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Knowledge, Attitudes, and Practices of Less Invasive Surfactant Administration Technique Among Workers in the Neonatal Intensive Care Units in Jordan

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Abstract: Background: Less invasive surfactant administration (LISA) is a technique of giving surfactants through a thin catheter. It has demonstrated potential in improving the respiratory outcomes in premature babies. The aim was to assess the knowledge, attitudes, practices, and barriers to using the LISA technique among neonatal intensive care unit (NICU) staff in Jordan. **Methods:** A prospective-observational web-based survey was conducted among 202 NICU staff (general pediatricians, neonatologists, and pediatric residents) from all major health sectors in two Jordanian governorates (Zarqa and Amman). The questionnaire contained 28 demographic, occupational, knowledge, and practice data items. **Results:** Response rate was 50.5%. Neonatologists were more likely to use LISA (35.1%) than pediatric residents (20.3%) and general pediatricians (43.2%). All LISA users (n = 74, 100%) know the technique, compared to non-users (52.3%) ($p < 0.001$). The main perceived advantages of LISA were a reduced need for intubation (100% vs. 57.8%) ($p < 0.001$; OR 57.8, 95% CI 18.9–176.8). And lower risk of airway complications (95.9% vs. 25%) ($p < 0.001$; OR 57.8, 95% CI 18.9–176.8). The overall knowledge score was significantly higher among LISA users (14.57 ± 3.81) than non-users (10.2 ± 4.95) ($p < 0.001$; OR 4.37, 95% CI 3.0–5.7). The total score for LISA-specific attitudes and practice was 13.92 ± 3.92. Among non-users, a strong majority (82%) expressed an intention to adopt it in the future. Knowledge score was significantly correlated with practice score ($r = 0.320$, $p = 0.005$; 95% CI 0.11–0.52). **Conclusions:** This study revealed moderate knowledge of LISA among Jordanian NICU staff, while its practice remains limited due to systemic barriers.

Keywords: Less invasive surfactant administration; preterm infant; Respiratory distress syndrome; neonatal intensive care unit; Surfactant; knowledge, attitudes and practice (KAP); Jordan.

Introduction

Preterm newborns, particularly those born very early, are highly susceptible to respiratory distress syndrome (RDS) caused by surfactant deficiency [1]. RDS and its complications remain major contributors to morbidity and mortality in this group [2]. Exogenous surfactant therapy is the most effective treatment [3]. Surfactant plays a critical role in lung function by reducing surface tension and preventing alveolar collapse [4]. In its absence, affected infants develop severe respiratory distress within the first hours of life, often requiring mechanical ventilation and facing complications such as pneumothorax, peri-intraventricular hemorrhage (PIVH), bronchopulmonary dysplasia (BPD), and death [5].

Several techniques are available for surfactant administration, including Surfactant Administration through Laryngeal Mask Airway (SALSA), Minimally Invasive Surfactant Therapy (MIST), Less Invasive Surfactant Administration (LISA), and Intubate-Surfactant-Extubate (INSURE) [6]. The INSURE method, one of the earliest and most widely used approaches, involves endotracheal intubation, instillation of surfactant, brief positive pressure ventilation, and subsequent extubation to non-invasive support [7,8]. To reduce the risks associated with intubation and mechanical ventilation, less invasive techniques such as LISA, MIST, and SALSA were developed [9,10].

LISA involves the use of a thin catheter introduced under laryngoscopic guidance, allowing spontaneous breathing while

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surfactant is delivered with non-invasive respiratory support, thereby avoiding prolonged invasive ventilation [11,12]. MIST uses a semi-rigid vascular catheter inserted without a laryngoscope, also permitting spontaneous breathing [13]. In the SALSA method, surfactant is administered via a supraglottic airway device positioned in the pharynx, eliminating the need to pass through the vocal cords [14]. Nebulization has been explored as a potential least-invasive option, but its clinical application remains limited by challenges such as appropriate particle size, surfactant stability, delivery time, and dosing efficiency [15].

Over the past decade, surfactant administration practices have shifted from intubation and mechanical ventilation, through INSURE and continuous positive airway pressure (CPAP), toward LISA. This method enables effective surfactant delivery while the infant maintains spontaneous breathing [16]. LISA has been successfully applied in preterm infants from as early as 22 weeks of gestation. It has been associated with shorter hospital stays, reduced oxygen requirements, and lower rates of complications such as intraventricular hemorrhage and retinopathy of prematurity, without adverse effects on growth or neurodevelopment [11,17].

International experience shows that LISA is widely practiced in Canada [18] and Europe [19] but is less commonly used in the United States [20], likely due to differences in provider experience and patient characteristics. Variation also exists within Europe; for example, only 32% of neonatal intensive care units (NICUs) in Nordic countries report regular LISA use [19]. Closer countries like India observed high practice of LISA among NICUs [21]. In the Middle East, reports remain limited, with most evidence coming from Turkey and Iran, where comparisons have been made between LISA and INSURE [22, 23].

