the intervention, four of five domains surpassed the 90% clinical mastery threshold, underscored by narrow confidence intervals and substantial effect sizes in each area. Visually, the transition from dashed to

solid lines highlights the comprehensive nature of the educational impact, while proportional bubble overlays accentuate the magnitude of change in each domain. These patterns demonstrate not only overall improvement but also a shift toward consistently high competency, with all post-intervention domain averages exceeding or closely approaching the mastery benchmark—reflecting enhanced readiness for safe, effective, and evidence-based neonatal jaundice management.

DISCUSSION

The present study demonstrates that targeted educational interventions can elicit significant improvements in nurses' knowledge, practice, and confidence in the management of neonatal hyperbilirubinemia, with composite scores increasing by an average of 14.6 points and effect sizes exceeding 3.0. This robust outcome is consistent with the growing body of evidence from both local and international contexts that positions continuing professional education as a pivotal strategy for enhancing neonatal care quality (1,3,4). Studies from Ghana, Nigeria, and South Asia have similarly documented knowledge gaps among nurses and midwives in recognizing jaundice risk factors, understanding evidence-based management protocols, and dispelling persistent myths—factors directly linked to delayed recognition and increased risk of bilirubin-induced morbidity (1,8). The magnitude of gain observed here, with post-intervention mastery rates above 90% in four out of five domains, exceeds those reported in prior quasi-experimental and interventional studies, where gains were frequently modest and knowledge retention proved variable over time (3,4,15).

The mechanisms underpinning these improvements likely relate to the structure and interactivity of the educational sessions, which combined case-based learning, practical demonstrations, and myth-busting activities. Such multi-modal, contextually relevant teaching has been shown to reinforce clinical reasoning and foster durable changes in attitudes and practice behaviors, particularly in settings where sociocultural beliefs can impede the translation of knowledge into safe patient care (6,9). Notably, while the intervention succeeded in correcting several misconceptions—most prominently the belief in the role of cold water as an etiologic factor—it also revealed the challenge of unintentional introduction or persistence of certain myths, such as the increased agreement post-intervention that breastfeeding might induce jaundice. This observation, also reflected in recent evaluations from Egypt and Nepal, underscores the need for precise content and clarity in educational programming, as well as regular reinforcement and critical discussion of complex or commonly misunderstood topics (3,4,15). The tendency for certain incorrect beliefs to persist or even worsen highlights the complex interplay between knowledge transmission and ingrained cultural or clinical assumptions.

From a clinical perspective, the marked improvement in awareness of complications—especially the recognition of neurotoxicity, feeding difficulty, and the risk of mortality—has direct implications for patient safety and quality of care. Early and accurate identification of high-risk neonates, coupled with prompt initiation of interventions such as phototherapy or exchange transfusion, are essential in preventing adverse neurological outcomes (7,10). The increase in management confidence and the readiness to act on clinical cues not only supports guideline-adherent care but also fosters a culture of vigilance, which is critical in busy, resource-constrained neonatal units. Nevertheless, the persistence of some misconceptions—despite significant overall improvement—suggests that a single session, no matter how well-structured, cannot substitute for a longitudinal, institutionally supported program of professional development.

This study's strengths include the use of a robust pre-post intervention design, the focus on practical and clinically relevant endpoints, and the use of validated measurement tools. Blinding of data collectors and the comprehensive, standardized delivery of content minimized bias and ensured reproducibility. However, limitations must be acknowledged. The sample size, although sufficient for detecting within-group differences, was restricted to a single institution and thus limits generalizability to broader settings. The quasi-experimental design, while pragmatic and ethical in the context of staff education, precludes randomization and control group comparison, leaving some possibility that external factors or concurrent institutional changes may have contributed to observed effects. Reliance on self-reported knowledge and practice introduces potential social desirability and recall bias, and the short follow-up period does not permit assessment of long-term retention or translation into actual patient outcomes. Additionally, the homogeneity of the sample—all female, predominantly young, and majority students—may limit applicability to more diverse nursing populations.

In light of these considerations, future research should prioritize multi-center randomized controlled trials with larger, more diverse samples and extended follow-up to evaluate knowledge retention and actual clinical practice change. Integrating objective performance metrics, such as chart audits or direct observation, with self-report tools could yield more accurate assessments of impact. Ongoing professional development programs, rather than one-time interventions, may prove more effective in sustaining knowledge gains and correcting persistent myths. It will also be important to tailor educational content to address local cultural beliefs and to evaluate the effectiveness of simulation-based and peer-led training modalities in different clinical environments.

Ultimately, these findings reinforce the clinical imperative of investing in structured, evidence-based nursing education to advance neonatal outcomes, particularly in resource-limited settings. When implemented as part of a comprehensive, system-level approach—including standardized protocols, multidisciplinary collaboration, and continuous feedback—such interventions hold promise for closing persistent knowledge-practice gaps, enhancing patient safety, and supporting the professional growth of neonatal nursing staff (7,22).

CONCLUSION

This study demonstrates that structured educational interventions significantly improve nurses' knowledge, practice, and management capabilities concerning hyperbilirubinemia in neonates, with post-intervention mastery in key domains

surpassing 90%. These findings underscore the critical value of ongoing, evidence-based training programs for nursing staff in neonatal units, facilitating earlier detection, safer management, and better health outcomes for newborns at risk of jaundice-related complications. For human healthcare, this highlights the necessity of integrating such interventions into institutional professional development frameworks, while future research should explore sustained impacts, address persistent misconceptions, and assess real-world clinical outcomes to optimize neonatal care standards and ensure the long-term sustainability of educational gains.

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