In Jordan, neonatal care faces challenges including resource limitations and a rising burden of high-risk deliveries, both of which contribute to high preterm mortality [24]. However, little is known about the knowledge or practice of LISA among Jordanian NICU staff. This study, therefore, aimed to assess current LISA practice, evaluate provider knowledge, and identify barriers to its implementation to inform strategies that may improve neonatal outcomes.

Materials and Methods

Study Design

This study was a cross-sectional, descriptive, web-based survey conducted between September 2023 and September 2024. The primary outcome was knowledge of Less Invasive Surfactant Administration (LISA), measured through participants' knowledge scores. Secondary outcomes included self-reported practice of LISA and perceived barriers to its use. Key exposures included the healthcare sector (governmental, military, private, university), profession (neonatologist, pediatric resident, general pediatrician), years of experience, and geographic area of practice (Amman and Zarqa). Subgroup analyses were performed across the groups, with years of experience and NICU exposure considered as potential confounders.

Several measures were taken to minimize bias. Selection bias was minimized by contacting all NICU healthcare providers in the targeted sectors through professional networks, WhatsApp groups, email, and the Jordanian Pediatric Society registry (400 physicians). Response bias was mitigated by ensuring anonymity and confidentiality. Measurement bias was reduced by adapting a previously validated questionnaire, which was reviewed by neonatology experts for local relevance.

Study Setting

The study was conducted across NICUs in governmental, military, university-affiliated, and private hospitals located within the Amman and Zarqa governorates in Jordan, totaling 9 NICUs in 9 hospitals. Site representatives at these hospitals facilitated the distribution of the survey link to eligible participants. Invitations and data collection began in September 2023 and were concluded by the end of September 2024.

Participants

Eligible participants were neonatologists, general pediatricians working in NICUs, and pediatric residents affiliated with NICUs in the specified governorates. The sample included NICU workers from all targeted sectors proportionately. Participation required written informed consent. Individuals who did not provide consent or who were not actively practicing in NICU settings were excluded from the study. An initial invitation was sent to 400 eligible healthcare providers, identified from the Jordanian Pediatric Society registry across health sectors in the targeted regions, resulting in 202 respondents.

Sample Size

The sample size was determined using convenience sampling. No formal power calculation was performed due to the descriptive, exploratory nature of this research**.** A total of 400 eligible NICU healthcare providers were invited, of whom 202 responded, yielding a 50.5% response rate. This sample was considered adequate to represent different professional roles and institutional affiliations and to provide a 95% CI with a 5% margin of error.

The use of convenience sampling may have introduced selection bias and limited generalizability. However, participants represented all targeted sectors (governmental, military, private, and university), and no specific characteristics were available to distinguish non-respondents from respondents, as demographic data for non-respondents were not collected.

Data Collection

Data were collected using a structured questionnaire developed by Google Forms. Completing the survey required approximately 15 minutes. The questionnaire link was shared via WhatsApp and email. Reminder messages were sent, and anonymity was emphasized. Up to two email/WhatsApp reminders were sent to maximize the response rate. Responses were collected anonymously (without identifiers) to ensure confidentiality. The survey instrument was adapted from previously published questionnaires used by Pawale et al. (2023) and Mehmet et al. (2020) [21,22], with necessary modifications to fit the Jordanian NICU context. Therefore, the questionnaire was not entirely researcher-developed but adapted from validated tools, and this adaptation was reviewed by neonatology experts to improve content validity.

Survey Structure

The questionnaire consisted of 28 items divided into four sections. The first section collected demographic and occupational data, including age, gender, profession, years of experience, current NICU affiliation, and governorate of practice. The second section assessed participants' knowledge of LISA. The third section examined LISA-related practices among users, while the fourth section explored perceived barriers to LISA use among non-users.

Scoring System

Scoring for knowledge and practice was designed to capture participants' understanding of LISA indications, benefits, complications, procedural aspects, and educational sources. Knowledge items were scored from 1 to 10 points each, with

cumulative scores. Practice-related questions for LISA users covered frequency of use, premedication practices, gestational age range, catheter preference, and procedural techniques, with scores ranging from 1 to 5 points per item. The cumulative scoring provided an overall measure of participants' knowledge and practical experience with LISA. For example, participants who reported using LISA regularly scored higher than those reporting occasional or rare use. Similarly, responses reflecting adherence to recommended practice were assigned higher values**.** The cumulative practice score represented **a** higher frequency and closer alignment with recommended LISA practice**.**

Validity and Reliability

The questionnaire underwent content validation through review by an experienced neonatologist, ensuring clarity and relevance. A pilot study involving 10% of the target population was conducted to assess survey clarity and feasibility. Pilot participants were excluded from the final analysis. Following the pilot, minor wording adjustments were made to two questions, with no structural changes required**.** Reliability testing demonstrated acceptable internal consistency: Cronbach's alpha values were 0.74 for the knowledge section, 0.78 for the practice section, and 0.72 for the barriers section, all exceeding the 0.70 threshold.

Statistical Analysis

Statistical analysis was conducted using SPSS version 26.0. The normality of continuous variables was assessed using the Shapiro-Wilk test. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize demographic characteristics and survey responses. For comparisons between two groups, such as LISA users and non-users, independent t-tests were used for normally distributed data, while the Mann-Whitney U test was applied for non-normally distributed variables. Qualitative variables were analyzed using the Chi-square test or Fisher's exact test, as appropriate. To identify predictors of LISA utilization, binary logistic regression analysis was conducted. A p-value of less than 0.05 was considered statistically significant for all analyses.

Ethical Considerations

The local ethics committee of Hashemite University approved the study (IRB# 9/1/2023/2024). All participants provided written informed consent before participation, and participant responses were anonymous and confidential. All study procedures adhered to ethical standards for research involving human participants. The study complied with the Declaration of Helsinki.

Results

Table 1 provides a comparative analysis of the basic characteristics of participants based on their practice of the LISA method. The mean age was 37.5 ± 10.52 years for all participants, with no significant difference between LISA users (35.8 ± 10.26 years) and non-users (38.58 ± 10.57 years) (p = 0.36). Gender distribution showed that 64.9% of LISA users were male, compared to 50.8% in the non-user group, with a near-significant difference (p = 0.05; OR 1.78, 95% CI 0.99–3.22). Professionally, neonatologists were more likely to use LISA (35.1%) than pediatric residents (20.3%) and general pediatricians (43.2%), with a statistically significant association (p = 0.002; OR 2.73, 95% CI 1.45–5.14). Experience level significantly differed between groups (p < 0.001; OR 6.29, 95% CI 2.15–18.39), as 20.3% of LISA users had over 20 years of experience compared to only 3.9% of non-users, while those with less than five years of experience were more represented among non-users (53.9% vs. 35.1%; OR 0.47, 95% CI 0.26–0.86). NICU affiliation did not significantly influence LISA practice (p = 0.25), with the majority of participants working in Ministry of Health hospitals (48%), followed by private hospitals (21.3%) and Royal Medical Services (21.3%).

Table (1): Basic characteristics of participants.

Variable	Parameter	All N=202	LISA non-practicing N=128	LISA practicing N=74	p-value
Age	Mean ± SD	37.5 ± 10.52	38.58 ± 10.6	35.8 ± 10.3	0.36
	Min-max	23-68	25-68	23-68	
	25-34 yrs	102 (50.5%)	63 (49.6%)	39 (53.4%)	
	35-44 yrs	52 (25.7%)	30 (23.6%)	22 (30.1%)	
	45-59 yrs	33 (16.3%)	25 (19.7%)	8 (11%)	
	>60 yrs	13 (6.4%)	9 (7.1%)	4 (5.5%)	
Gender	Male	113 (55.9%)	65 (50.8%)	48 (64.9%)	0.05
	Female	89 (44.1%)	63 (49.2%)	26 (35.1%)	
Profession	Neonatologist	47 (23.3%)	21 (16.4%)	26 (35.1%)	0.002
	Pediatric Resident	69 (34.2%)	54 (42.2%)	15 (20.3%)	
	General Pediatrician	80 (39.6%)	48 (37.5%)	32 (43.2%)	
	Other subspeciality	6 (3%)	5 (3.9%)	1 (1.4%)	
Years of experience in neonatology/pediatrics	<5 years	95 (47%)	69 (53.9%)	26 (35.1%)	<0.001
	5-10 yrs	53 (26.2%)	38 (29.7%)	15 (20.3%)	
	11-15 yrs	16 (7.9%)	9 (7%)	7 (9.5%)	
	16-20 yrs	18 (8.9%)	7 (5.5%)	11 (14.9%)	
	>20 yrs	20 (9.9%)	5 (3.9%)	15 (20.3%)	
Current NICU affiliation	Ministry of Health	97 (48%)	68 (53.1%)	29 (39.2%)	0.25
	Royal Medical Service	43 (21.3%)	26 (20.3%)	17 (23%)	
	University hospital	19 (9.4%)	10 (7.8%)	9 (12.2%)	
	Private hospital	43 (21.3%)	24 (18.8%)	19 (25.7%)	

Table 2 assessed the knowledge of participants regarding the LISA technique. All LISA users (100%) know the technique compared to non-users (52.3%) (p < 0.001). Knowledge of surfactant administration methods varied, with all LISA users being familiar with the INSURE method, compared to 68.75% of non-users (p < 0.001). Awareness of MIST (54.05% vs. 6.25% (p < 0.001; OR 17.0, 95% CI 7.2–40.4), NEB (36.48% vs. 3.13% (p < 0.001; OR 16.7, 95% CI 5.5–50.6), and SALSA (52.7% vs. 5.5%)(p < 0.001; OR 18.7, 95% CI 7.6–45.9) was also significantly higher among LISA users (p < 0.001). Regarding perceptions of LISA's safety and efficacy, 52.7% of LISA users rated it as very safe and effective, compared to only 19.5% of non-users (p < 0.001; OR 4.6, 95% CI 2.4–8.9). Similarly, 70.3% of LISA users believed the literature was strong enough to

recommend it as standard care, versus 45.3% of non-users ($p < 0.001$; OR 2.9, 95% CI 1.6–5.2).

The main perceived advantages of LISA included reduced need for intubation (100% vs. 57.8%), lower risk of airway complications (95.9% vs. 25%) ($p < 0.001$; OR 57.8, 95% CI 18.9–176.8), and enhanced patient comfort (90.5% vs. 3.1%) ($p < 0.001$; OR 197.1, 95% CI 44.5–872.5). Notably, 40.5% of LISA users reported no complications, while 46.9% of non-users identified airway complications as a concern ($p < 0.001$; OR 0.06, 95% CI 0.02–0.16). Sources of knowledge also differed significantly, with LISA users relying more on scientific publications (85.1% vs. 2.34%) ($p < 0.001$; OR 243.7, 95% CI 67.1–885.3), online resources (70.3% vs. 0%), and formal training (67.6% vs. 6.25%) ($p < 0.001$; OR 31.0, 95% CI 13.0–73.7). The total knowledge score was significantly higher among LISA users (14.57 ± 3.81) compared to non-users (10.2 ± 4.95) ($p < 0.001$; OR 4.37, 95% CI 3.0–5.7), suggesting a strong association between experience with LISA and greater knowledge of neonatal surfactant administration practices.

Table (2): LISA scores among participants.

Variable	Parameter	All N=202	LISA non-practicing N=128	LISA practicing N=74	p-value
Knowledge of surfactant administration methods	INSURE	162 (80%)	88 (68.8%)	74 (100%)	<0.001
	LISA	141 (69.8%)	67 (52.3%)	74 (100%)	<0.001
	MIST	48 (23.7%)	8 (6.3%)	40 (54.1%)	<0.001
	NEB	31 (15.3%)	4 (3.1%)	27 (36.5%)	<0.001
	SALSA	46 (22.7%)	7 (5.5%)	39 (52.7%)	<0.001
Knowledge of LISA (RDS treatment)	Yes	141 (69.8%)	67 (52.3%)	74 (100%)	<0.001
Perception of safety and efficacy	Very safe & effective	64 (31.7%)	25 (19.5%)	39 (52.7%)	<0.001
Belief that literature supports LISA as standard care	Yes	110 (54.4%)	58 (45.3%)	52 (70.3%)	<0.001
Main advantages of LISA	Reduced need for intubation	148 (73.3%)	74 (57.8%)	74 (100%)	<0.001
	Lower risk of airway complications	103 (51%)	32 (25%)	71 (95.9%)	<0.001
	Enhanced patient comfort	71 (35.1%)	4 (3.1%)	67 (90.5%)	<0.001
Complications during LISA	No complications	34 (16.4%)	4 (3.1%)	30 (40.5%)	<0.001
Source of knowledge about LISA	Scientific publications	66 (32.7%)	3 (2.3%)	63 (85.1%)	<0.001
	Online resources	52 (25.7%)	0 (0%)	52 (70.3%)	<0.001
	Formal training	58 (28.7%)	8 (6.3%)	50 (67.6%)	<0.001
Total knowledge score	Mean ± SD	11.8 ± 5.0	10.2 ± 4.9	14.57 ± 3.8	<0.001

Table 3 examined LISA practice-specific among participants who had experience with the technique. Practical skills in LISA were primarily acquired through hands-on training during residency or fellowship programs (39.2%), mentorship from experienced practitioners (20.3%), and self-directed learning (19%). Notably, 28.4% of participants were unsure of how they had acquired proficiency. In terms of frequency, 44.6% reported using LISA occasionally, 28.4% rarely, and 27% regularly. Premedication before LISA was uncommon, with only 18.9% using it, and benzodiazepines (12.2%) were the most frequently administered medication. The majority (47.3%) considered all gestational ages appropriate for LISA, while 27% specifically selected the 28–32-week range. Regarding the preferred timing of LISA, 43.2% administered it within the first six hours of life, while 33.8% used it whenever necessary. The primary indications included prophylactic treatment for extremely preterm infants (62.2%) and failed non-invasive respiratory support (37.8%). A vast majority (96%) were willing to consider LISA again if an infant required a repeat surfactant dose. The special surfactant catheter was the most preferred device (62.2%), followed by the feeding tube (55.4%). Almost all users (97.3%) performed oral intubation during LISA. While 54.1% know published guidelines for LISA, institutional guidelines were available to only 37.8% of respondents. The total score for LISA-specific knowledge and practice was 13.92 ± 3.92, ranging from 7 to 25, reflecting variability in expertise and adherence to standardized protocols among users. The mean practice score correlated positively with knowledge score ($r = 0.320$, $p = 0.005$; 95% CI 0.11–0.52), indicating that higher knowledge levels were associated with better practice.

For participants who had not used LISA (N=128), perceptions of the technique varied. While 57.8% believed it may be easy to perform, 42.2% considered it challenging. Among those who found it difficult, the main barriers included a lack of staff expertise (12.5%), difficulty in catheter insertion (10.2%), and inadequate airway visualization (5.5%). Interestingly, 14.1% were uncertain about the specific challenges (Figure 1). Despite these concerns, a strong majority (82%) expressed an intention to implement LISA in the future, indicating a willingness to adopt the technique with proper training and institutional support. The likelihood of intending to adopt LISA was nearly threefold higher among those who perceived the procedure as easy (OR 2.9, 95% CI 1.6–5.3, $p < 0.001$). (Table 4).

Table (3): LISA practicing-knowledge and practice score.

Variable	Parameter	LISA non-practicing N=74
How did you acquire practical skills and proficiency in implementing the Less Invasive Surfactant Administration (LISA) practice in neonatology?	Hands-on training during residency or fellowship programs	29(39.2%)
	Mentorship and guidance from experienced practitioners	15(20.3%)
	Participation in simulation-based training exercises	3(4%)
	Continuous professional development programs or workshops	10(13.5%)
	Self-directed learning and personal experience	14(19%)
	I don't know	21(28.4%)

Variable	Parameter	LISA non-practicing N=74
How frequently do you utilize LISA in your practice?	Occasionally	33(44.6%)
	Rarely	21(28.4%)
	Regularly	20(27%)
Do you use premedication beforeperforming LISA?	No	60(81.1%)
	Yes	14(18.9%)
Medications used for premedication	Intravenous opioids (e.g., fentanyl)	6(8.1%)
	Oral sucrose	4(5.4%)
	Topical anesthetics (e.g., lidocaine)	2(2.7%)
	Atropine	1(1.3%)
	Benzodiazepines	9(12.2%)
The gestational age range considered appropriate for LISA	<24 w	1 (1.4%)
	24 – 26 w	4 (5.4%)
	26 – 28 w	6 (8.1%)
	28 – 32 w	20 (27%)
	>32 w	8 (10.8%)
	All gestational ages	35 (47.3%)
Which is the most preferred time interval to use LISA?	Every time	25 (33.8%)
	0 – 6 h	32 (43.2%)
	6 – 12 h	11 (14.9%)
	12 – 24 h	5 (6.8%)
	>24 h	1 (1.4%)
Primary indications for LISA	Failed non-invasive respiratory support	28(37.8%)
	Prophylactic treatment for extremely preterm infants	46(62.2%)
Would you consider LISA again if an infant needs a repeat dose of surfactant after 6-12 hours?	No	3 (4%)
	Yes	71 (96%)
What is the preferred catheter in LISA?	Special surfactant catheter	46 (62.2%)
	Angiocath (Hobart method)	2 (2.7%)
	Feeding tube	41 (55.4%)
	Suction catheter	4 (5.4%)
	Vascular catheter	3 (4.1%)
Which intubation method do you use in LISA?	Oral	72 (97.3%)
	Nasal	2 (2.7%)
Do you know about any published guidelines or recommendations for LISA?	No	34 (45.9%)
	Yes	40 (54.1%)
Do you have guidelines for LISA at your institution?	No	46 (62.2%)
	Yes	28 (37.8%)
Total score	Mean ± SD	13.92 ± 3.92
	Min-max	7-25

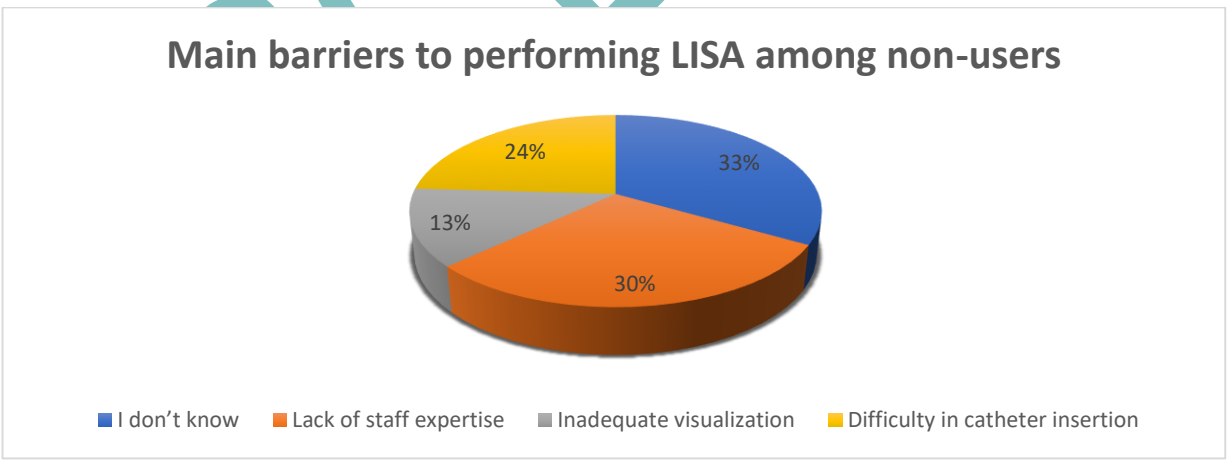

Figure (1): Summarizing the main barriers to performing LISA among non-users.

Table (4): LISA non-practicing-specific questions.

Variable	Parameter	LISA non-practicing N=128
Do you think it is easy to perform LISA on your patient	No	54 (42.2%)
	Yes	74 (57.8%)
If no, what do you think the Challenges or difficulties faced during LISA are? (N=54)	I don't know	18 (33%)
	Lack of staff expertise	16 (30%)
	Inadequate visualization of the airway	7 (13%)
	Difficulty in catheter insertion	13 (24%)
Do you have a plan or intention in the future to do LISA at work	No	23 (18%)
	Yes	105 (82%)

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Table 5 reveals no statistically significant associations between demographic and occupational characteristics with knowledge and practice scores among LISA users. However, certain trends are observed. Neonatologists had the highest mean knowledge score (15.54 ± 3.75) and practice score (14.57 ± 3.8), while Pediatric residents had lower scores (13.67 ± 3.84 for knowledge and 12.4 ± 2.89 for practice). Participants with 11-15 years of experience demonstrated the highest knowledge (16.43 ± 3.15) and practice (15.86 ± 4.1) scores. Although gender did not show significant differences (p = 0.49 for knowledge, p = 0.53 for practice), institutional affiliation and location appear to influence LISA knowledge and practice. For example, neonatologists had on average 1.9 points higher knowledge scores compared to residents (95% CI: 0.3 to 4.1), although this did not reach statistical significance. Similarly, those with 11–15 years of experience scored 2.8 points higher in practice compared to the <5-year group (95% CI: 0.4 to 6.0), suggesting a possible trend with increasing experience.

Table (5): Association between demographic and occupational characteristics with knowledge and practice score among LISA users.

Variable	Parameter	Knowledge score	Practice score
Gender	Male	14.79 ± 3.74	13.71 ± 4.22
	Female	14.15 ± 3.96	14.31 ± 3.34
p-value		**0.49**	**0.53**
Profession	Neonatologist	15.54 ± 3.75	14.57 ± 3.8
	Pediatric Resident	13.67 ± 3.84	12.4 ± 2.89
	General Pediatrician	14.34 ± 3.76	14.19 ± 4.31
	Other subspeciality	10 ± 0.00	16 ± 0.00
p-value		**0.25**	**0.39**
Years of experience	<5 years	14.15 ± 3.81	14.35 ± 3.89
	5-10 yrs	13.67 ± 4.67	12.4 ± 4.2
	11-15 yrs	16.43 ± 3.15	15.86 ± 4.1
	16-20 yrs	14.91 ± 3.56	14.09 ± 3.01
	>20 yrs	15.07 ± 3.34	13.67 ± 4.11
p-value		**0.54**	**0.36**
Current ICU affiliation	Ministry of Health	14.55 ± 4.29	13.03 ± 3.64
	Royal Medical Service	14.65 ± 3.7	13.18 ± 3.9
	University hospital	15.56 ± 3.04	15.67 ± 3.04
	Private hospital	14.05 ± 3.59	15.11 ± 4.39
p-value		**0.82**	**0.13**

The correlation analysis indicates that most demographic and occupational characteristics do not significantly correlate with knowledge and practice scores among LISA users. Profession (r = -0.163, p = 0.164) and years of experience in neonatology/pediatrics (r = 0.123, p = 0.297) had no significant correlation with knowledge or practice scores. Gender also did not demonstrate a meaningful correlation with either knowledge (r = -0.081, p = 0.495) or practice (r = 0.073, p = 0.534) scores.

However, NICU affiliation significantly correlated with practice scores (r = 0.246, p = 0.034; 95% CI 0.02–0.45), suggesting that the institutional setting may influence LISA practice. Importantly, knowledge score was significantly correlated with practice score (r = 0.320, p = 0.005; 95% CI 0.11–0.52), indicating that higher knowledge levels are associated with better LISA practice (Table 6).

Table (6): Correlation between demographic and occupational characteristics with knowledge and practice score among LISA users.

Variable	Parameter	Knowledge score	Practice score
Profession	r-value	-0.163	0.002
	p-value	0.164	0.983
Years of experience in neonatology/pediatrics	r-value	0.123	-0.011
	p-value	0.297	0.924
Current NICU affiliation(s)	r-value	-0.030	0.246*
	p-value	0.800	0.034
Gender	r-value	-0.081	0.073
	p-value	0.495	0.534
Knowledge score	r-value		0.320**
	p-value		0.005

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

DISCUSSION

Premature infants with respiratory distress highlight the fragility of life. Neonatal RDS, caused by surfactant deficiency, remains a major challenge in neonatal care [25]. RDS affects not only immediate survival; RDS often carries long-term complications [26]. Several techniques for surfactant administration have been developed, including INSURE, LISA, MIST, and SALSA. Among these, the LISA has shown promising benefits, particularly in reducing dependence on mechanical ventilation and minimizing complications [27]. LISA represents a less invasive alternative with the potential for improved outcomes. A recent meta-analysis reported better results with LISA for the combined outcomes of death and BPD at 36 weeks [28].

This is the first study in Jordan to assess the knowledge, attitudes, and practices of LISA among NICU staff. It also examines barriers to LISA adoption and explores practical solutions. Of the 400 invited participants, 202 responded (50.5%), including neonatologists, pediatricians, and pediatric residents from all major health sectors. Most responses were

from the Ministry of Health (48%), followed by the Royal Medical Services, private hospitals, and university hospitals. Most participants had 1–10 years of experience, reflecting a strong representation of pediatric residents and young specialists.

Compared with the study in Turkey, among the 87 respondents, 38 (43.7 %) were from university hospitals, followed by 23 (26.4%) from training and research hospitals, 15 (17%) from public hospitals, and 11 (12.6%) from private hospitals [22]. In another UK study, the response rate was 100%from 191 neonatal units [29].

The survey showed that 69.8% of respondents know LISA, indicating good knowledge but with gaps.

About one-third reported insufficient knowledge, highlighting the need for comprehensive training. Most respondents learned about LISA through formal education, scientific literature, or online resources, underscoring the value of accessible, evidence-based materials. In India, 20 (37.7%) LISA users learned through in-house seminars, while 21 (39.6%) gained knowledge via online videos [21]. In a German study, 117 (96%) of 122 (74%) NICUs reported experience with LISA, and 82% identified it as their preferred method of surfactant administration [30].

About half of the participants considered current evidence sufficient to recommend LISA as standard care. Many recognized LISA's advantages, such as reduced intubation and ventilation, fewer airway complications, lower BPD risk, and improved comfort. However, they also noted complications, particularly laryngospasm (34%) and surfactant reflux (37%), reflecting a balanced understanding of risks and benefits. These findings align with previous literature showing LISA associated with lower BPD and mortality rates in recent years [13, 31].

Despite moderate knowledge, only 36.6% had performed LISA, and just 10% reported regular use in their NICUs. Adoption rates were lower than in Spain (89%) [32], Turkey (81%) [22], and India (68%) [21], but closer to those in the United States (15%) [20] and Nordic countries (32%) [19]. Major barriers included insufficient training and a lack of local guidelines, reflecting systemic challenges in Jordanian NICUs.

In this study, the main indications for LISA were prophylactic treatment in extremely preterm infants and failure of non-invasive respiratory support. According to German research, NICUs' guidelines for administering surfactants varied greatly. Most NICUs (89%) used FiO2 thresholds alone or with other criteria, such as lung ultrasonography (3%), Silverman score/signs of dyspnea (41%), or both [30].

Practitioners who had performed LISA often used it prophylactically for extremely preterm infants, with 95% willing to use it again if necessary. Most did not use premedication, in contrast to Nordic countries, where it is routine in 78% of cases [31]. In a European survey, 52% of neonatologists reported not using premedication for LISA [34]. Furthermore, a German study revealed variations in the practice of LISA in highly immature children (e.g., 36% failed to conduct LISA in neonates under 24–26 weeks) [30]. Addressing these discrepancies could further align local practices with international standards.

Barriers to LISA adoption in Jordan included a lack of staff expertise, difficulty with catheter insertion, and time constraints. Additionally, the absence of specific institutional guidelines exacerbates these challenges. Similar barriers were reported in Nordic countries, including a lack of familiarity and perceived limited benefits [33]. In Jordan, INSURE remains the preferred surfactant administration method, likely due to its established use and relative simplicity [34]. A UK survey reported that LISA was not performed due to lack of training (51%) or absence of standardized guidelines (49%), findings consistent with our study [29], which agreed with the current study. Many practitioners expressed willingness to adopt LISA if training and guidelines were available.

Significant disparities in LISA knowledge and practice were observed among different specialties. Neonatologists had the highest knowledge (15.54 ± 3.75) and practice rates (14.57 ± 3.8), followed by general pediatricians (14.34 ± 3.76 and 14.19 ± 4.31, respectively). Pediatric residents had the lowest levels of knowledge (13.67 ± 3.84) and practice (12.4 ± 2.89) scores, highlighting the need for targeted training and mentorship. Experienced neonatologists and pediatricians can play a key role in guiding residents through training and knowledge transfer. Training specialist teams and following locally approved guidelines can support successful LISA implementation [35]. A Scottish study found that staff trained in endotracheal intubation adapted quickly to LISA, as the procedures are similar [36].

In Jordan, limited LISA use mirrors regional trends, highlighting the need for structured training and national guidelines to improve neonatal outcomes. Our findings of variable knowledge and limited LISA adoption among Jordanian NICU providers are consistent with reports from other Middle Eastern countries. A Turkish national survey reported wide variability in LISA practices and gaps in training and sedation protocols. Similarly, an Iranian study demonstrated the feasibility and benefits of LISA/MIST compared with INSURE, with lower intubation rates and reduced need for mechanical ventilation, though practice rates were not assessed [35].

Strengths

This study has several strengths. It was the first in Jordan to assess the knowledge, attitudes, and practices of LISA among NICU staff. The inclusion of varied expertise and healthcare settings helped validate the questionnaire, enhancing survey reliability and consistency. The study also provided insight into the indications, benefits, complications, and adverse effects of LISA, which may improve neonatal care. Finally, the study examined the relationship between knowledge and practice scores, highlighting the gap between theoretical knowledge and clinical practice.

Limitations

This study has some limitations. First, the 50.5% response rate may limit the representativeness of findings across all NICU staff in Jordan. The study focused on providers' knowledge and practice but did not directly examine patient outcomes. Multiple factors influence rates of BPD, invasive ventilation, and mortality among preterm infants in Jordanian NICUs. Therefore, it does not provide strong evidence regarding NICU outcomes. Linking provider practices, such as LISA use, to these outcomes should be prioritized in future research. Institutional protocols for LISA may vary across settings, potentially influencing responses. Finally, the observational design limited the ability to assess changes in knowledge and practice over time.

Conclusion

This study shows moderate knowledge of LISA among Jordanian NICU staff, but practice remains limited due to systemic barriers. Addressing these challenges through standardized guidelines and comprehensive training programs could enhance LISA adoption and improve neonatal outcomes.

Recommendations and Future Directions

The findings highlight the urgent need for targeted initiatives to promote LISA in Jordanian NICUs. Key recommendations include:

- Developing National Guidelines: Establish standardized, evidence-based protocols for LISA and other surfactant techniques tailored to the Jordanian healthcare context.
- Enhancing Training Programs: Provide workshops, simulation-based training, and continuous education to strengthen staff competency and confidence in LISA.
- Wider LISA adoption in Jordan could improve neonatal outcomes by reducing mechanical ventilation, BPD, and mortality among preterm infants. Addressing the knowledge and training gaps identified in this study is a clinical priority.
- Pilot Implementation: Launch pilot programs in select NICUs, monitor outcomes, and expand based on results.
- Regular Monitoring: Conduct periodic surveys and audits to monitor LISA adoption and effectiveness.
- Future research should evaluate the clinical impact of widespread LISA implementation and identify strategies for sustainable integration into routine care through multicenter trials assessing outcomes such as BPD, duration of respiratory support, and survival.

Disclosure Statements

- **Ethics approval and consent to participate:** The local ethics committee of Hashemite University approved the study (IRB# 9/1/2023/2024). All participants provided written informed consent before participation, and all study procedures adhered to ethical standards for research involving human participants. The study complied with the Declaration of Helsinki.
- **Consent for publication:** Not applicable
- **Availability of data and materials:** The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. Any materials used in the study can also be provided upon reasonable request to the corresponding author. The raw data required to reproduce these findings are available in the body and illustrations of this manuscript.
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